Policy Development for Sustainable Transformations. The Analysis of Systemic Feedback Loops in the Case of the Water Supply in Central Northern Namibia.

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International Conference on Fresh Water Governance for Sustainable Development
November 5th, 2012, Drakensberg, South Africa

Overview

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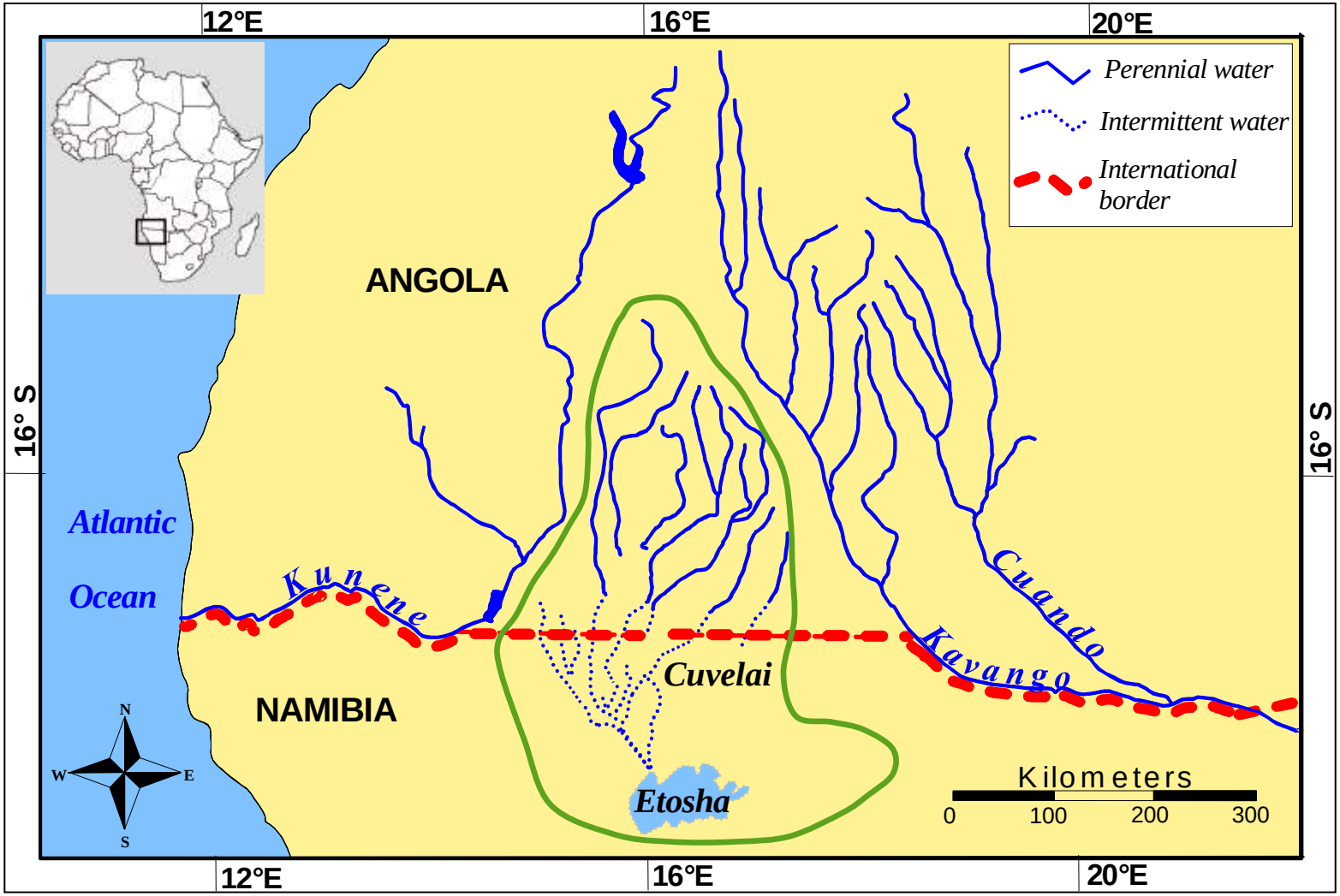
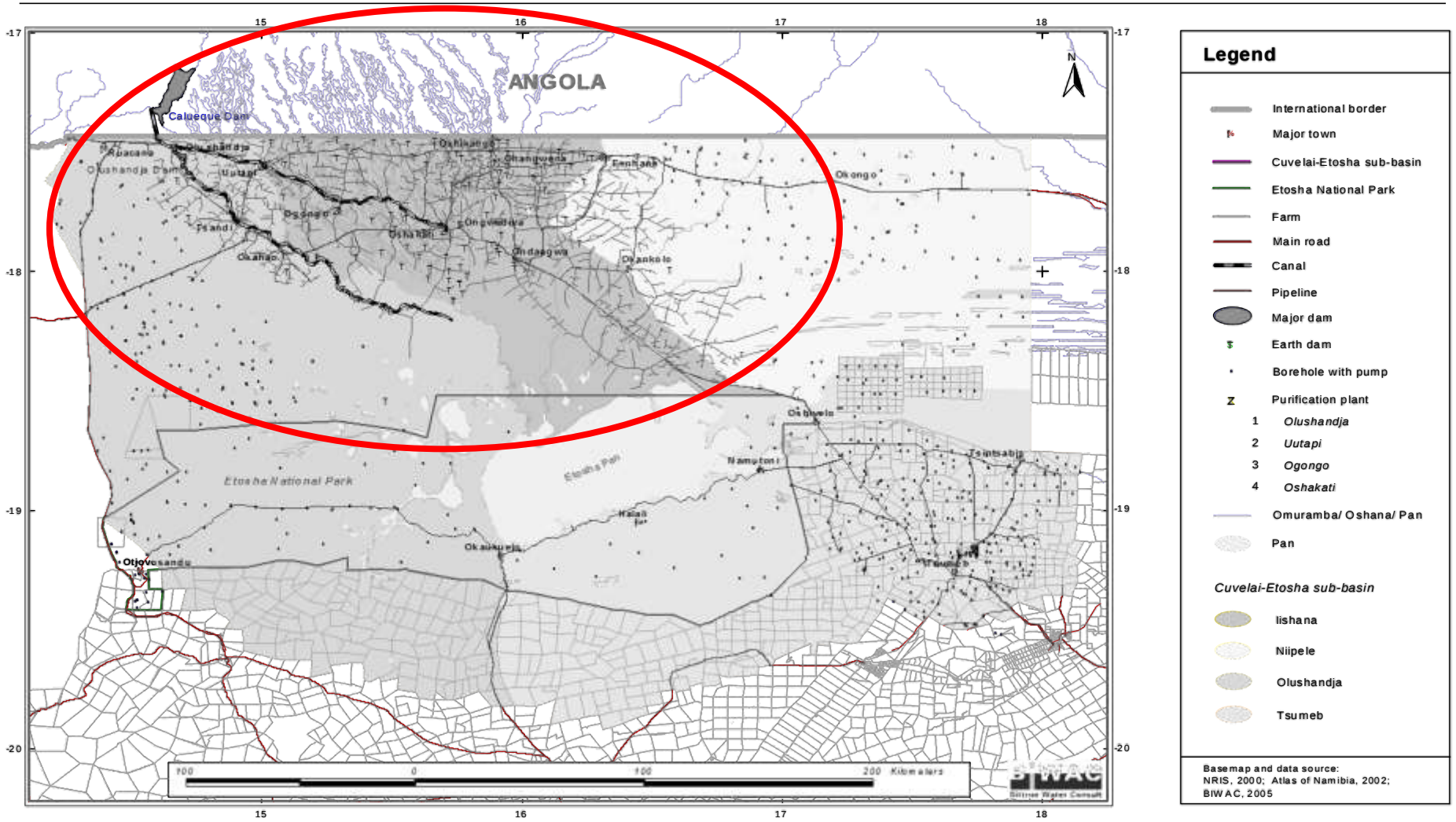
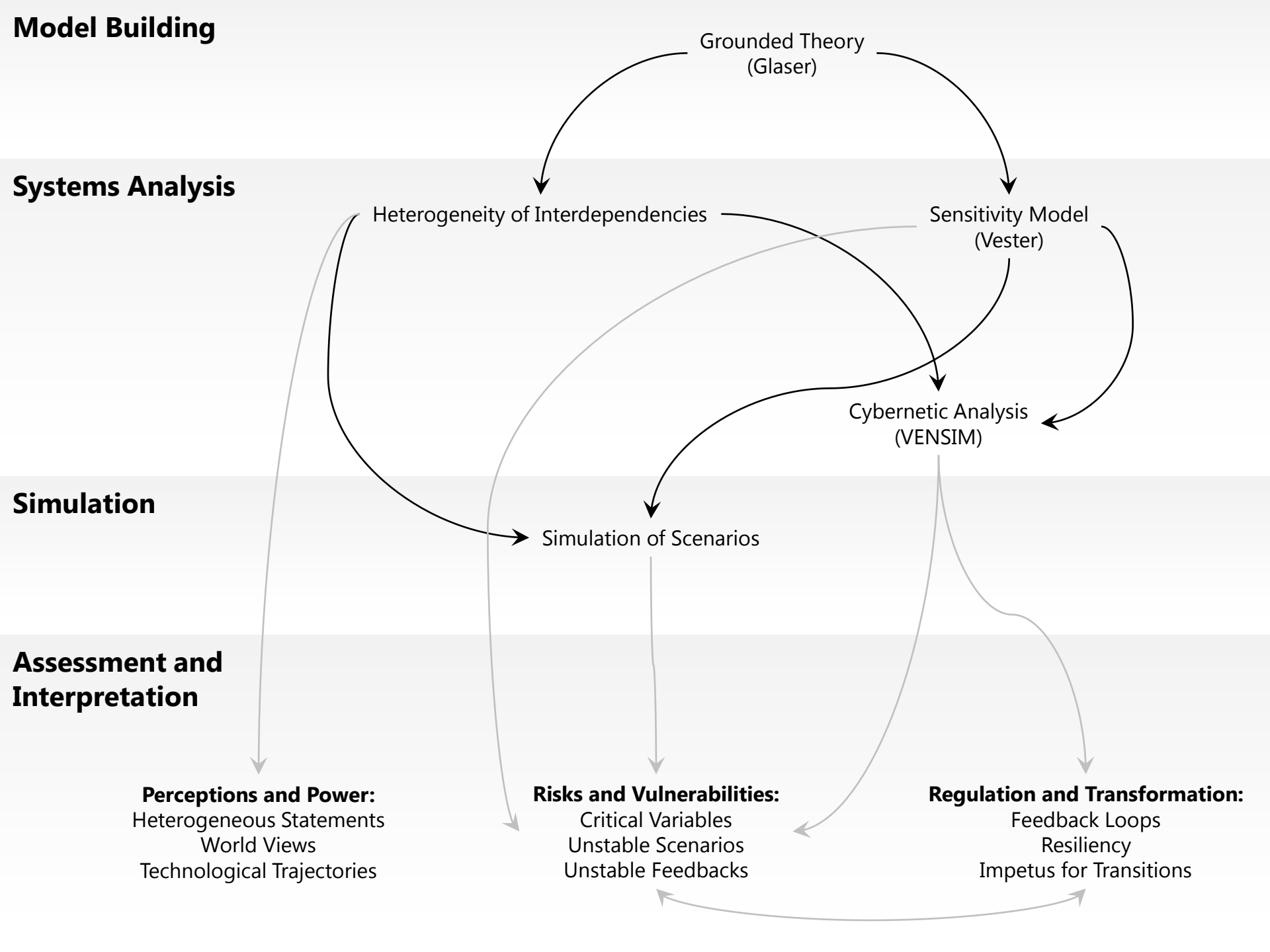
- The Cuvelai catchment area
- Modelling approach
  - Grounded Theory
  - Sensitivity Model
  - Systemic heterogeneity
  - Cybernetic analysis
  - Simulation of scenarios
- Conclusions

The Cuvelai Catchment Area



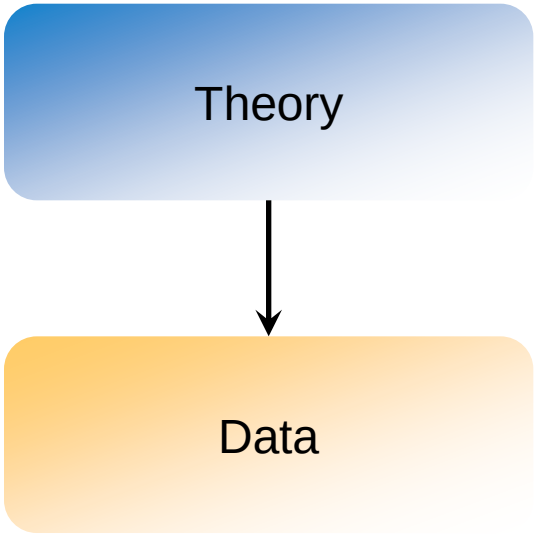
Regional Water Supply Infrastructure



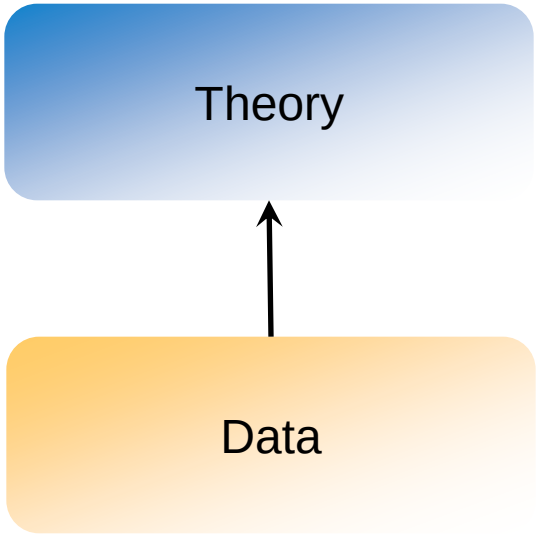

Model Building
Grounded Theory
(Glaser)
Systems Analysis
Heterogeneity of Interdependencies
Sensitivity Model
(Vester)
Cybernetic Analysis
(VENSIM)
Simulation
Simulation of Scenarios
Assessment and
Interpretation
Perceptions and Power:
Heterogeneous Statements
World Views
Technological Trajectories
Risks and Vulnerabilities:
Critical Variables
Unstable Scenarios
Unstable Feedbacks
Regulation and Transformation:
Feedback Loops
Resiliency
Impetus for Transitions

Approaches of Scientific Theory

- Deduction (QDA)



- Induction (GT)



- Preconceived hypotheses
- Forcing/imposing of theory
- Top-down approach
- Opposite of participation
- Problem perceptions cannot be grasped

Grounded Theory (GT)

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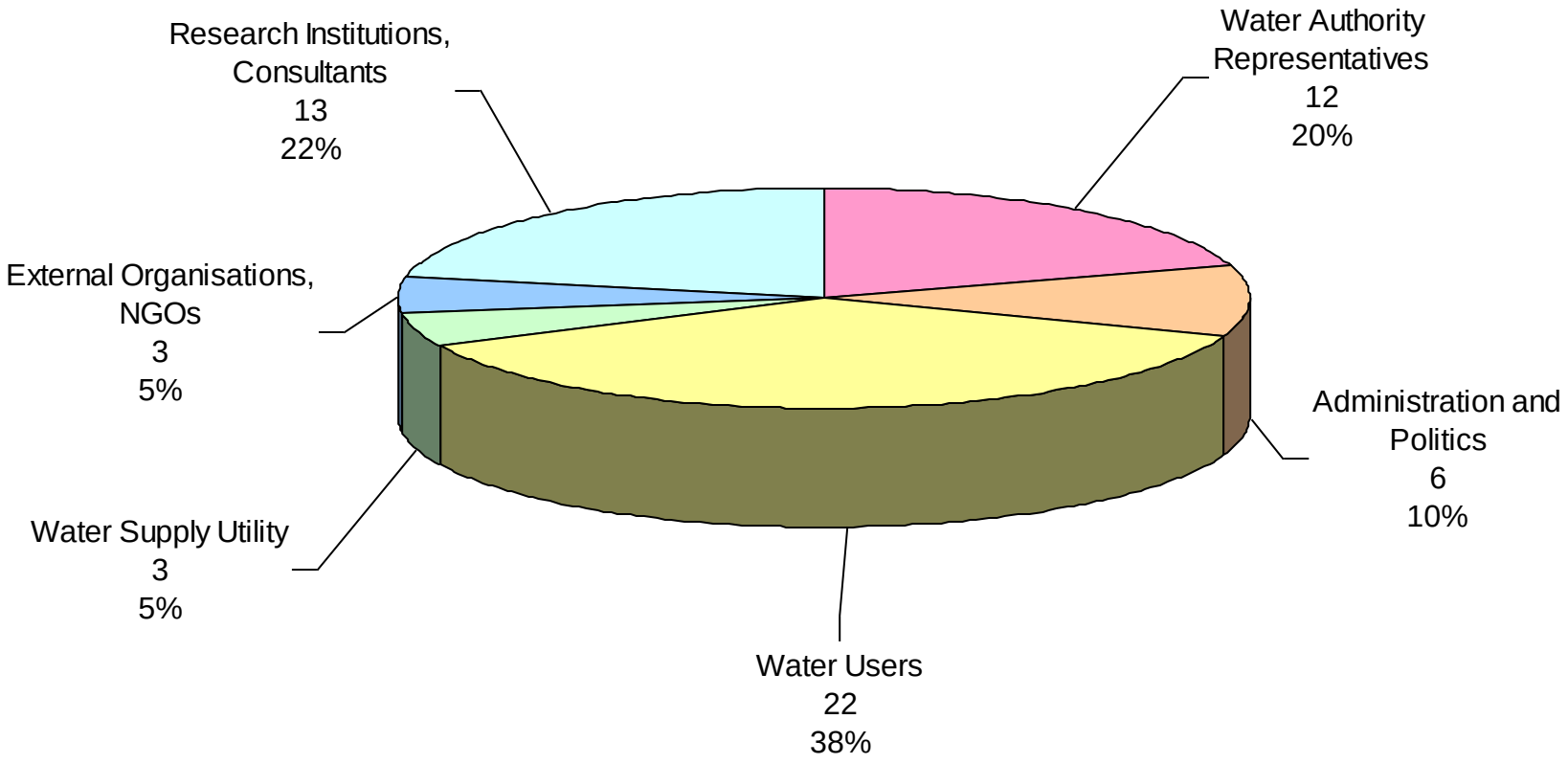
- Developed by the sociologists Barney Glaser and Anselm Strauss in the mid-1960‘s
- Definitions by Glaser:
  - „[…] classic GT is simply a set of integrated **conceptual hypotheses** systematically generated to produce an **inductive theory** about a substantive area.“
  - “The goal of grounded theory is to generate a **conceptual theory** that accounts for a pattern of behavior which is relevant and **problematic for those involved**. The goal is not voluminous description, nor clever verification.“

- GT Procedures
  - Focused interviews
  - Theoretical coding
  - Theoretical saturation
  - Conceptual emergence


B. Glaser, 2005

http://en.wikipedia.org/wiki/File:Glasr75.jpg

Sample Structure



Interview Contents

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- Core topic
  - Provision,
  - Acquisition,
  - Utilisation of water
- Included interdependencies
  - Impacts
  - Effects
  - Requirements
  - Constraints
- Dimensions
  - Technological
  - Ecological
  - Social
  - Economic
  - Political and institutional
- Temporal dimension
  - Past (path dependencies),
  - Assumed future developments
- Spatial dimension
  - Urban,
  - Rural structural classes
- Stakeholder analysis
  - Perceptions
  - Attitudes
  - Power
  - Options for action
  - Vulnerability

Identification of System Variables

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1. Large-scale water supply
2. Technical problems with the large-scale water supply system
3. Oshanas and excavation dams (Omatale)
4. Shallow dug wells (Omuthima)
5. Dug wells (Oshikweyo)
6. Rainwater harvesting
7. Sanitation
8. Other water supply techniques

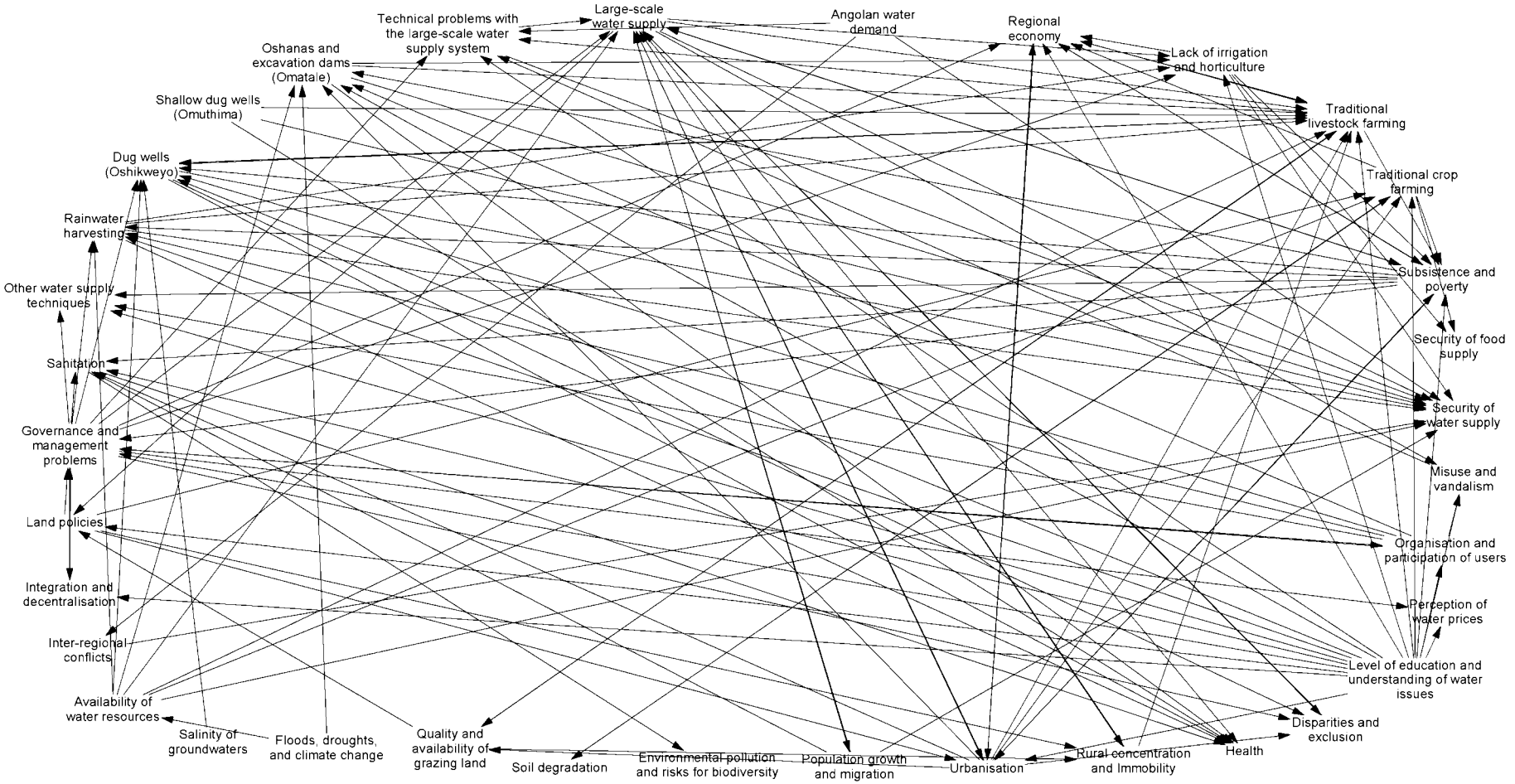
9. Governance and management problems
10. Water supply and sanitation policies
11. Land policies
12. Integration and decentralisation
13. Inter-regional conflicts
14. Attitudes and distribution of power

15. Availability of water resources
16. Salinity of groundwaters
17. Floods, droughts, and climate change
18. Quality and availability of grazing land
19. Soil Degradation
20. Deforestation
21. Environmental pollution and risks for biodiversity

22. Population growth and migration
23. Urbanisation
24. Rural concentration and immobility
25. Health
26. Disparities and exclusion
27. Level of education and understanding of water issues
28. Perception of water prices
29. Organisation and participation of users
30. Misuse and vandalism
31. Security of water supply
32. Security of food supply

33. Subsistence and poverty
34. Traditional crop farming
35. Traditional livestock farming
36. Lack of irrigation and horticulture
37. Regional economic state
38. Angolan water demand

Visualization of Interdependencies



Evaluation of Interdependencies Using the Cross-Impact-Matrix (Vester)

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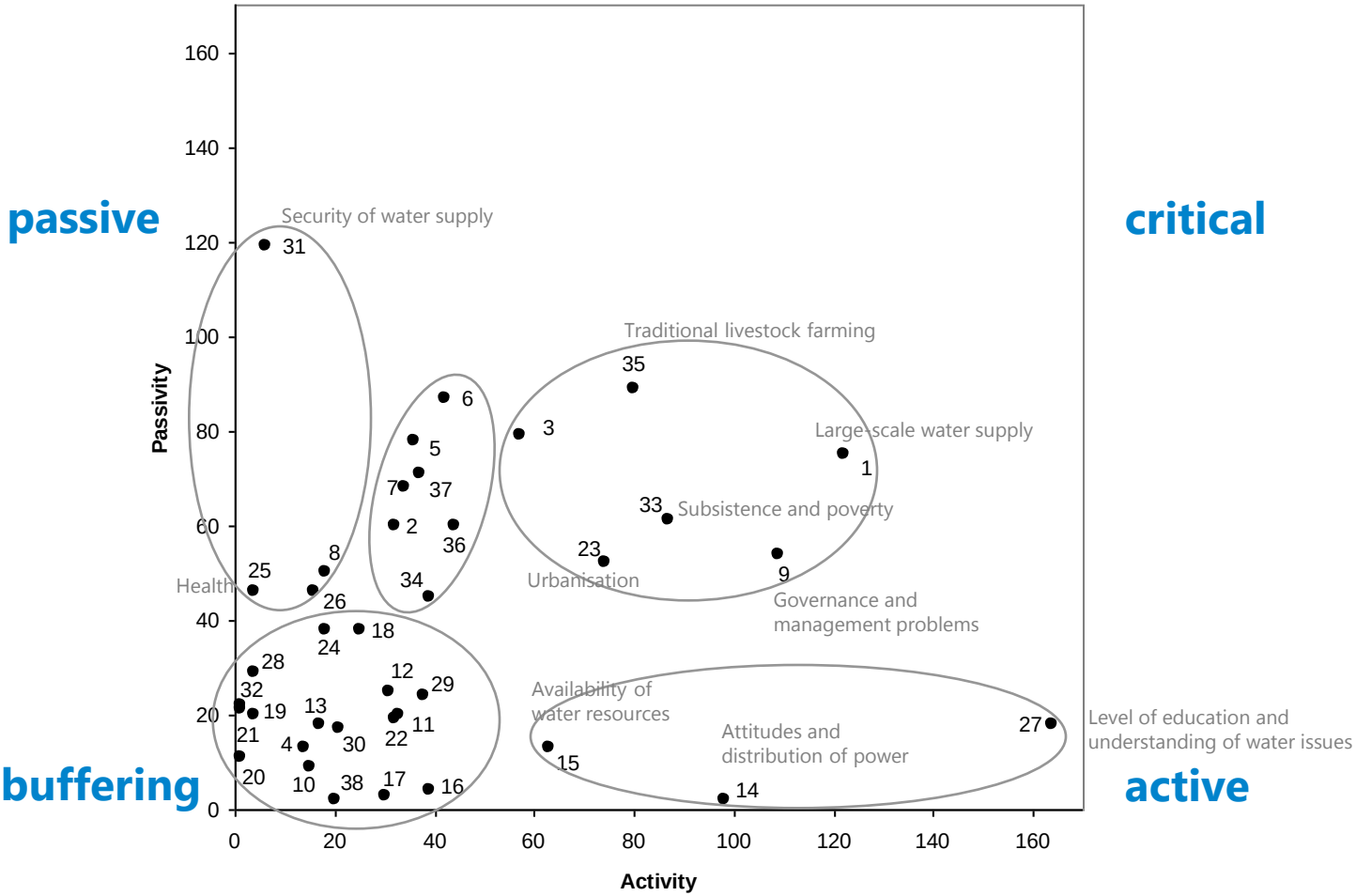
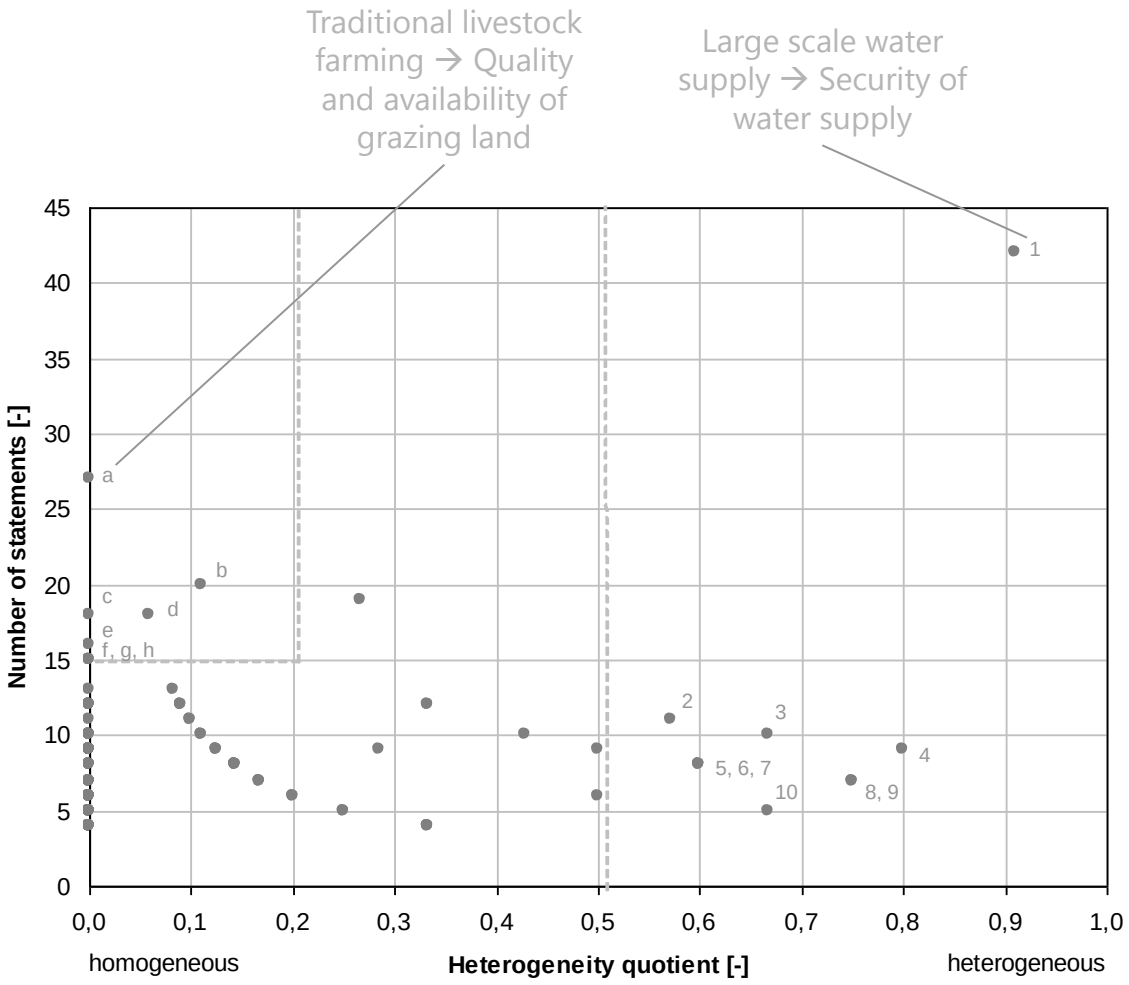
	Large-scale water supply	Technical problems with the large-scale wa	Oshanas and excavation dams (Ometale)	Shallow dug wells (Omuthima)	Dug wells (Oshikweyo)	Rainwater harvesting	Sanitation	Other water supply techniques	Governance and management problems	Water supply and sanitation policies	Land policies	Integration and decentralisation	Inter-regional conflicts	Attitudes and distribution of power	Availability of water resources	Salinity of groundwaters	Floods, droughts, and climate change	Quality and availability of grazing land	Soil degradation	Deforestation	Environmental pollution and risks for biodiv	Population growth and migration	Urbanisation	Rural concentration and immobility	Health	Disparities and exclusion	Level of education and understanding of w	Perception of water prices	Organisation and participation of users	Misuse and vandalism	Security of water supply	Security of food supply	Subsistence and poverty	Traditional crop farming	Traditional livestock farming	Lack of irrigation and horticulture	Regional economic state	Angolan water demand	Activity	Passivity	Q-value	P-value
1 Large-scale water supply			3	2	1	2	1	1	2			1	1								1	6	9	13	6	8	1	3	2	4	27	1	4		7	13	2	1	122	75	1,63	9150
2 Technical problems with the large-scale	6		1		3	2		1	2																	1				15	1							32	60	0,53	1920
3 Oshanas and excavation dams (Ometale)				2				1									1	2	1	3				11	2					12		2	1	12	6	1		57	79	0,72	4583
4 Shallow dug wells (Omuthima)																								4	1					4				4		1		14	13	1,08	182
5 Dug wells (Oshikweyo)		2							2						1					1			2	5	5				1	6		2		9			36	78	0,46	2888
6 Rainwater harvesting					1				2									2	2		1			4	2	1				7		3		5	12			42	87	0,48	3654
7 Sanitation									3	1					1					7		2		12	3					3						2		34	68	0,50	2312
8 Other water supply techniques		2											2							2			1		2					3		2			3		1	18	50	0,36	900
9 Governance and management problems	8	15	3		5	7	14	5		3	2	5										2		1	6	3	6	4		3		2	2	1	4	8		109	54	2,02	5886
10 Water supply and sanitation policies	1		2		1	2	1	1				3	1															1		2								15	9	1,67	135
11 Land policies									1	2	1						1	1			3	8	7										4	3	2			33	20	1,65	660
12 Integration and decentralisation	1	1	2		2	2	2	2	7	2	3														1	3		1		2								31	25	1,24	775
13 Inter-regional conflicts	2		2		2	2		3				1																		4						1		17	18	0,94	306
14 Attitudes and distribution of power	9		11		9	20	17	8	2			5			1		2				1	8			2	2						1						98	2	49,00	196
15 Availability of water resources	5	2	7	4	7	8		3					1				1	1	1		1			2		2				6			7	4	1			63	13	4,85	819
16 Salinity of groundwaters	3	1	4	2	12	2		3	1																									1	1			30	3	10,00	90
17 Floods, droughts, and climate change			8		1	1	2	1							9	1		3	3	2	1		1							1	2		2			1		39	4	9,75	156
18 Quality and availability of grazing land											5	1												5										14				25	38	0,66	950
19 Soil degradation																																	4					4	20	0,20	80
20 Deforestation																	1																					1	11	0,09	11
21 Environmental pollution and risks for																								1														1	21	0,05	21
22 Population growth and migration	8	2					4		1						1					1			3				1			4	3			1		3		32	19	1,68	608
23 Urbanisation	7	2	5		3	1	5	1	2		1						5			1	2		2	1	6	2				1		4	8	8	2	5		74	52	1,42	3848
24 Rural concentration and immobility	8	2				1			1				1							1														4				18	38	0,47	684
25 Health																					2					1										1		4	46	0,09	184
26 Disparities and exclusion	5				1	1			1																	1	3			2				1	1			16	46	0,35	736
27 Level of education and understanding of		7	11	2	8	11	10	8	14		4	7		2						1			5	1		1		8	16	4	1		5	10	5	11	12		164	18	9,11	2952
28 Perception of water prices			1																											2					1			4	29	0,14	116
29 Organisation and participation of users	3	3	5		5	5	1	5	4			1															2			4								38	24	1,58	912
30 Misuse and vandalism		7				1	2		2																2		2				2				1	2			21	17	1,24	357
31 Security of water supply			1	1		2																			1							1							6	119	0,05	714
32 Security of food supply																																1							1	22	0,05	22
33 Subsistence and poverty	4		10		9	14	9	5	7											1		1	4		1	2		3			2			3	2	1	9		97	61	1,43	5307
34 Traditional crop farming		2								1	2							1	9				1									7	8			2	6		39	45	0,87	1755
35 Traditional livestock farming	2	5	1		7	1		1			2		3					25	2			2		3			3	1		1	2	2	9				8		80	89	0,90	7120
36 Lack of irrigation and horticulture		3	1		1	2		1							2			1						1						1	4	4	11		1		11		44	60	0,73	2640
37 Regional economic state			1									1	1							1	3	3	9	1							1	2	6	2	6				37	71	0,52	2627
38 Angolan water demand	3	4											8																		5							20	2	10,00	40
Passivity	75	60	79	13	78	87	68	50	54	9	20	25	18	2	13	3	4	38	20	11	21	19	52	38	46	46	18	29	24	17	119	22	61	45	89	60	71	2				

Activity-Passivity-Diagram



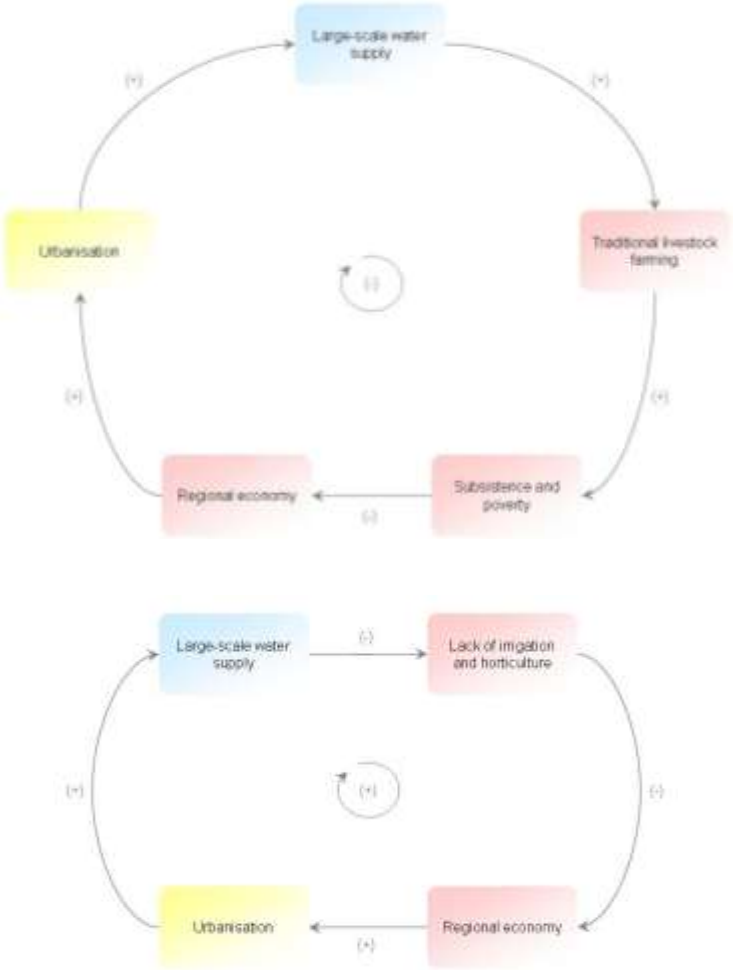
Heterogeneity of Systemic Interdependencies

- Interview statements diverse due to different perceptions, world views or intentions
- Assessment of interdependencies using heterogeneity indicator
- Identification of exeptionally heterogenous/homogenous interdependencies



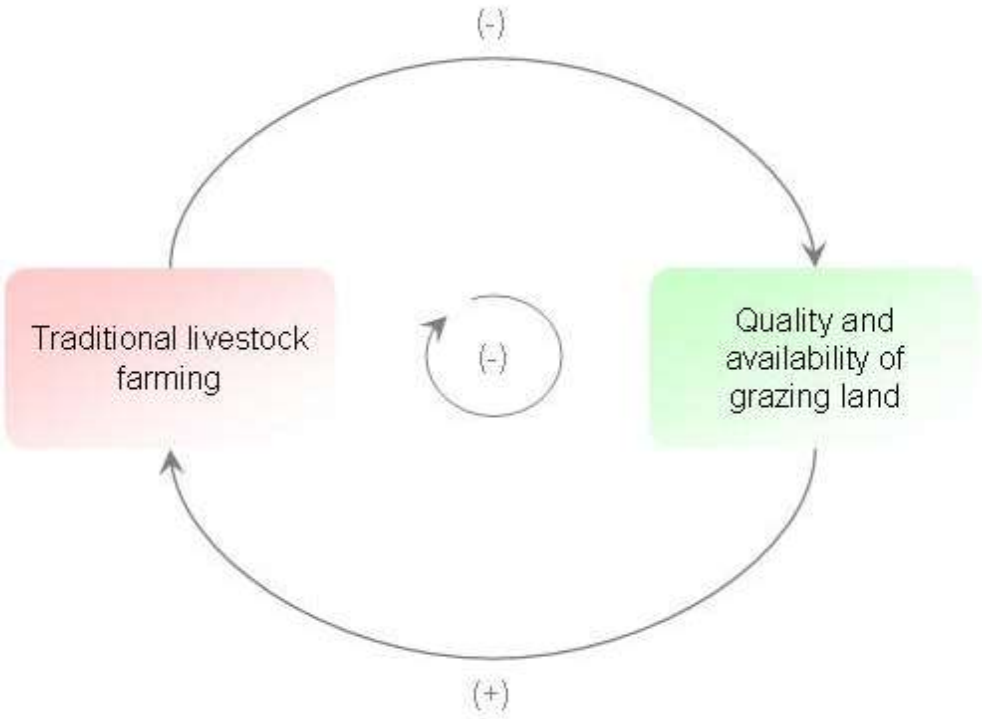
Systemic Feedback Loops

- Analysis and assessment of systemic feedback loops (with VENSIM)
  - Identification of positive and negative feedback loops
  - Identification of balancing feedbacks for closed loop control
  - Identification of self-reinforcing or unstable feedback loops
- After data reduction, 98 feedback loops identified (70 positive, 28 negative)
- Variable “Large-scale water supply” involved in 40 positive and 21 negative feedback loops



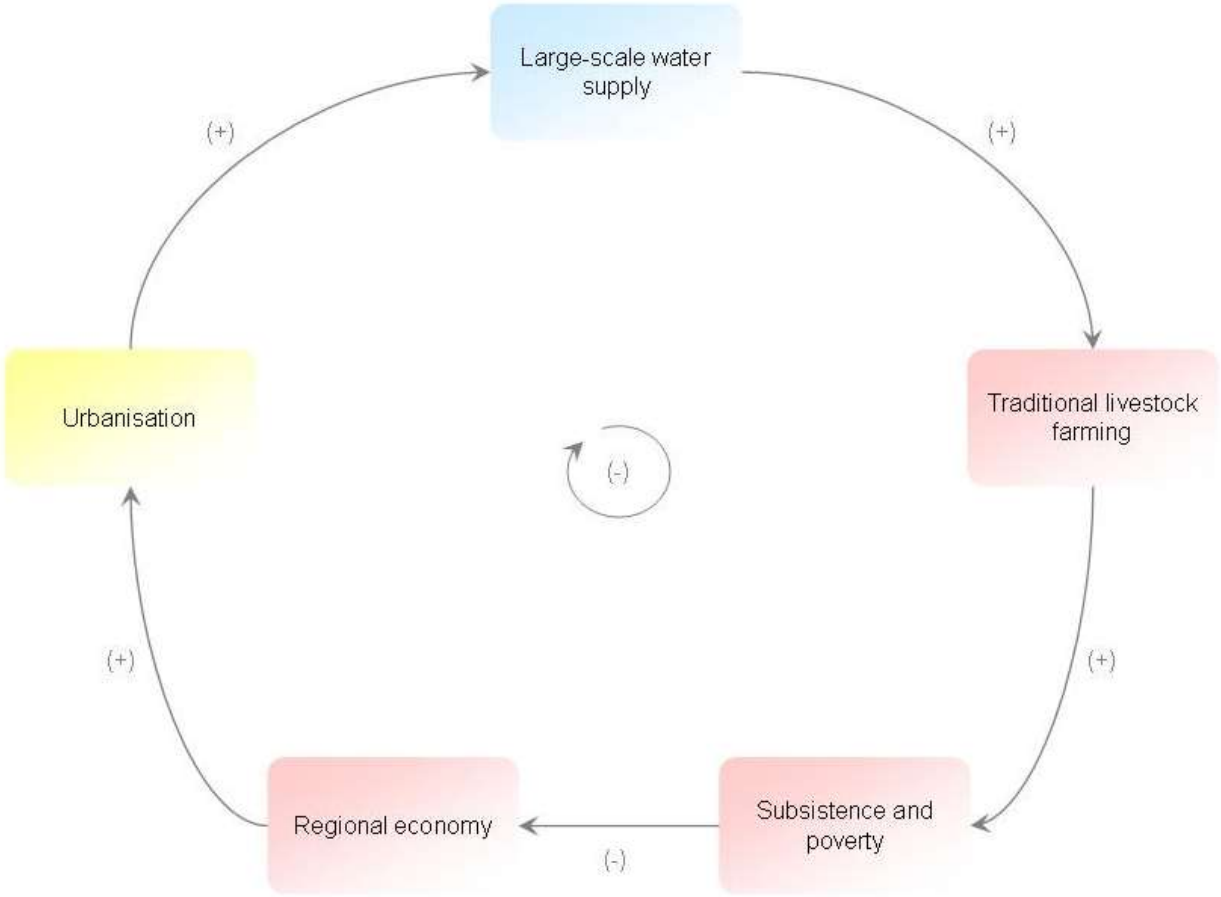
Examples of Feedback Loops (1)

- Systemic resiliency through balancing feedbacks



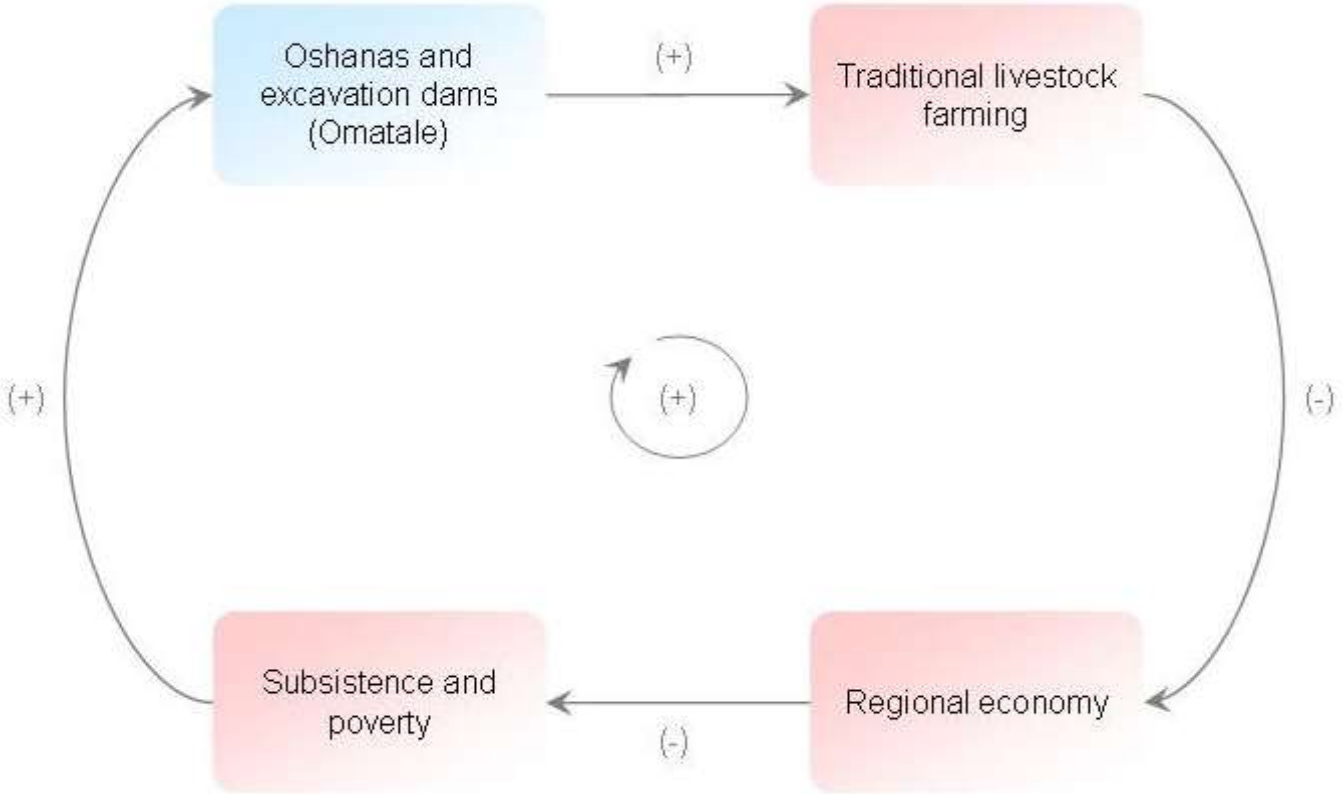
Examples of Feedback Loops (2)

- Balancing feedbacks for closed loop control



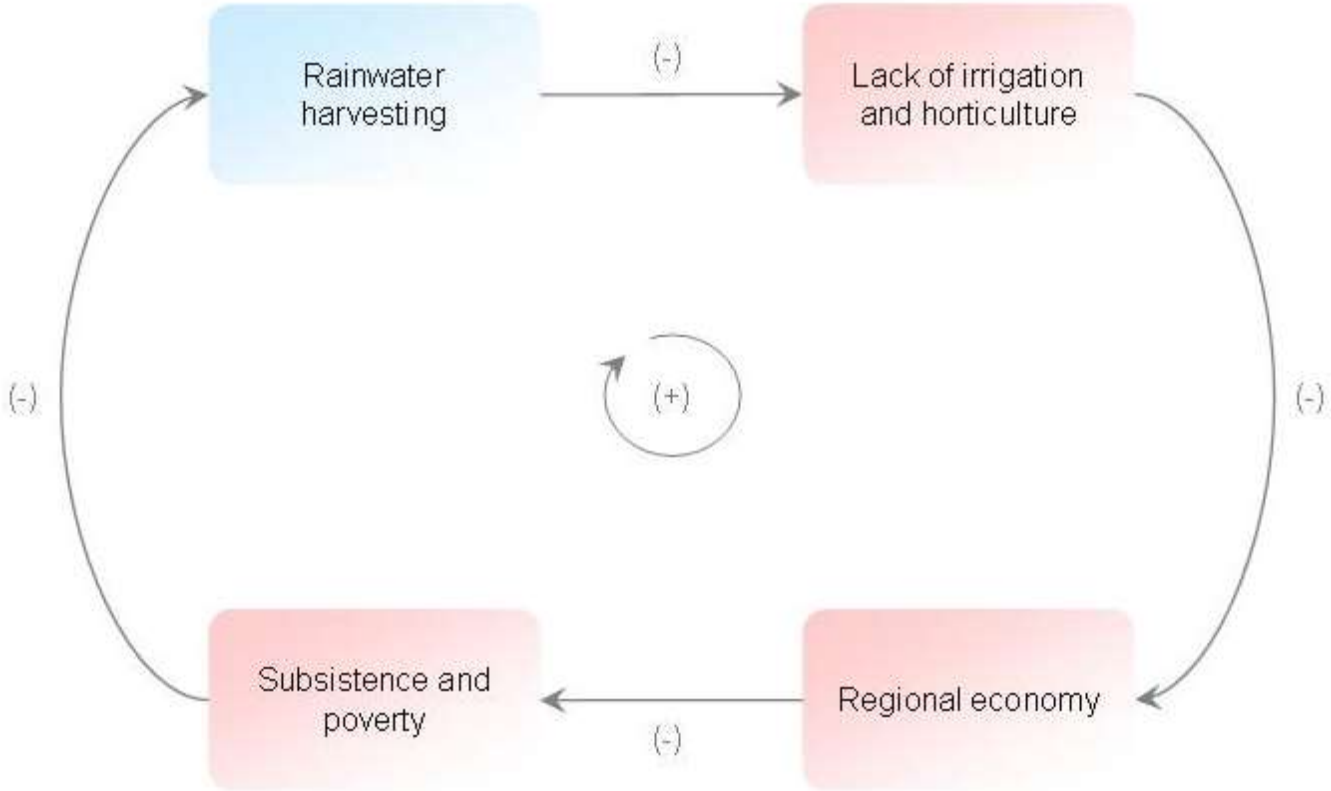
Examples of Feedback Loops (3)

- Self-reinforcing feedbacks as vicious circles



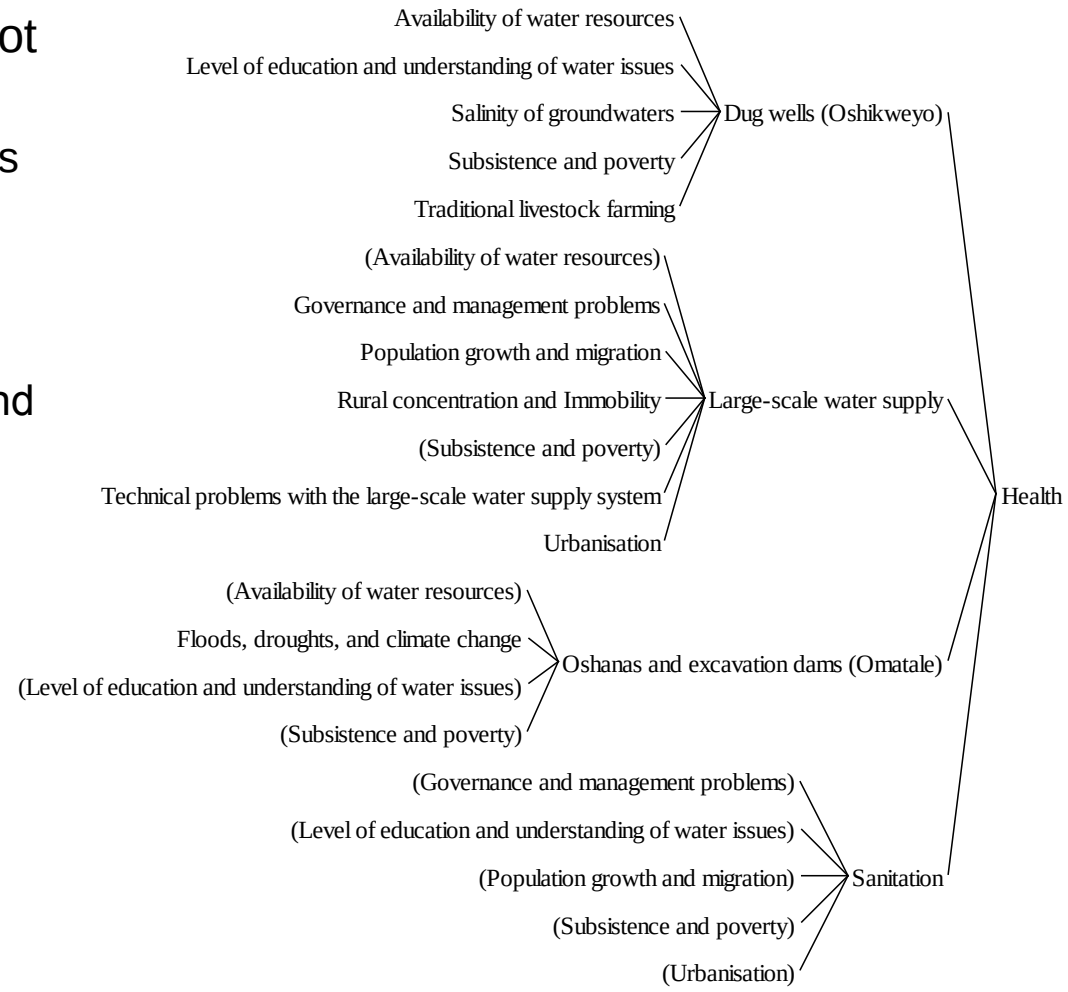
Examples of Feedback Loops (4)

- Impetus for systemic transitions using self-reinforcing feedbacks



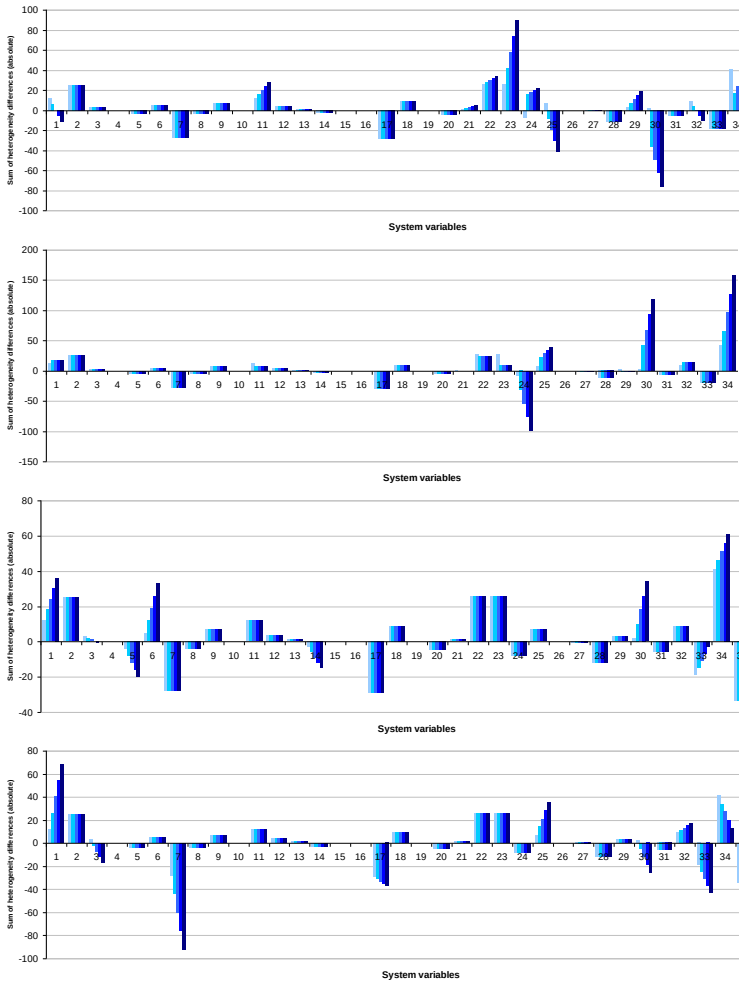
Cause-Effect-Chains

- Open loop control of variables not involved in feedback loops
  - Effects trees of systemic sources
  - Causes trees of systemic sinks
- Example „Health“
  - Most outstanding negatively related cause is “Subsistence and poverty”
  - Most outstanding positively related cause is “Level of education and understanding of water issues”
  - Remarkable since four direct causes of health are technical water-related variables



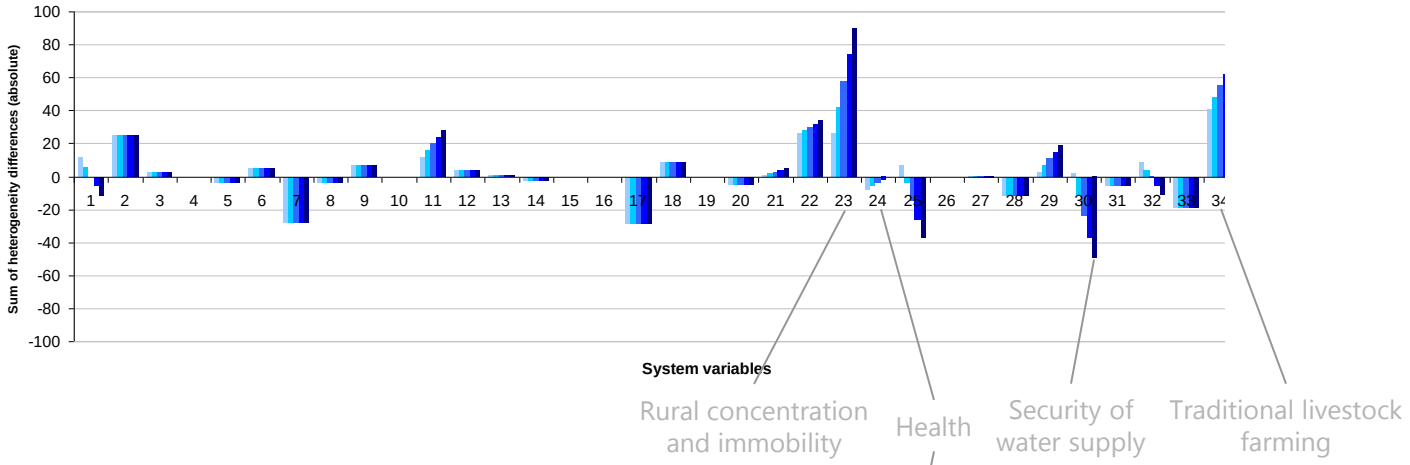
Simulation of Water Supply Scenarios

- Variables of the technical dimension
  - Large-scale water supply
  - Alternative water supply techniques (traditional, decentralised)
  - Hybrid water supply regimes
- Other key variables / driving forces
  - Social (e.g. population growth, urbanisation)
  - Ecological (e.g. climate change)
  - Economical
- Identification of stable and unstable variables and/or scenarios

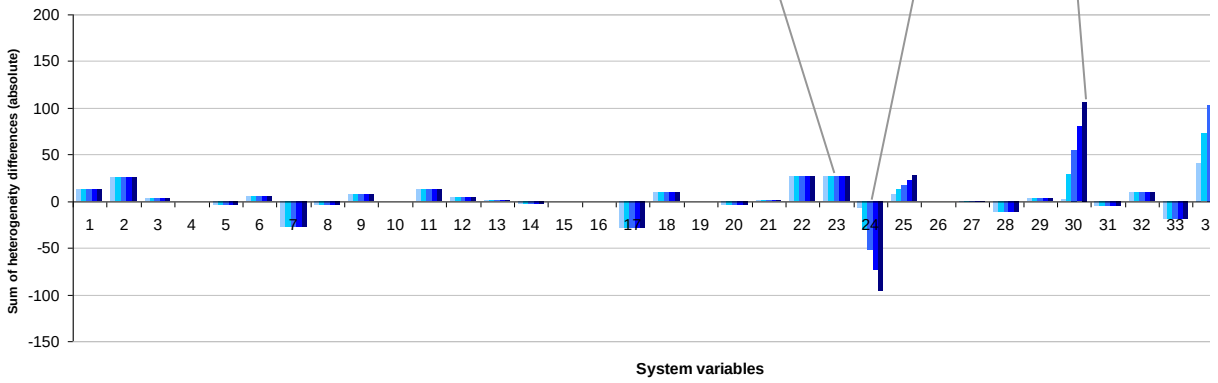


Simulation of Water Supply Scenarios

- W1: Expansion of the large-scale water supply system



- W2: Expansion of alternative water supply techniques



Conclusions

- Perceptions and power
  - Differing problem perceptions
  - Correlation between certain world views and stakeholder groups
  - Power structures which enable or prevent systemic transitions
- Risks and vulnerabilities
  - Critical system variables
  - Unstable feedback loops
  - Critical scenarios
- Regulation and Transformation
  - Closed loop control of negative feedback loops
  - Open loop control using cause-effect-chains
  - Systemic resiliency or inertia due to balancing feedbacks (“vicious circles”)
  - Impetus for transitions using self-reinforcing feedbacks

→ Policy development for sustainable transitions of socio-technical regimes

Thank you for your attention

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CUVEwaters integrated water resources management

ISOE

Indicators

- If we describe the cross impact matrix as

$$\begin{pmatrix} a_{11} & \cdots & a_{1j} & \cdots & a_{1n} \\ \vdots & \ddots & & & \\ a_{i1} & & a_{ij} & & \vdots \\ \vdots & & & \ddots & \\ a_{n1} & & \cdots & & a_{nn} \end{pmatrix}$$

- Where:
  - *a* = number of mentioned interdependencies between two system variables
  - *i* = 1, 2, …, n (rows)
  - *j* = 1, 2, …, n (columns)
  - *n* = number of system variables

- Activity α of a system variable *i*

$$\alpha_i = \sum_{j=1}^{n} a_{ij}$$

- Passivity β of a system variable *j*

$$\beta_j = \sum_{i=1}^{n} a_{ij}$$

- Q-value of a system variable *i*

$$Q_i = \frac{\alpha_i}{\beta_i}$$

- P-value of a system variable *i*

$$P_i = \alpha_i \cdot \beta_i$$

Indicator Rankings

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No.	Name	Activity	Passivity	Q-value	P-value
14	Attitudes and distribution of power	98	2	49,00	196
16	Salinity of groundwaters	30	3	10,00	90
38	Angolan water demand	20	2	10,00	40
17	Floods, droughts, and climate change	39	4	9,75	156
27	Level of education and understanding of wat	164	18	9,11	2952
15	Availability of water resources	63	13	4,85	819
9	Governance and management problems	109	54	2,02	5886
22	Population growth and migration	32	19	1,68	608
10	Water supply and sanitation policies	15	9	1,67	135
11	Land policies	33	20	1,65	660
1	Large-scale water supply	122	75	1,63	9150
29	Organisation and participation of users	38	24	1,58	912
33	Subsistence and poverty	87	61	1,43	5307
23	Urbanisation	74	52	1,42	3848
12	Integration and decentralisation	31	25	1,24	775
30	Misuse and vandalism	21	17	1,24	357
4	Shallow dug wells (Omuthima)	14	13	1,08	182
13	Inter-regional conflicts	17	18	0,94	306
35	Traditional livestock farming	80	89	0,90	7120
34	Traditional crop farming	39	45	0,87	1755
36	Lack of irrigation and horticulture	44	60	0,73	2640
3	Oshanas and excavation dams (Ometale)	57	79	0,72	4503
18	Quality and availability of grazing land	25	38	0,66	950
2	Technical problems with the large-scale wate	32	60	0,53	1920
37	Regional economic state	37	71	0,52	2627
7	Sanitation	34	68	0,50	2312
6	Rainwater harvesting	42	87	0,48	3654
24	Rural concentration and Immobility	18	38	0,47	684
5	Dug wells (Oshikweyo)	36	78	0,46	2808
8	Other water supply techniques	18	50	0,36	900
26	Disparities and exclusion	16	46	0,35	736
19	Soil degradation	4	20	0,20	80
28	Perception of water prices	4	29	0,14	116
20	Deforestation	1	11	0,09	11
25	Health	4	46	0,09	184
31	Security of water supply	6	119	0,05	714
21	Environmental pollution and risks for biodiver	1	21	0,05	21
32	Security of food supply	1	22	0,05	22

No.	Name	Activity	Passivity	Q-value	P-value
1	Large-scale water supply	122	75	1,63	9150
35	Traditional livestock farming	80	89	0,90	7120
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4	Shallow dug wells (Omuthima)	14	13	1,08	182
17	Floods, droughts, and climate change	39	4	9,75	156
10	Water supply and sanitation policies	15	9	1,67	135
28	Perception of water prices	4	29	0,14	116
16	Salinity of groundwaters	30	3	10,00	90
19	Soil degradation	4	20	0,20	80
38	Angolan water demand	20	2	10,00	40
32	Security of food supply	1	22	0,05	22
21	Environmental pollution and risks for biodiver	1	21	0,05	21
20	Deforestation	1	11	0,09	11

Conclusions

- Summary
  - Relevant system variables were identified
  - Their interdependencies were assessed and interpreted
  - Outstanding variables were identified to understand the system
- Lessons learned
  - Problem perceptions of all stakeholders have to be integrated
  - Scope needs to be widened to the institutional and social environment
  - Interdisciplinarity turned out to be important
  - Comprehend the whole system, not only isolated aspects

- Outlook
  - Simulations of alternative water supply scenarios
  - Sustainability assessment
  - Identification of regulation mechanisms

  → Sustainable systemic transformations

Theories and Methods

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- Relevant theories
  - Integrated Water Resources Management
  - Sustainable development
  - Development theory
  - Systems theory and cybernetics
- Applied methods
  - Qualitative social research: Grounded Theory (Glaser)
  - Systemic/cybernetic modelling: Sensitivity Model (Vester)
  - Sustainability assessment (Bossel)

The Process of Modeling

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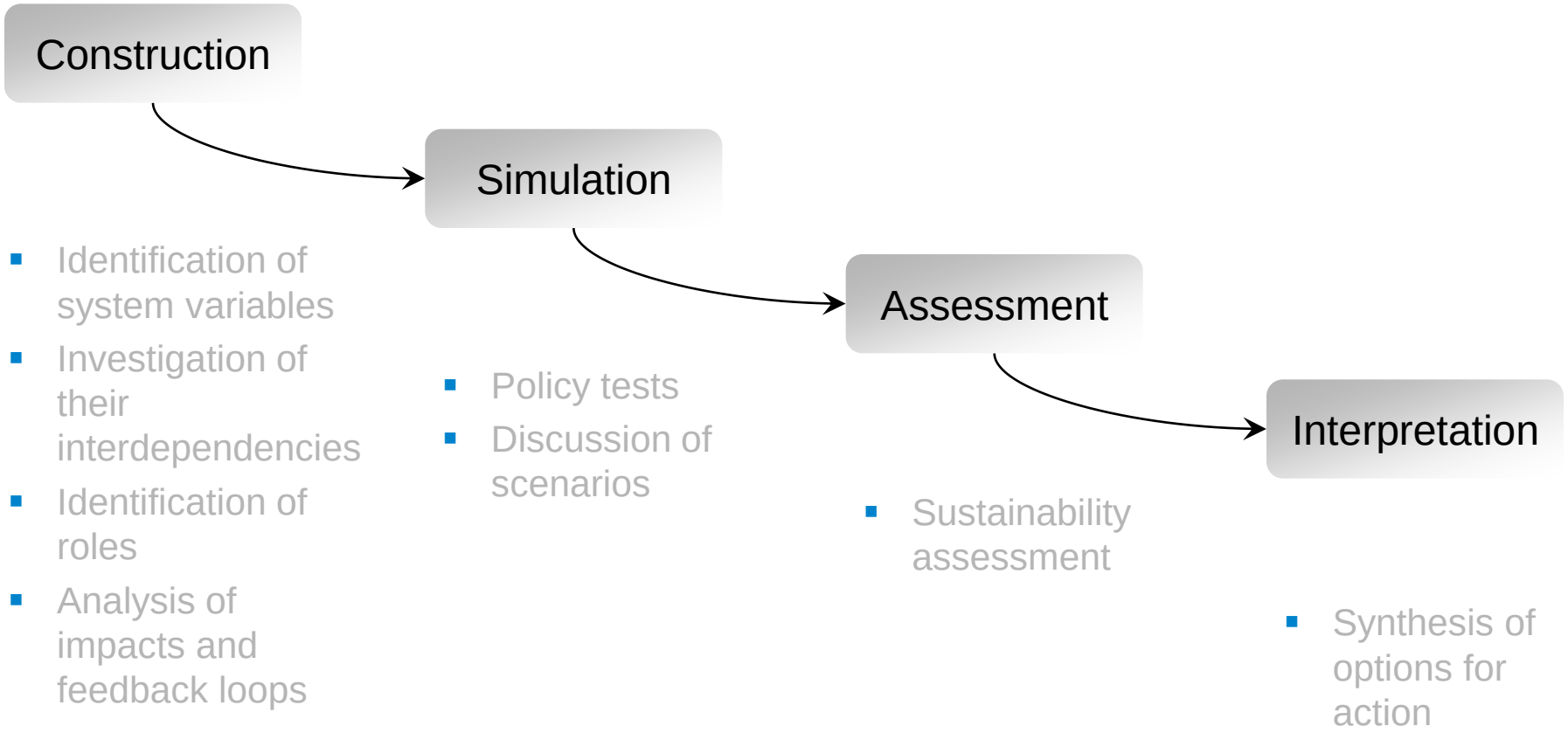

Alternative Technological Options

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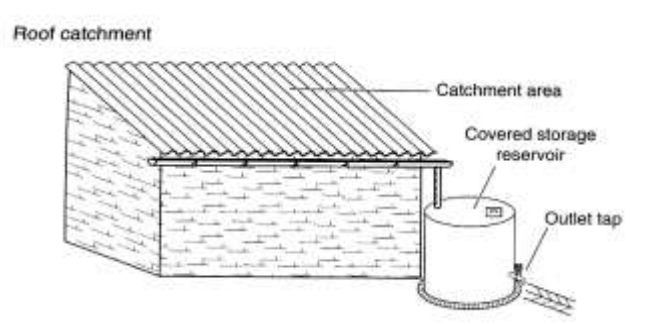
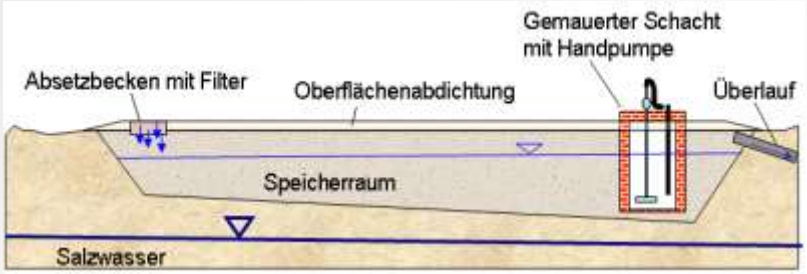
- Rainwater Harvesting



Source: Development Technology Unit, University of Warwick

- Subsurface Water Storage



- (Solar-thermal) GW-Desalination

- Traditional Water Supply Techniques
  - Ometale (excavation dams)
  - Omuthima (hand dug shallow wells)
  - Oshikweyo (hand dug wells)

Scenarios of Alternative Water Supply

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Scenario 1:

- Centralized, large scale water supply
- Supply only by pipeline grid

(...)

Scenario (1+i):

- Decentral small scale water supply
- Complementary to the water grid
- In rural, peripheral areas

(...)

Scenario (n):

- Decentral small scale water supply
- In rural but also in urban areas (as an additional source)
- Aim: reduction of the dependency on the Kunene water

List of Interviews

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Code of interviewee	Date of interview	Place of interview
07a-WM-01	17.8.2007	Pfungstadt
07a-WM-02	29.8.2007	Windhoek
07a-WM-03	30.8.2007	Windhoek
07a-WM-05	3.9.2007	Oshakati
07a-WM-06	4.9.2007	Oshakati
07a-WM-07	4.9.2007	Oshakati
07a-WM-08	10.9.2007	Windhoek
07a-WM-09	10.9.2007	Windhoek
07a-WM-10	13.9.2007	Windhoek
07b-WM-01	2.8.2007	Windhoek
07b-WM-02	6.8.2007	Windhoek
07b-WM-03	7.8.2007	Windhoek
07b-WM-04	9.8.2007	Windhoek
07a-AP-01	4.9.2007	Oshakati
07a-AP-02	5.9.2007	Oshakati
07a-AP-03	5.9.2007	Oshakati
07a-AP-04	7.9.2007	Oshakati
07a-AP-05	13.9.2007	Windhoek
07b-AP-01	10.10.2007	Windhoek
07a-WU-01	5.9.2007	Oshakati
07a-WU-02	6.9.2007	Oshakati
09-WU-01	21.11.2009	Oshakati
09-WU-02	26.10.-30.11.2009	Epyeshona, Oshakati
09-WU-03	26.10.-29.11.2009	Epyeshona
09-WU-04	8.11.2009	Etunda
09-WU-05	26.10.-29.11.2009	Epyeshona
09-WU-06	9.-29.11.2009	Epyeshona
09-WU-07	9.-29.11.2009	Epyeshona
09-WU-08	9.-29.11.2009	Epyeshona
09-WU-09	9.-29.11.2009	Epyeshona
09-WU-10	26.10.-30.11.2009	Epyeshona
09-WU-11	21.11.2009	Amutanga
09-WU-12	24.11.2009	Epyeshona
09-WU-13	18.11.2009	Oshakati
09-WU-14	2.-30.11.2009	Epyeshona
09-WU-15	26.10.-30.11.2009	Epyeshona
09-WU-16	22.11.2009	Ondiri Nawa
09-WU-17	26.10.-28.11.2009	Oshakati
09-WU-18	6.11.2009	Epyeshona
09-WU-19	13.11.2009	Epyeshona
07a-WSU-01	3.9.2007	Oshakati
07a-WSU-02	6.9.2007	Oshakati
07b-WSU-01	21.8.2007	Windhoek
07a-EI-01	11.9.2007	Windhoek
07b-EI-01	15.8.2007	Windhoek
07a-SC-02	13.9.2007	Windhoek
07a-SC-03	17.9.2007	Windhoek
07b-SC-01	16.8.2007	Windhoek
07b-SC-02	16.8.2007	Windhoek
07b-SC-03	21.8.2007, 20.9.2007	Windhoek
07b-SC-04	18.9.2007	Windhoek
07b-SC-05	18.9.2007	Windhoek
07b-SC-06	18.9.2007	Windhoek
09-SC-01	25.10.-6.11.2009	Oshakati
09-SC-02	29.10.2009, 3.+7.11.2009	Oshakati
09-SC-03	28.10.2009	Ondangwa
09-SC-04	3.11.-29.11.2009	Oshakati, Epyeshona
09-SC-05	8.11.2009, 15.11.2009	Olushandja
07a-NGO-01	14.9.2007	Windhoek

Affiliation of the Interviewees (1)

- Water sector
  - Namibia Water Corporation Ltd (NamWater)
  - Ministry on Agriculture, Water and Forestry (MAWF)
    - Department of Water Affairs (DWA)
    - Directorate of Rural Water Supply (DRWS)
    - Hydrological Division
  - Iishana Basin Management Committee (IBMC)
  - Water Point Committee
  - Local Water Committee
- Research institutions
  - University of Namibia (UNAM)
    - Department of Geography
    - Department of Natural Resources and Conservation
    - Interdisciplinary Research Center
  - Polytechnic of Namibia (Polytech)
    - Department of Civil Engineering
    - Department of Agriculture
  - Desert Research Foundation of Namibia (DRFN)

Affiliation of the Interviewees (2)

- Administration and politics
  - Ministry of Lands and Resettlement (MLR)
    - Natural Resource Information Service (NRIS)
    - Oshana Land Board
  - Ministry on Environment and Tourism (MET)
  - Ministry of Regional and Local Government, Housing & Rural Development (MRLGHRD)
  - Oshakati Town Council
- External organisations, NGOs
  - United Nations Development Programme (UNDP)
  - Namibian Development Trust
  - Southern African Development Community (SADC)
  - Gesellschaft für Technische Zusammenarbeit (GTZ)
- Consultants, water users
  - Consulting engineers
  - Traditional authorities
  - Water users

Methodology

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- Requirements of an adequate methodology?

  - Grounded in social-empirical terms

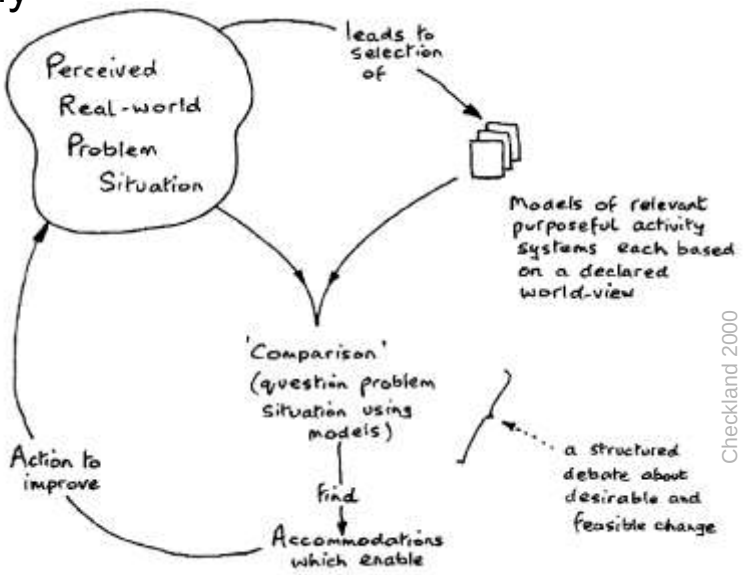
    → Qualitative social research

  - Capable of modelling systemic interdependencies

    → Systemic and cybernetic modelling approaches

Holistic Approaches

- Examples
  - Peter Checkland's Soft Systems Methodology (Checkland 2000)
  - Jac Vennix' Group Model Building (Vennix 1999, Andersen et al. 2006)
  - Roland Scholz' Transdisciplinary Case Study Approach (Scholz et al. 2006)
- Procedure
  - Messy or ill-defined social problems
  - Tackled by making use of group interviews
  - Some kind of systems analysis
  - Assessment of scenarios
  - To achieve desired transition management



Disadvantages of Group-Oriented Approaches

- Group-dynamic processes bias validity of data
  - Groups tend to discuss in an unstructured manner
  - Avoid any conflicts → lack of critical reflection
  - Participants adopt a defensive position to prevent a loss of face
  - Opinion leadership of individuals or factions
  - Power constellations based on gender, age, ethnicity, religion, or traditional hierarchies
  - (Vennix; Rogers, Roethlisberger; Janis, Mann; Klimoski, Karol; Argyris)
- Negative interview quality
- Group interviews rejected

Methods of Qualitative Social Research

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- Types of individual interviews
  - structured
  - semi-structured
  - focused
  - unstructured
  - (…)

- Interview guideline
  - Preconceived questions
  - Preconceived model
  - Preconceived results?

?

- Goal: verbal model of the system
  - description and explanation of systemic interdependencies
  - while comprising worldviews or perceptions of stakeholders

History of Ideas

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- Positivist empiricism („naive inductivism“)
  - Mind should be freed from preconceived ideas
  - 17th and 18th century (Bacon, Locke)
- Kant
  - Critique of the pitfalls of early empiricism
  - Observation is always „theoryladen“ (there is no tabula rasa)
- Glaser/Strauss
  - Theoretical sensitivity („armamentarium of categories and hypotheses”)

Diverging Concepts

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- Glaser
  - 14 coding families, e.g.
    - Degree of an attribute or property
    - Relation between a whole and its elements
    - Cultural phenomena (values, norms, etc.)

⟷

- Strauss/Corbin
  - Coding paradigms / axial coding
    - Conditions
    - Interaction among the actors
    - Strategies and tactics
    - Consequences

→ Kelle's critique of naive empiricism
- Concept of hypothetical or abductive inference
- Concept of empirical content or falsifiability of statements
- Concept of corroboration

Terminology

- Proposition
  - Meaningful declarative sentence
- Theory
  - A collection of explanations/ propositions that explain the subject of the research
  - Accepted by a respective peer group of scientists
- Hypothesis
  - Proposition(s) not yet verified
- Method
  - Technique to obtain findings
- Model
  - Reduced representation of a real phenomenon
- Incident/Indicator
  - Is the unit of analysis in GT
  - Reported by interviewees
- Code
  - Represents incidents
  - Identifying anchors that allow the key points of the data to be gathered
- Concept
  - Collections of codes of similar content
  - Allows the data to be grouped
  - Implies theoretical interrelations between concepts
- Variable
  - Interchangeably used for concept
- Category
  - Broad groups of similar concepts
  - Used to generate a theory

QDA vs. GT

„incapable of integration“

- Qualitative data analysis (QDA) ⟷ Grounded Theory (GT)
  - Begins with preconceived hypotheses
  - Explicit goal is description
  - Prime concern is accuracy, truth, trustworthiness or objectivity of the data, constructivism, participant voice, rigorous data collection, positivism
  - „Adequacy of data“ is QDA concern
  - „Generalized story“ is QDA concern
  - Begins with no preconceived theory
  - Product is not description (inductive theory is explanatory)
  - Conceptual hypotheses of GT do not entail the problems of accuracy (irrelevant in GT)
  - GT is not accurate facts
  - GT fractures the story in the service of conceptualization

→ Mixing of QDA and GT: downgrading and eroding GT to just another QDA method

GT Procedures

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1. Theoretical coding
   - Patterns are sought and conceptualized
2. Theoretical sampling
   - Decision what data to collect next
3. Constant comparative method
   - All data are constantly compared to generate concepts
4. Core variable
   - Set of grounded concepts organized around a core category
5. Theoretical saturation
   - No more new concepts emerge
6. Conceptual emergence
   - GT is generated
7. Memoing
   - Immediate recording of conceptual ideas
8. Sorting and writing up
   - Sorting of memos ends up in written GT

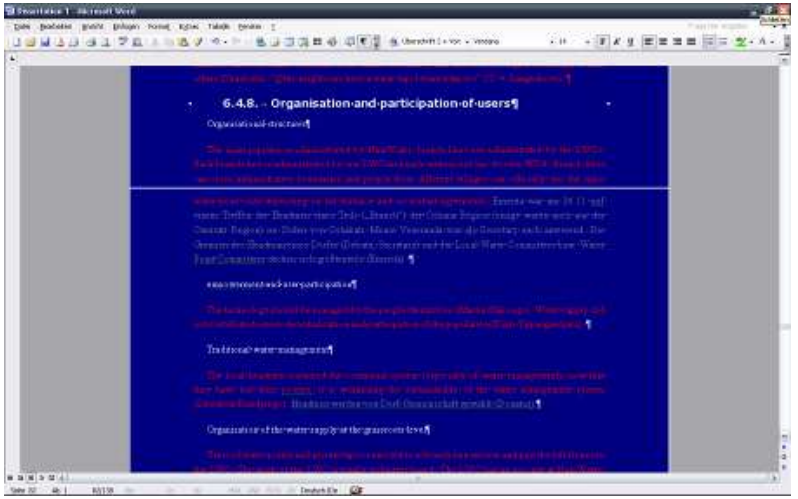
GT Procedures (1)

- Theoretical sensitivity
  - Ability to enter the research setting with as few predetermined ideas as possible
  - To conceptualize and organize, make abstract connections, visualize and think multivariately
- Start of GT analysis
  - Right off with data collecting and analysis
  - Researcher does not encourage participants to talk about a subject of little interest
  - No filtering of data
- Handling of data
  - GT can use any data, but favorite data is qualitative
  - All types of interviews (style emerges)
  - Data is not to be discounted as „subjective“, „obvious“, „constructed“
- Use of literature
  - No review of literature before the emergence of a core category
  - After that, literature can be integrated as another source of data

GT Procedures (2)

- Theoretical coding
  - Conceptualization of data through grouping it into codes
  - Code gives condensed, abstract view of the data
  - Substantive codes conceptualize the empirical substance
  - Theoretical codes conceptualize how the substantive codes may relate to each other
  - Codes become theory that explains what is happening in the data
  - Using constant comparative method

- Example for incident
  - *“There have been lots of earth dams in the past but they have been pushed away by the pipeline.” (NamWater official, 07a-WSU-01)*
- Code: „Usage of Ometale“
- Concept: „Oshanas and excavation dams (Ometale)”



GT Procedures (3)

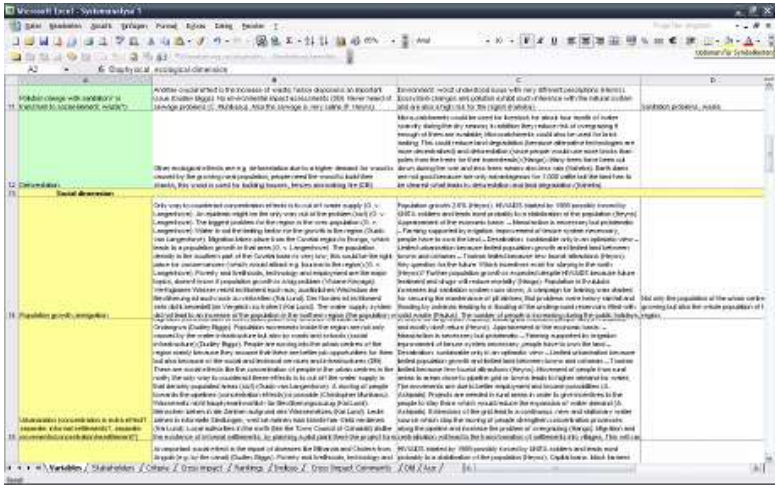
- Open coding
  - Line-by-line coding of the data
  - New categories emerge
  - New incidents fit into existing categories
  - Coding into as many categories as fit successive, different incidents
  - Ensures the grounding of categories
  - Verifies and saturates categories
  - Minimizes missing an important category, nothing has been left out

- Theoretical sampling
  - Process of data collection
  - What categories and where to collect next
  - By identifying emerging gaps in the theory
  - Collection cannot be planned in advance
  - Ensure the data's relevance

GT Procedures (4)

- Constant comparative method
  - Incidents are compared to incidents
  - Concepts and hypotheses are generated
  - Concepts are compared to more incidents
  - Densification of concepts by developing their properties
  - Finally, concepts are compared to concepts
  - Integration into hypotheses between the concepts
  - Generation of theory

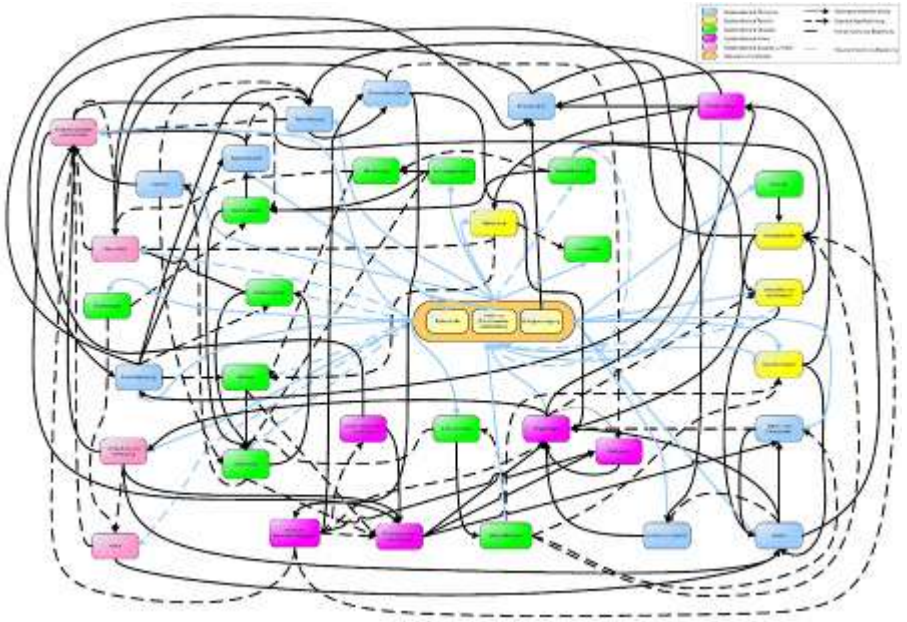
- Incident
  - *“There have been lots of earth dams in the past but they have been pushed away by the pipeline.” (NamWater official, 07a-WSU-01)*
- Concept „Large-scale water supply“ relates to concept „Oshanas and excavation dams (Ometale)”



GT Procedures (5)

- Core variable
  - Can be any kind of theoretical code
  - Is central, and relating to as many other categories as possible
  - Accounts for most of the variation around the problem of the study
  - Integrates the theory
- Selective coding
  - Cease open coding
  - After core variable has been discovered
  - Delimit coding to only those variables related to core variable

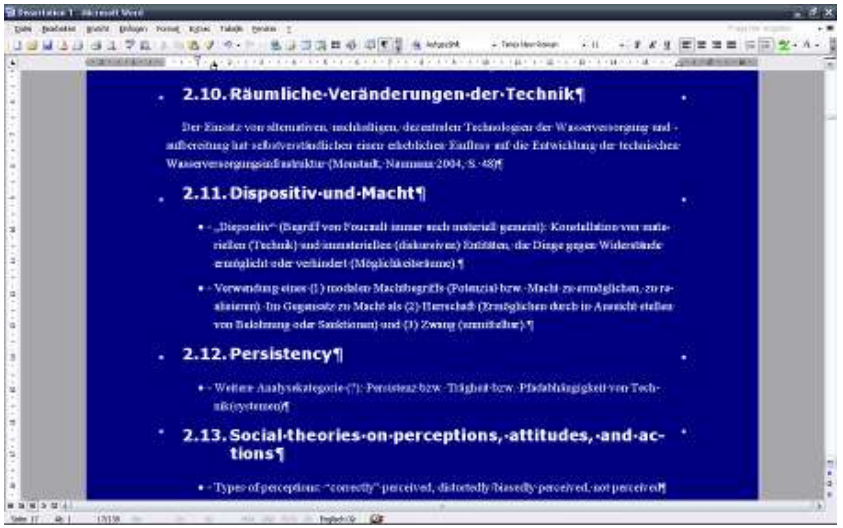
- Core variable is „Large-scale water supply“



GT Procedures (6)

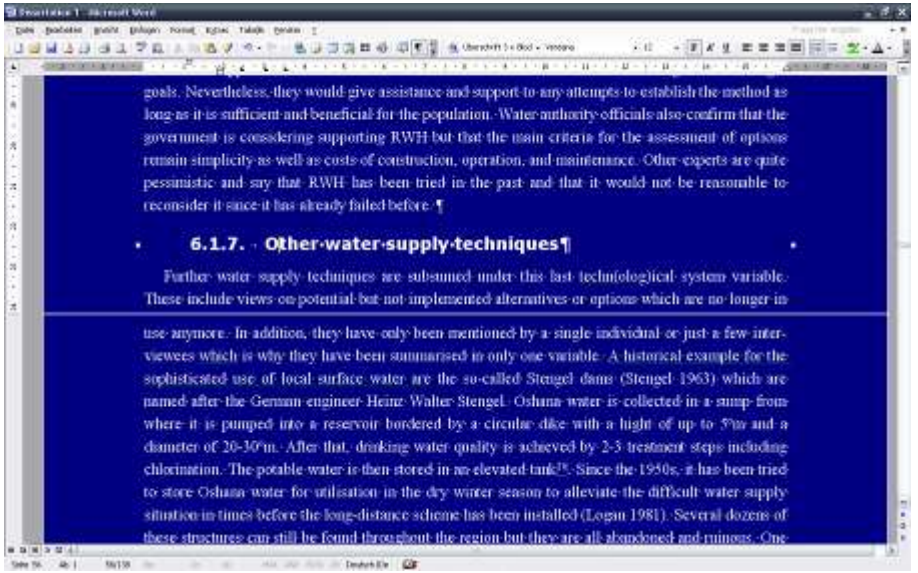
- Delimiting
  - Theory solidifies
  - Major modifications become fewer and fewer
  - Theory is reformulated with a smaller set of concepts
- Example
  - Former social concept „Sanitary conditions“ and former ecological concept „Pollution“ were merged to the technical concept „Sanitation“

- Memoing
  - Parallels data analysis
  - Theoretical notes about data and conceptual connections between categories
  - Integrate these connections with clusters of other categories to generate the theory



GT Procedures (7)

- Sorting and writing up
  - Sorting of memos by sorting of categories and properties
  - Sorted memos generate the theoretical outline
  - Full articulation of multivariate theory through integrated set of hypotheses



goals. Nevertheless, they would give assistance and support to any attempts to establish the method as long as it is sufficient and beneficial for the population. Water authority officials also confirm that the government is considering supporting RWH but that the main criteria for the assessment of options remain simplicity as well as costs of construction, operation, and maintenance. Other experts are quite pessimistic and say that RWH has been tried in the past and that it would not be reasonable to reconsider it since it has already failed before.¶

6.1.7. Other water supply techniques¶

Further water supply techniques are subsumed under this last techn(olog)ical system variable. These include views on potential but not implemented alternatives or options which are no longer in use anymore. In addition, they have only been mentioned by a single individual or just a few interviewees which is why they have been summarised in only one variable. A historical example for the sophisticated use of local surface water are the so-called Stengel dams (Stengel 1963) which are named after the German engineer Heinz Walter Stengel. Oshana water is collected in a sump from where it is pumped into a reservoir bordered by a circular dike with a hight of up to 5^m and a diameter of 20-30^m. After that, drinking water quality is achieved by 2-3 treatment steps including chlorination. The potable water is then stored in an elevated tank[5]. Since the 1950s, it has been tried to store Oshana water for utilisation in the dry winter season to alleviate the difficult water supply situation in times before the long-distance scheme has been installed (Logan 1981). Several dozens of these structures can still be found throughout the region but they are all abandoned and ruinous. One

Normalised Cross Impact Matrix

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	Large-scale water supply	Technical problems with the large-scale wa	Oshanas and excavation dams (Omatale)	Shallow dug wells (Omuthima)	Dug wells (Oshikweyo)	Rainwater harvesting	Sanitation	Other water supply techniques	Governance and management problems	Water supply and sanitation policies	Land policies	Integration and decentralisation	Inter-regional conflicts	Attitudes and distribution of power	Availability of water resources	Salinity of groundwaters	Floods, droughts, and climate change	Quality and availability of grazing land	Soil Degradation	Deforestation	Environmental pollution and risks for biodiv	Population growth and Migration	Urbanisation	Rural concentration and Immobility	Health	Disparities and exclusion	Level of education and understanding of wa	Perception of water prices	Organisation and participation of users	Misuse and vandalism	Security of water supply	Security of food supply	Subsistence and poverty	Traditional crop farming	Traditional livestock farming	Lack of irrigation and horticulture	Regional economic state	Angolan water demand	Activity	Passivity	Q-value	P-value
1 Large-scale water supply			1	1	1	1	1	1	1			1	1								1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	26	16	1,63	416
2 Technical problems with the large-scale	1		1		1	1		1	1																	1			1	1								9	16	0,56	144
3 Oshanas and excavation dams (Omatale)				1				1										1	1	1	1				1	1			1			1	1	1	1	1	14	19	0,74	266
4 Shallow dug wells (Omuthima)																									1	1			1					1		1		5	6	0,83	30
5 Dug wells (Oshikweyo)		1							1							1					1		1	1	1				1	1		1		1			11	18	0,61	198
6 Rainwater harvesting					1				1									1	1			1		1	1	1			1			1		1	1			12	20	0,60	240
7 Sanitation									1	1						1					1		1	1	1				1							1		9	12	0,75	108
8 Other water supply techniques		1											1								1			1		1						1		1			1	9	17	0,53	153
9 Governance and management problems	1	1	1		1	1	1	1		1	1	1										1		1	1	1	1	1		1		1	1	1	1	1		22	17	1,29	374
10 Water supply and sanitation policies	1		1		1	1	1	1				1	1														1		1									10	5	2,00	50
11 Land policies									1	1	1							1	1			1	1	1									1	1	1			11	8	1,38	88
12 Integration and decentralisation	1	1	1		1	1	1	1	1	1	1														1	1		1		1								14	9	1,56	126
13 Inter-regional conflicts	1		1		1	1		1				1																							1			8	8	1,00	64
14 Attitudes and distribution of power	1		1		1	1	1	1	1			1			1		1					1	1		1	1						1						15	1	15,00	15
15 Availability of water resources	1	1	1	1	1	1		1					1			1	1	1		1				1		1				1				1	1	1		18	4	4,50	72
16 Salinity of groundwaters	1	1	1	1	1	1		1	1								1	1																1	1			10	3	3,33	30
17 Floods, droughts, and climate change			1		1	1	1	1							1	1		1	1	1	1		1							1	1			1			1	16	3	5,33	48
18 Quality and availability of grazing land											1	1												1											1				4	8	0,50	32
19 Soil Degradation																																		1				1	7	0,14	7
20 Deforestation																	1																					1	9	0,11	9
21 Environmental pollution and risks for																								1														1	9	0,11	9
22 Population growth and Migration	1	1					1		1						1					1			1				1			1	1			1		1	12	8	1,50	96
23 Urbanisation	1	1	1		1	1	1	1	1		1							1		1	1		1	1	1	1			1			1	1	1	1	1		22	11	2,00	242
24 Rural concentration and Immobility	1	1					1		1				1							1			1											1				7	11	0,64	77
25 Health																						1					1										1	3	10	0,30	30
26 Disparities and exclusion	1				1	1			1																	1	1		1				1	1				9	16	0,56	144
27 Level of education and understanding of		1	1	1	1	1	1	1	1		1	1		1				1				1	1		1		1	1	1		1	1	1	1	1		24	10	2,40	240
28 Perception of water prices			1																									1							1			3	9	0,33	27
29 Organisation and participation of users	1	1	1		1	1	1	1	1			1																1	1									11	5	2,20	55
30 Misuse and vandalism		1				1	1		1																1			1		1				1	1			9	7	1,29	63
31 Security of water supply			1	1		1																			1							1						5	24	0,21	120
32 Security of food supply																																1						1	8	0,13	8
33 Subsistence and poverty	1		1		1	1	1	1	1											1		1	1		1	1		1			1		1	1	1	1		18	15	1,20	270
34 Traditional crop farming		1								1	1							1	1				1									1	1			1	1	10	12	0,83	120
35 Traditional livestock farming	1	1	1		1	1		1			1		1					1	1			1		1		1	1		1	1	1	1	1				1	19	19	1,00	361
36 Lack of irrigation and horticulture		1	1		1	1		1							1			1					1					1	1	1	1	1		1		1	14	13	1,08	182
37 Regional economic state			1									1	1							1	1	1	1	1					1	1	1	1	1					13	15	0,87	195
38 Angolan water demand	1	1											1																1									4	2	2,00	8
Passivity	16	16	19	6	18	20	12	17	17	5	8	9	8	1	4	3	3	8	7	9	9	8	11	11	10	16	10	9	5	7	24	8	15	12	19	13	15	2				

Indicator Rankings: P-Value

TECHNISCHE UNIVERSITÄT DARMSTADT

- Normalised

		Activity	Passivity	Q-value	P-value
1	Large-scale water supply	26	16	1,63	416
9	Governance and management problems	22	17	1,29	374
35	Traditional livestock farming	19	19	1,00	361
33	Subsistence and poverty	18	15	1,20	270
3	Oshanas and excavation dams (Ometale)	14	19	0,74	266
23	Urbanisation	22	11	2,00	242
6	Rainwater harvesting	12	20	0,60	240
27	Level of education and understanding of wat	24	10	2,40	240
5	Dug wells (Oshikweyo)	11	18	0,61	198
37	Regional economic state	13	15	0,87	195
36	Lack of irrigation and horticulture	14	13	1,08	182
8	Other water supply techniques	9	17	0,53	153
2	Technical problems with the large-scale wate	9	16	0,56	144
26	Disparities and exclusion	9	16	0,56	144
12	Integration and decentralisation	14	9	1,56	126
31	Security of water supply	5	24	0,21	120
34	Traditional crop farming	10	12	0,83	120
7	Sanitation	9	12	0,75	108
22	Population growth and Migration	12	8	1,50	96
11	Land policies	11	8	1,38	88
24	Rural concentration and Immobility	7	11	0,64	77
15	Availability of water resources	18	4	4,50	72
13	Inter-regional conflicts	8	8	1,00	64
30	Misuse and vandalism	9	7	1,29	63
29	Organisation and participation of users	11	5	2,20	55
10	Water supply and sanitation policies	10	5	2,00	50
17	Floods, droughts, and climate change	16	3	5,33	48
18	Quality and availability of grazing land	4	8	0,50	32
4	Shallow dug wells (Omuthima)	5	6	0,83	30
16	Salinity of groundwaters	10	3	3,33	30
25	Health	3	10	0,30	30
28	Perception of water prices	3	9	0,33	27
14	Attitudes and distribution of power	15	1	15,00	15
20	Deforestation	1	9	0,11	9
21	Environmental pollution and risks for biodiver	1	9	0,11	9
32	Security of food supply	1	8	0,13	8
38	Angolan water demand	4	2	2,00	8
19	Soil Degradation	1	7	0,14	7

- Absolute

		Activity	Passivity	Q-value	P-value
1	Large-scale water supply	122	75	1,63	9150
35	Traditional livestock farming	80	89	0,90	7120
9	Governance and management problems	109	54	2,02	5886
33	Subsistence and poverty	87	61	1,43	5307
3	Oshanas and excavation dams (Ometale)	57	79	0,72	4503
23	Urbanisation	74	52	1,42	3848
6	Rainwater harvesting	42	87	0,48	3654
27	Level of education and understanding of wat	164	18	9,11	2952
5	Dug wells (Oshikweyo)	36	78	0,46	2808
36	Lack of irrigation and horticulture	44	60	0,73	2640
37	Regional economic state	37	71	0,52	2627
7	Sanitation	34	68	0,50	2312
2	Technical problems with the large-scale wate	32	60	0,53	1920
34	Traditional crop farming	39	45	0,87	1755
18	Quality and availability of grazing land	25	38	0,66	950
29	Organisation and participation of users	38	24	1,58	912
8	Other water supply techniques	18	50	0,36	900
15	Availability of water resources	63	13	4,85	819
12	Integration and decentralisation	31	25	1,24	775
26	Disparities and exclusion	16	46	0,35	736
31	Security of water supply	6	119	0,05	714
24	Rural concentration and Immobility	18	38	0,47	684
11	Land policies	33	20	1,65	660
22	Population growth and Migration	32	19	1,68	608
30	Misuse and vandalism	21	17	1,24	357
13	Inter-regional conflicts	17	18	0,94	306
14	Attitudes and distribution of power	98	2	49,00	196
25	Health	4	46	0,09	184
4	Shallow dug wells (Omuthima)	14	13	1,08	182
17	Floods, droughts, and climate change	39	4	9,75	156
10	Water supply and sanitation policies	15	9	1,67	135
28	Perception of water prices	4	29	0,14	116
16	Salinity of groundwaters	30	3	10,00	90
19	Soil Degradation	4	20	0,20	80
38	Angolan water demand	20	2	10,00	40
32	Security of food supply	1	22	0,05	22
21	Environmental pollution and risks for biodiver	1	21	0,05	21
20	Deforestation	1	11	0,09	11

Indicator Rankings: Q-Value

TECHNISCHE UNIVERSITÄT DARMSTADT

- Normalised

		Activity	Passivity	Q-value	P-value
14	Attitudes and distribution of power	15	1	15,00	15
17	Floods, droughts, and climate change	16	3	5,33	48
15	Availability of water resources	18	4	4,50	72
16	Salinity of groundwaters	10	3	3,33	30
27	Level of education and understanding of wat	24	10	2,40	240
29	Organisation and participation of users	11	5	2,20	55
10	Water supply and sanitation policies	10	5	2,00	50
23	Urbanisation	22	11	2,00	242
38	Angolan water demand	4	2	2,00	8
1	Large-scale water supply	26	16	1,63	416
12	Integration and decentralisation	14	9	1,56	126
22	Population growth and Migration	12	8	1,50	96
11	Land policies	11	8	1,38	88
9	Governance and management problems	22	17	1,29	374
30	Misuse and vandalism	9	7	1,29	63
33	Subsistence and poverty	18	15	1,20	270
36	Lack of irrigation and horticulture	14	13	1,08	182
13	Inter-regional conflicts	8	8	1,00	64
35	Traditional livestock farming	19	19	1,00	361
37	Regional economic state	13	15	0,87	195
4	Shallow dug wells (Omuthima)	5	6	0,83	30
34	Traditional crop farming	10	12	0,83	120
7	Sanitation	9	12	0,75	108
3	Oshanas and excavation dams (Ometale)	14	19	0,74	266
24	Rural concentration and Immobility	7	11	0,64	77
5	Dug wells (Oshikweyo)	11	18	0,61	198
6	Rainwater harvesting	12	20	0,60	240
2	Technical problems with the large-scale wate	9	16	0,56	144
26	Disparities and exclusion	9	16	0,56	144
8	Other water supply techniques	9	17	0,53	153
18	Quality and availability of grazing land	4	8	0,50	32
28	Perception of water prices	3	9	0,33	27
25	Health	3	10	0,30	30
31	Security of water supply	5	24	0,21	120
19	Soil Degradation	1	7	0,14	7
32	Security of food supply	1	8	0,13	8
20	Deforestation	1	9	0,11	9
21	Environmental pollution and risks for biodiver	1	9	0,11	9

- Absolute

		Activity	Passivity	Q-value	P-value
14	Attitudes and distribution of power	98	2	49,00	196
16	Salinity of groundwaters	30	3	10,00	90
38	Angolan water demand	20	2	10,00	40
17	Floods, droughts, and climate change	39	4	9,75	156
27	Level of education and understanding of wat	164	18	9,11	2952
15	Availability of water resources	63	13	4,85	819
9	Governance and management problems	109	54	2,02	5886
22	Population growth and Migration	32	19	1,68	608
10	Water supply and sanitation policies	15	9	1,67	135
11	Land policies	33	20	1,65	660
1	Large-scale water supply	122	75	1,63	9150
29	Organisation and participation of users	38	24	1,58	912
33	Subsistence and poverty	87	61	1,43	5307
23	Urbanisation	74	52	1,42	3848
12	Integration and decentralisation	31	25	1,24	775
30	Misuse and vandalism	21	17	1,24	357
4	Shallow dug wells (Omuthima)	14	13	1,08	182
13	Inter-regional conflicts	17	18	0,94	306
35	Traditional livestock farming	80	89	0,90	7120
34	Traditional crop farming	39	45	0,87	1755
36	Lack of irrigation and horticulture	44	60	0,73	2640
3	Oshanas and excavation dams (Ometale)	57	79	0,72	4503
18	Quality and availability of grazing land	25	38	0,66	950
2	Technical problems with the large-scale wate	32	60	0,53	1920
37	Regional economic state	37	71	0,52	2627
7	Sanitation	34	68	0,50	2312
6	Rainwater harvesting	42	87	0,48	3654
24	Rural concentration and Immobility	18	38	0,47	684
5	Dug wells (Oshikweyo)	36	78	0,46	2808
8	Other water supply techniques	18	50	0,36	900
26	Disparities and exclusion	16	46	0,35	736
19	Soil Degradation	4	20	0,20	80
28	Perception of water prices	4	29	0,14	116
20	Deforestation	1	11	0,09	11
25	Health	4	46	0,09	184
31	Security of water supply	6	119	0,05	714
21	Environmental pollution and risks for biodiver	1	21	0,05	21
32	Security of food supply	1	22	0,05	22

Indicator Rankings: Activity

TECHNISCHE UNIVERSITÄT DARMSTADT

- Normalised

		Activity	Passivity	Q-value	P-value
1	Large-scale water supply	26	16	1,63	416
27	Level of education and understanding of wat	24	10	2,40	240
9	Governance and management problems	22	17	1,29	374
23	Urbanisation	22	11	2,00	242
35	Traditional livestock farming	19	19	1,00	361
15	Availability of water resources	18	4	4,50	72
33	Subsistence and poverty	18	15	1,20	270
17	Floods, droughts, and climate change	16	3	5,33	48
14	Attitudes and distribution of power	15	1	15,00	15
3	Oshanas and excavation dams (Ometale)	14	19	0,74	266
12	Integration and decentralisation	14	9	1,56	126
36	Lack of irrigation and horticulture	14	13	1,08	182
37	Regional economic state	13	15	0,87	195
6	Rainwater harvesting	12	20	0,60	240
22	Population growth and Migration	12	8	1,50	96
5	Dug wells (Oshikweyo)	11	18	0,61	198
11	Land policies	11	8	1,38	88
29	Organisation and participation of users	11	5	2,20	55
10	Water supply and sanitation policies	10	5	2,00	50
16	Salinity of groundwaters	10	3	3,33	30
34	Traditional crop farming	10	12	0,83	120
2	Technical problems with the large-scale wate	9	16	0,56	144
7	Sanitation	9	12	0,75	108
8	Other water supply techniques	9	17	0,53	153
26	Disparities and exclusion	9	16	0,56	144
30	Misuse and vandalism	9	7	1,29	63
13	Inter-regional conflicts	8	8	1,00	64
24	Rural concentration and Immobility	7	11	0,64	77
4	Shallow dug wells (Omuthima)	5	6	0,83	30
31	Security of water supply	5	24	0,21	120
18	Quality and availability of grazing land	4	8	0,50	32
38	Angolan water demand	4	2	2,00	8
25	Health	3	10	0,30	30
28	Perception of water prices	3	9	0,33	27
19	Soil Degradation	1	7	0,14	7
20	Deforestation	1	9	0,11	9
21	Environmental pollution and risks for biodiver	1	9	0,11	9
32	Security of food supply	1	8	0,13	8

- Absolute

		Activity	Passivity	Q-value	P-value
27	Level of education and understanding of wat	164	18	9,11	2952
1	Large-scale water supply	122	75	1,63	9150
9	Governance and management problems	109	54	2,02	5886
14	Attitudes and distribution of power	98	2	49,00	196
33	Subsistence and poverty	87	61	1,43	5307
35	Traditional livestock farming	80	89	0,90	7120
23	Urbanisation	74	52	1,42	3848
15	Availability of water resources	63	13	4,85	819
3	Oshanas and excavation dams (Ometale)	57	79	0,72	4503
36	Lack of irrigation and horticulture	44	60	0,73	2640
6	Rainwater harvesting	42	87	0,48	3654
17	Floods, droughts, and climate change	39	4	9,75	156
34	Traditional crop farming	39	45	0,87	1755
29	Organisation and participation of users	38	24	1,58	912
37	Regional economic state	37	71	0,52	2627
5	Dug wells (Oshikweyo)	36	78	0,46	2808
7	Sanitation	34	68	0,50	2312
11	Land policies	33	20	1,65	660
2	Technical problems with the large-scale wate	32	60	0,53	1920
22	Population growth and Migration	32	19	1,68	608
12	Integration and decentralisation	31	25	1,24	775
16	Salinity of groundwaters	30	3	10,00	90
18	Quality and availability of grazing land	25	38	0,66	950
30	Misuse and vandalism	21	17	1,24	357
38	Angolan water demand	20	2	10,00	40
8	Other water supply techniques	18	50	0,36	900
24	Rural concentration and Immobility	18	38	0,47	684
13	Inter-regional conflicts	17	18	0,94	306
26	Disparities and exclusion	16	46	0,35	736
10	Water supply and sanitation policies	15	9	1,67	135
4	Shallow dug wells (Omuthima)	14	13	1,08	182
31	Security of water supply	6	119	0,05	714
19	Soil Degradation	4	20	0,20	80
25	Health	4	46	0,09	184
28	Perception of water prices	4	29	0,14	116
20	Deforestation	1	11	0,09	11
21	Environmental pollution and risks for biodiver	1	21	0,05	21
32	Security of food supply	1	22	0,05	22

Indicator Rankings: Passivity

TECHNISCHE UNIVERSITÄT DARMSTADT

- Normalised

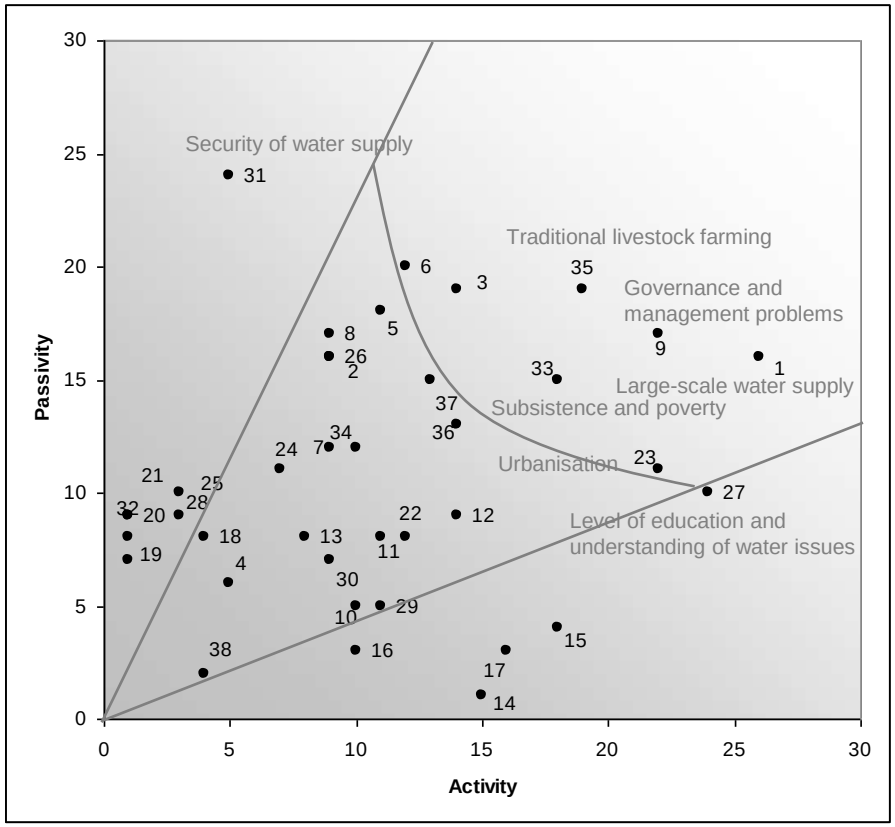
		Activity	Passivity	Q-value	P-value
31	Security of water supply	5	24	0,21	120
6	Rainwater harvesting	12	20	0,60	240
3	Oshanas and excavation dams (Ometale)	14	19	0,74	266
35	Traditional livestock farming	19	19	1,00	361
5	Dug wells (Oshikweyo)	11	18	0,61	198
8	Other water supply techniques	9	17	0,53	153
9	Governance and management problems	22	17	1,29	374
1	Large-scale water supply	26	16	1,63	416
2	Technical problems with the large-scale wate	9	16	0,56	144
26	Disparities and exclusion	9	16	0,56	144
33	Subsistence and poverty	18	15	1,20	270
37	Regional economic state	13	15	0,87	195
36	Lack of irrigation and horticulture	14	13	1,08	182
7	Sanitation	9	12	0,75	108
34	Traditional crop farming	10	12	0,83	120
23	Urbanisation	22	11	2,00	242
24	Rural concentration and Immobility	7	11	0,64	77
25	Health	3	10	0,30	30
27	Level of education and understanding of wat	24	10	2,40	240
12	Integration and decentralisation	14	9	1,56	126
20	Deforestation	1	9	0,11	9
21	Environmental pollution and risks for biodiver	1	9	0,11	9
28	Perception of water prices	3	9	0,33	27
11	Land policies	11	8	1,38	88
13	Inter-regional conflicts	8	8	1,00	64
18	Quality and availability of grazing land	4	8	0,50	32
22	Population growth and Migration	12	8	1,50	96
32	Security of food supply	1	8	0,13	8
19	Soil Degradation	1	7	0,14	7
30	Misuse and vandalism	9	7	1,29	63
4	Shallow dug wells (Omuthima)	5	6	0,83	30
10	Water supply and sanitation policies	10	5	2,00	50
29	Organisation and participation of users	11	5	2,20	55
15	Availability of water resources	18	4	4,50	72
16	Salinity of groundwaters	10	3	3,33	30
17	Floods, droughts, and climate change	16	3	5,33	48
38	Angolan water demand	4	2	2,00	8
14	Attitudes and distribution of power	15	1	15,00	15

- Absolute

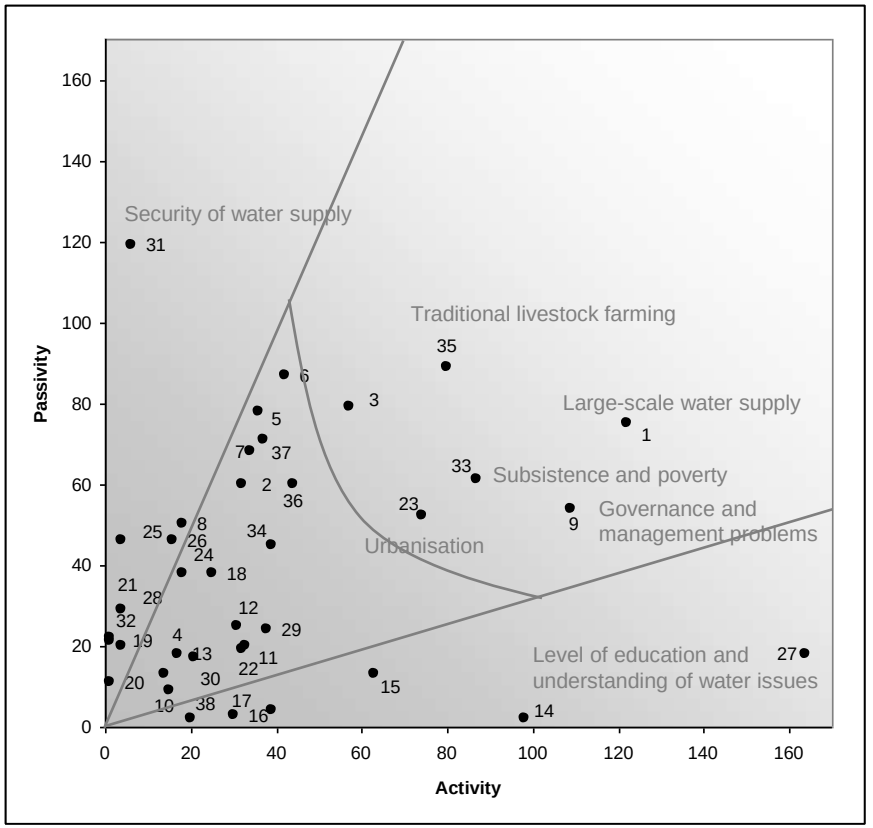
		Activity	Passivity	Q-value	P-value
31	Security of water supply	6	119	0,05	714
35	Traditional livestock farming	80	89	0,90	7120
6	Rainwater harvesting	42	87	0,48	3654
3	Oshanas and excavation dams (Ometale)	57	79	0,72	4503
5	Dug wells (Oshikweyo)	36	78	0,46	2808
1	Large-scale water supply	122	75	1,63	9150
37	Regional economic state	37	71	0,52	2627
7	Sanitation	34	68	0,50	2312
33	Subsistence and poverty	87	61	1,43	5307
2	Technical problems with the large-scale wate	32	60	0,53	1920
36	Lack of irrigation and horticulture	44	60	0,73	2640
9	Governance and management problems	109	54	2,02	5886
23	Urbanisation	74	52	1,42	3848
8	Other water supply techniques	18	50	0,36	900
25	Health	4	46	0,09	184
26	Disparities and exclusion	16	46	0,35	736
34	Traditional crop farming	39	45	0,87	1755
18	Quality and availability of grazing land	25	38	0,66	950
24	Rural concentration and Immobility	18	38	0,47	684
28	Perception of water prices	4	29	0,14	116
12	Integration and decentralisation	31	25	1,24	775
29	Organisation and participation of users	38	24	1,58	912
32	Security of food supply	1	22	0,05	22
21	Environmental pollution and risks for biodiver	1	21	0,05	21
11	Land policies	33	20	1,65	660
19	Soil Degradation	4	20	0,20	80
22	Population growth and Migration	32	19	1,68	608
13	Inter-regional conflicts	17	18	0,94	306
27	Level of education and understanding of wat	164	18	9,11	2952
30	Misuse and vandalism	21	17	1,24	357
4	Shallow dug wells (Omuthima)	14	13	1,08	182
15	Availability of water resources	63	13	4,85	819
20	Deforestation	1	11	0,09	11
10	Water supply and sanitation policies	15	9	1,67	135
17	Floods, droughts, and climate change	39	4	9,75	156
16	Salinity of groundwaters	30	3	10,00	90
14	Attitudes and distribution of power	98	2	49,00	196
38	Angolan water demand	20	2	10,00	40

Roles of System Variables

- Normalised



- Absolute



Upcoming Steps: Sustainability Assessment

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- Development theory
  - Exogeneous vs. endogeneous theories
  - Geodeterministic aspects
  - Systemic theory of development (Raymond Boudon)
    - Vicious circle of reproductive processes
    - Way out: cumulative processes
- Identification of assessment criteria from concepts of sustainable development
  - von Carlowitz
  - Meadows, Forrester
  - Brundtland
  - Jörissen et al. (KIT/FZK-ITAS)
  - Holling
  - Bossel
  - VDI (Ropohl, Hubig)

Systemic Dichotomy

Deterministic system of entities ⟷ **Contingent system of actions**

Ropohl 2005

Upcoming Steps: Stakeholder Analysis

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- Types of perceptions
  - "correctly" perceived (intersubjectively verifiable)
  - distortedly/biasedly perceived
  - not perceived

  ⟷ Heterogeneity of a system variable
- Options of attitudes
  - positive
  - negative
  - indifferent

  ⟷ Options for action
- Modes of power
  - able to change something
  - not able to change something

  ⟷ System variable
- Degree of vulnerability
  - affected
  - not affected

  ⟷ By a system variable

Literature

- Glaser, B. G.; Strauss, A. L. (1967): Discovery of Grounded Theory. Mill Valley, Ca. Sociology Press.
- Glaser, B. G.; Holton, J. (2004): Remodeling Grounded Theory. Forum Qualitative Sozialforschung / Forum: Qualitative Social Research, 5(2), Art. 4.