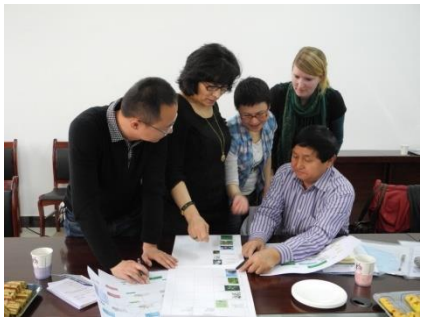
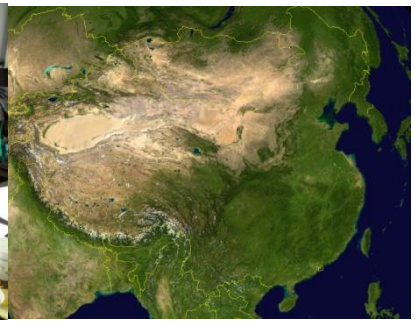
Transdisciplinary assessment of ecosystem services in the Tarim basin

Petra Döll (with input from WG Doluschitz and WG Ahlheim)

Goethe University Frankfurt, Germany

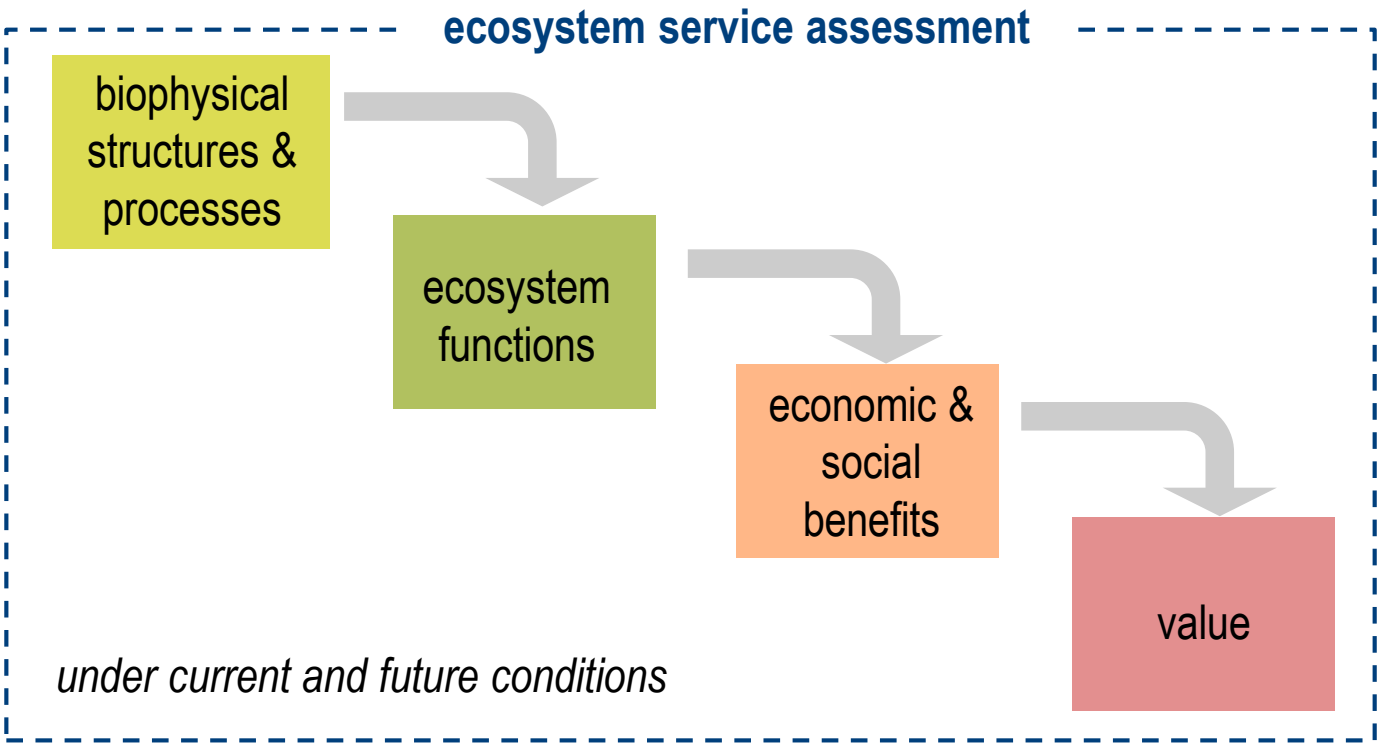
We express gratitude to German-Chinese research teams and especially to the late Prof. Dr. Hamid Yimit



Workflow for assessing an individual ecosystem service (ES)

(interpreting the cascade models of Haines-Young and Potschin (2009, 2010), and TEEB (2010))

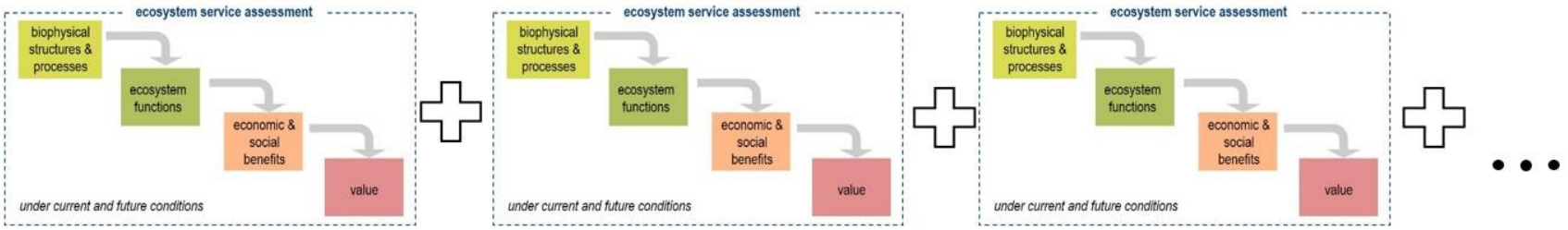


Barth and Döll, submitted (modified)

Ecosystem services assessment (ESA) (i.e. assessment of all relevant ES)

JOHANN WOLFGANG GOETHE UNIVERSITÄT FRANKFURT AM MAIN

Step 1



Step 2

Determine management options for maximizing value of bundle of all relevant ES, taking into account trade-off among individual ES

Steps 1 and 2 are best done by **transciplinary knowledge integration** among disciplinary scientists and practitioners/stakeholders

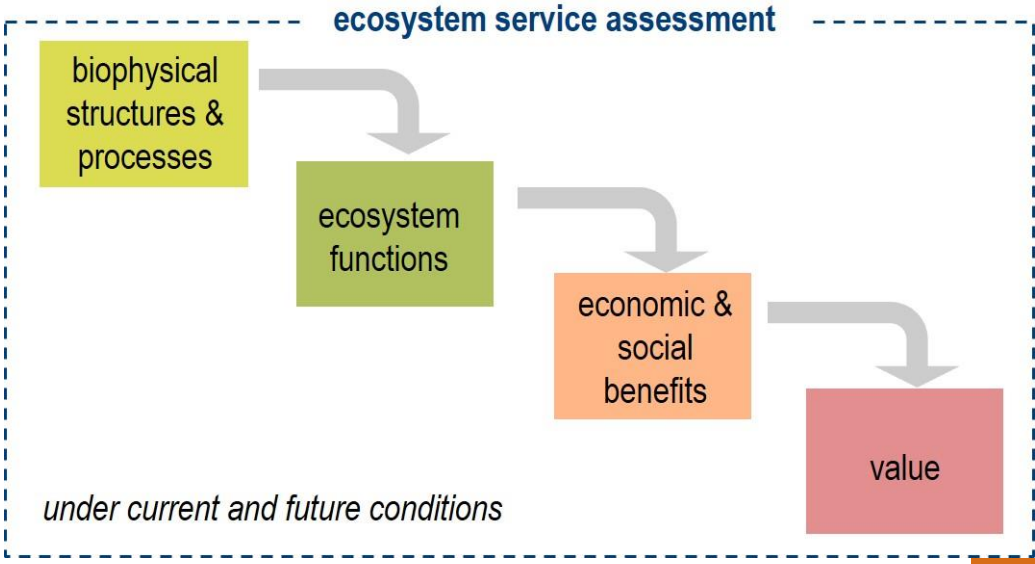
knowledge = systems knowledge + goal knowledge (values) + transformation knowledge

Research goal of SuMaRiO

Do **transdisciplinary ESA**

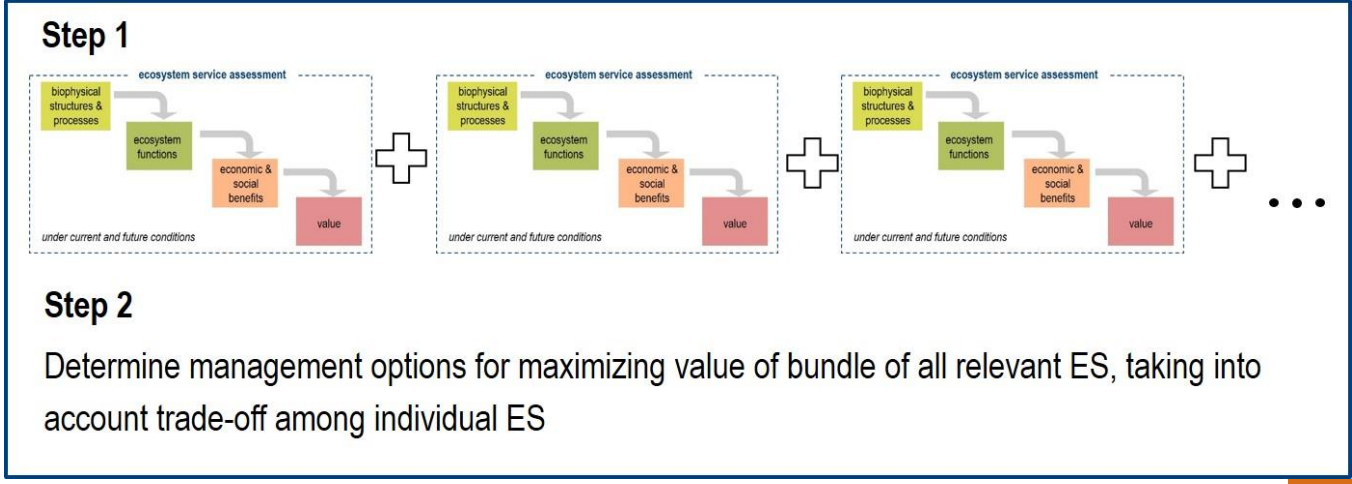
- to improve **recognition** and **understanding** of **ES** in the Tarim basin and
- promote explicit **integration** of the ES concept **into land and water resources management** in Xinjiang

Research goals achieved in WB 5



- understand **benefits of ecosystems and value of specific ES** for farmers, citizens and stakeholders/experts in monetary or non-monetary terms (WG Doluschitz, WG Ahlheim, WG Döll)
  - WG Doluschitz: quantify value of the ecosystem service food and fiber production in terms of yield (non-monetary) and farmer income (monetary)
  - WG Ahlheim: determine total value of sustainable oasis management (difference between the value of a healthy ecosystem after a change in oasis management and the current ecosystem) in terms of willingness to pay of Chinese cititizens (monetary)
  - WG Döll: quantify value of urban and peri-urban trees for dust and heat management (non-monetary)
- analyze and propose **policy measures for sustainable agricultural production** based on water price analysis and others (WG Doluschitz)

Research goals achieved in WB 5



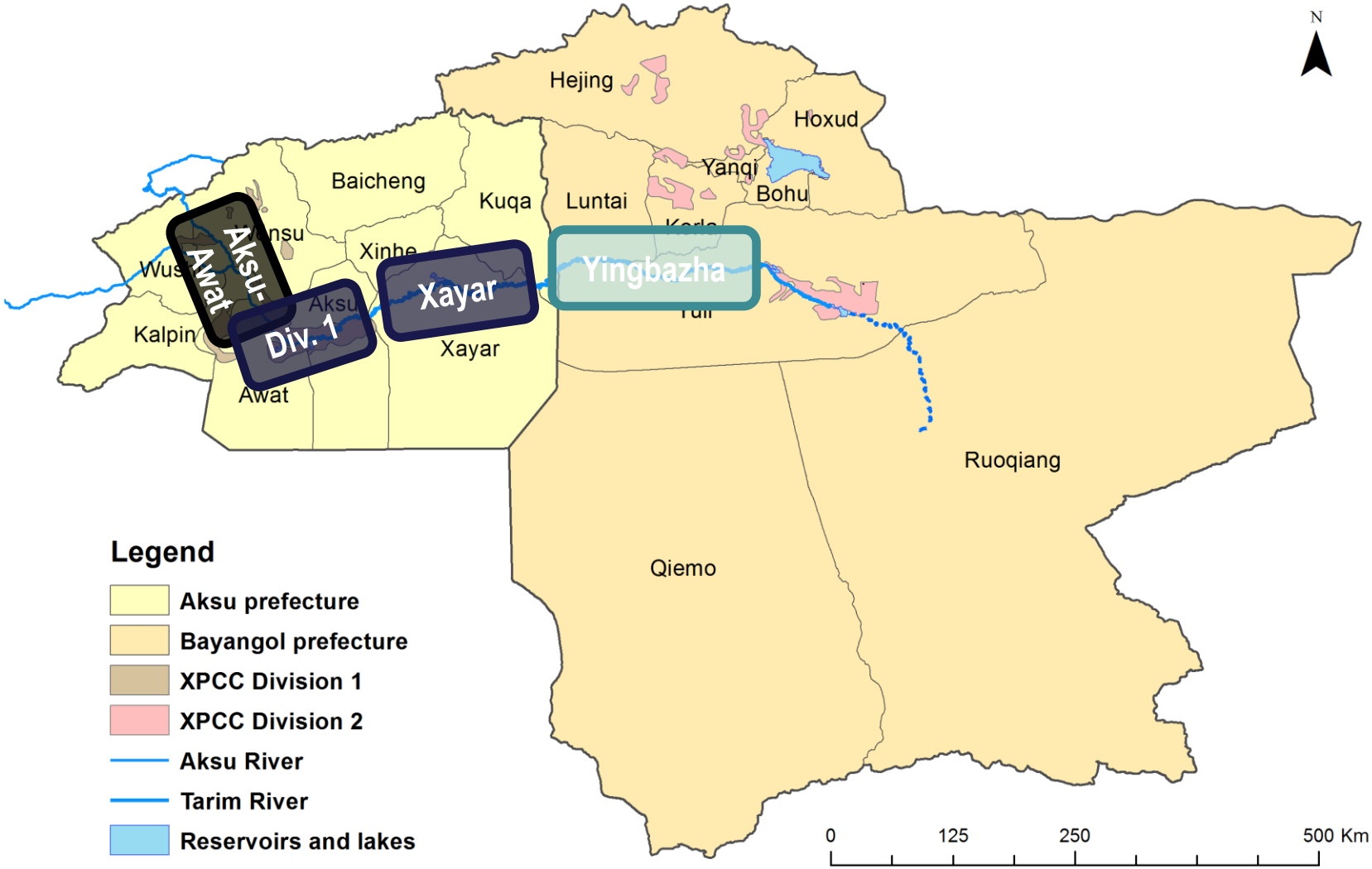
- 1 Integrate disciplinary knowledge and stakeholder knowledge regarding ES in the Tarim basin in a qualitative manner (e.g. identify ES relevant to stakeholders, relate benefits to ecosystem processes and functions) (AG Döll)
- 2 (Partly) based on 1, integrate disciplinary knowledge in a quantitative manner in the form of a Decision Support System (DSS) for the Tarim Basin (AG Brieden/AGDisse)
- 3 Create knowledge regarding transdisciplinary research methods suitable for TDR in China (AG Döll)

Valuation of ES food and fiber production
Policy measures for sustainable agricultural production (WG Doluschitz)

- Assessment of the socio-economic situation of agricultural production systems
  - Expert interviews, workshops, and 257 farm household interviews

JOHANN WOLFGANG GOETHE
UNIVERSITÄT
FRANKFURT AM MAIN

Location of household interviews



Valuation of ES food and fiber production Policy measures for sustainable agricultural production (WG Doluschitz and Chinese partners)

JOHANN WOLFGANG GOETHE UNIVERSITÄT FRANKFURT AM MAIN

- Assessment of the socio-economic situation of agricultural production systems
  - Expert interviews, workshops, and 257 farm household interviews
  - Econometric analysis of agr. production (determinants of yield, WUE and income)
  - Testing effectiveness and efficiency of agricultural and water policies using mathematical programming models
  - Bayesian network modeling to understand impact of water pricing

- Results
  - Current water pricing appears insufficient to save water.
  - Use of drip irrigation, owning a well, and location (Div. 1) were identified as major determinants for yield, WUE, and income.
  - High increase in volumetric water prices has the potential to reduce water consumption significantly.
  - To maintain agricultural productivity and incomes a) subsidizing of drip irrigation and alternative crops and b) improved agricultural extension (e.g. to increase farm productivity and to adapt to increased water prices) is required

Total value of sustainable oasis management (WG Ahlheim and Chinese partners)

- Method: Personal interviews according to the Contingent Valuation Method (CVM) aiming at the assessment of people's willingness to pay (WTP) to get a more sustainable oasis management in the Tarim basin realized.
- CVM interviews were conducted with people living on the project site (Tarim basin) and with people living in Beijing as an example of people living far away from the project site and still benefitting from the project.
- People in the Tarim basin receive **use values as well as nonuse values** from the oasis management project while Beijing residents receive only nonuse values. The total social value of the project equals the sum of use and nonuse values.
- 2.438 completed face-to-face street intercept interviews in Beijing (random sample); quota sampling to ensure a certain representativeness with respect to age, income and level of education

Total value of sustainable oasis management (WG Ahlheim and Chinese partners)

JOHANN WOLFGANG GOETHE UNIVERSITÄT FRANKFURT AM MAIN

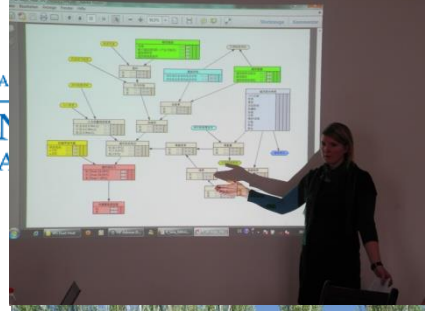
Results

- Mean WTP of Beijing residents for a more sustainable water management in the Tarim basin: **107 RMB per household per month (1% of income)**
- With 4 million households in urban Beijing, overall social value of sustainable management of Tarim basin for Beijing residents is estimated to be 429 mio RMB per month

Dust and heat management in oasis towns
(Dissertation of Sina Frank)

Due to very limited (access to) quantitative data relevant for dust and heat management (town geometries, building types and materials etc) but access to experts, research was refocused

- to address "**ecosystem services of urban and peri-urban vegetation**"; this focus was derived from interviews with local urban landscape planners
- such that knowledge of experts became the only source of information for the conditional probability tables of the BN (experts include local and international experts, incl. Ümüt Halik of WB4)



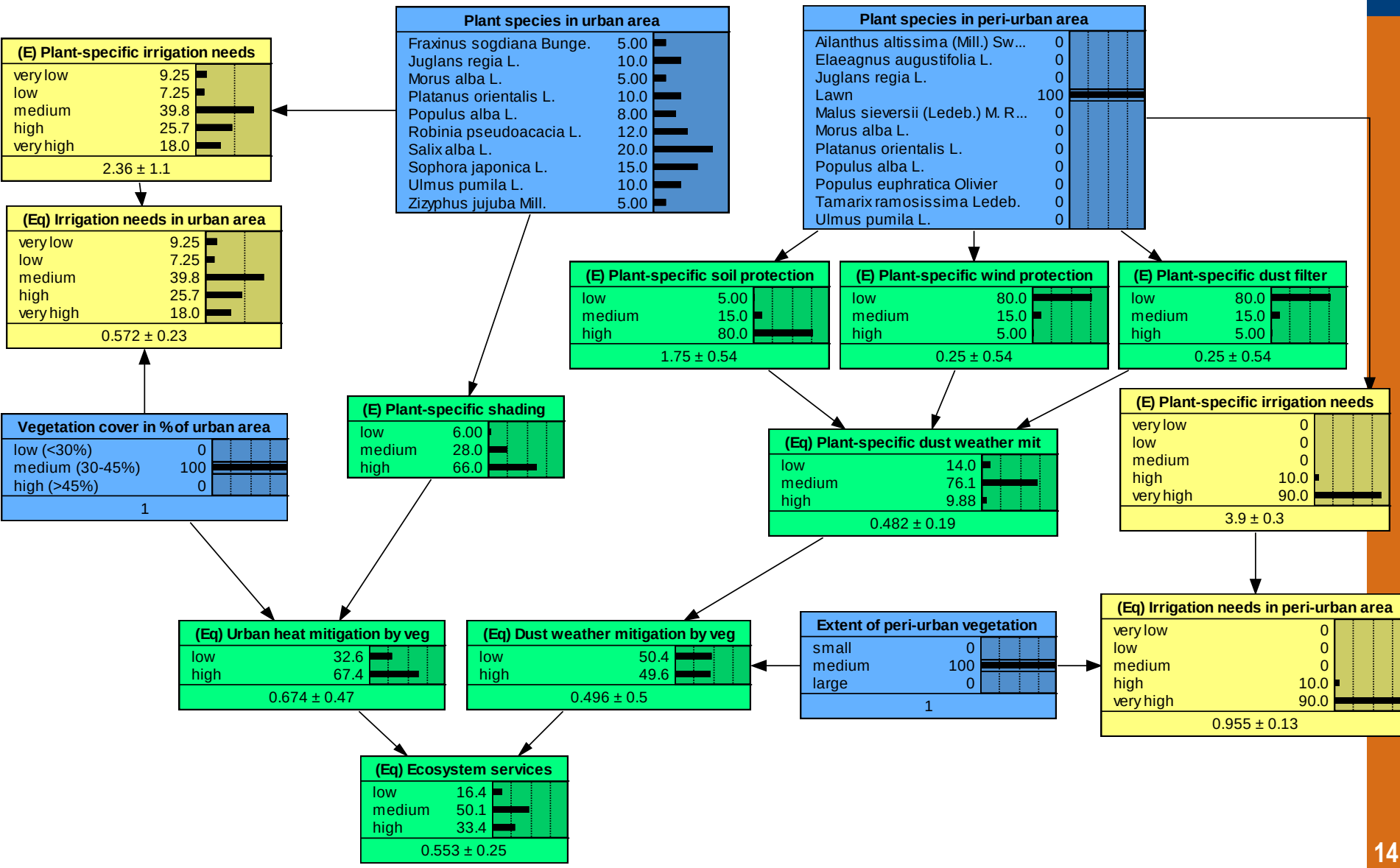

Interview partners and workshop participants

Interviews	Interview Partners	
	Experts working in academia	Experts working outside academia
Aksu		5
Korla		1
Beijing	3	
Germany	3	
Total	6	6

Workshops	Workshops Participants		Total
	Experts working in academia	Experts working outside academia	
Workshop I	8	4	12
Workshop II	4	3	7
Workshop III	5	2	7

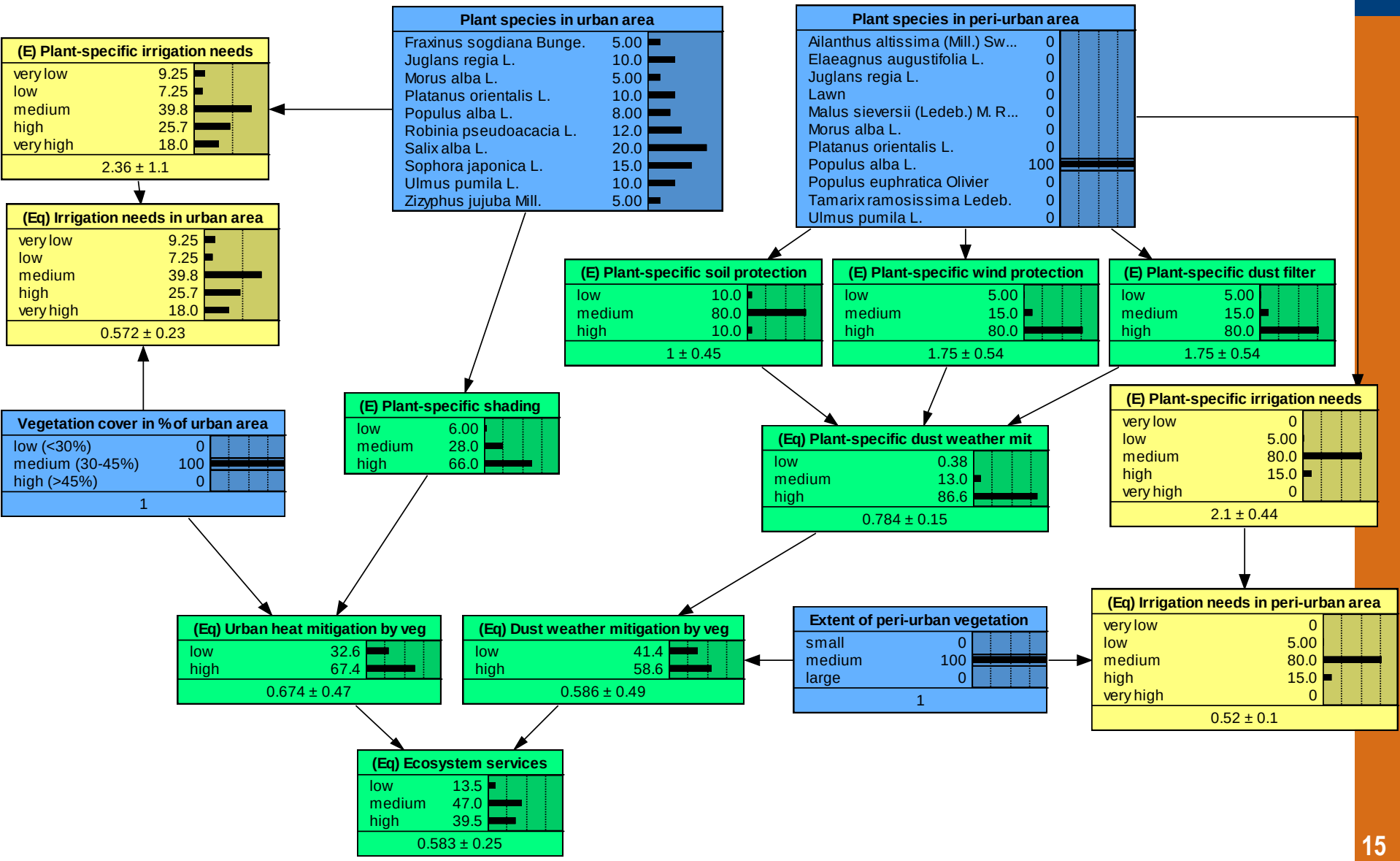
Bayesian Network on ecosystem services of urban and peri-urban vegetation

JOHANN WOLFGANG GOETHE UNIVERSITÄT FRANKFURT AM MAIN



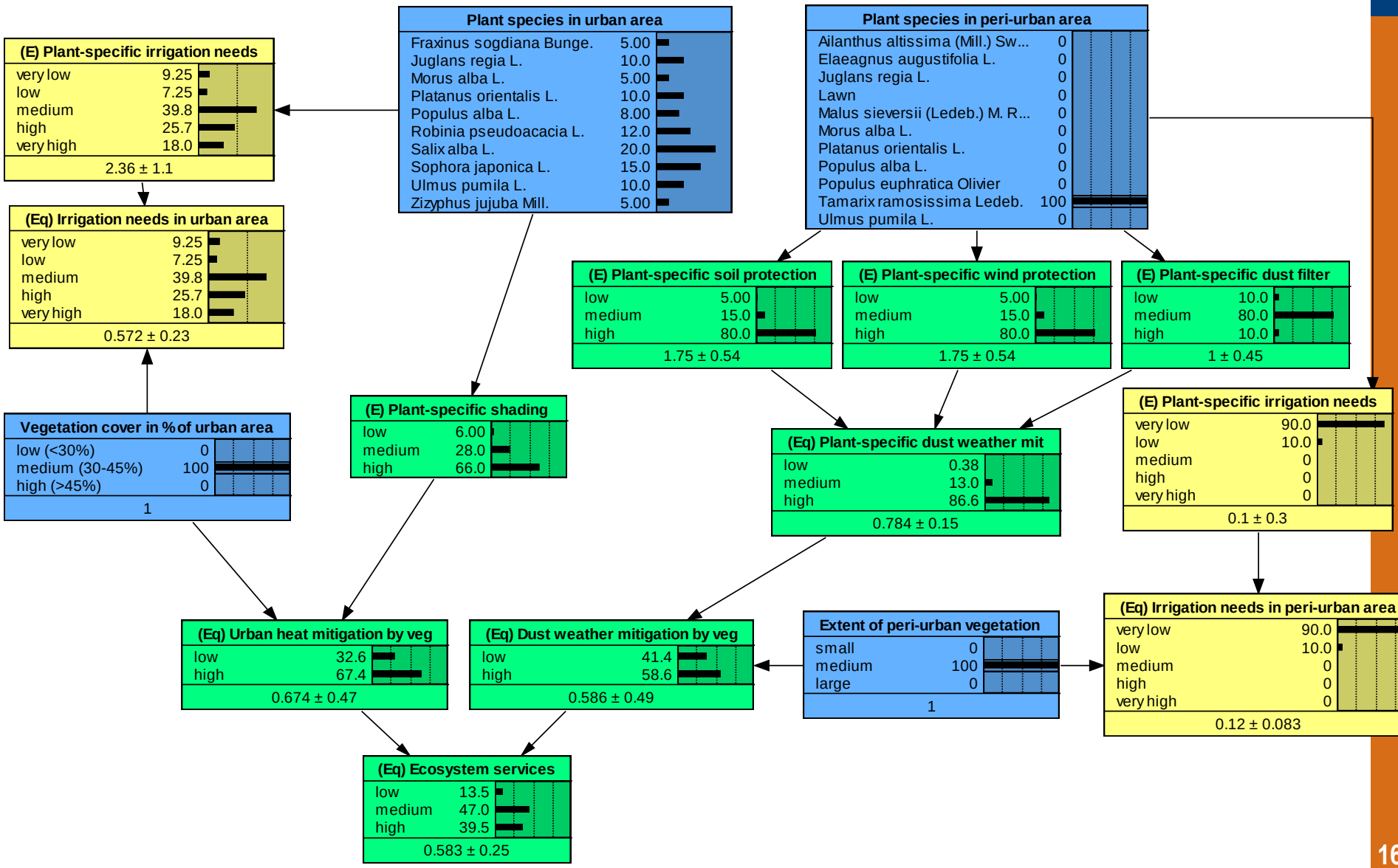
Bayesian Network on ecosystem services of urban and peri-urban vegetation

JOHANN WOLFGANG GOETHE UNIVERSITÄT FRANKFURT AM MAIN



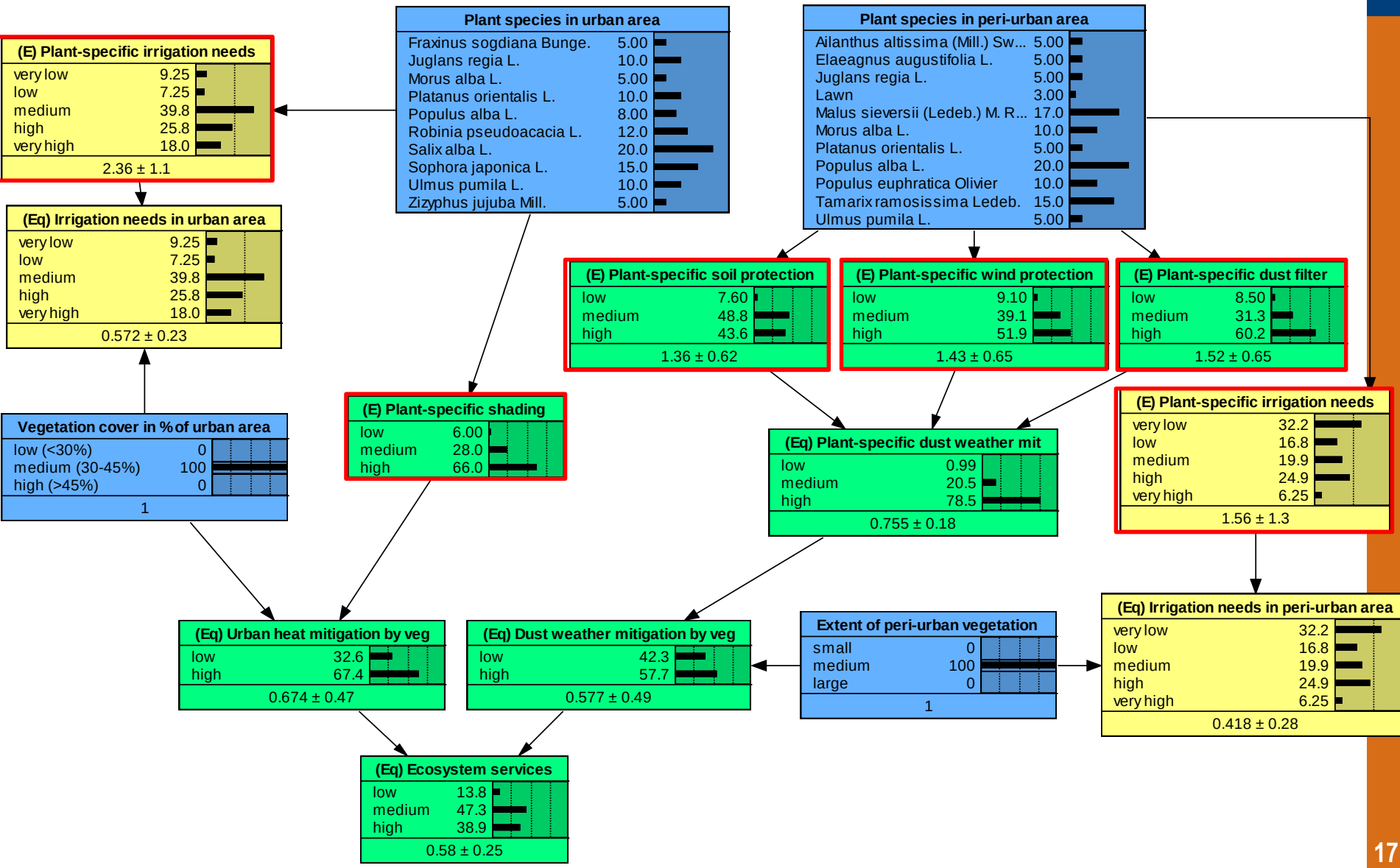
Bayesian Network on ecosystem services of urban and peri-urban vegetation

JOHANN WOLFGANG GOETHE UNIVERSITÄT FRANKFURT AM MAIN



Bayesian Network on ecosystem services of urban and peri-urban vegetation

JOHANN WOLFGANG GOETHE UNIVERSITÄT FRANKFURT AM MAIN



Generating conditional probability tables by expert elicitation

JOHANN WOLFGANG GOETHE UNIVERSITÄT FRANKFURT AM MAIN

		Irrigation needs (between 0 - 1) 1 highest need 0 lowest need	Soil stability Very high +++ (3) high ++ (2) rather high + (1) low – (0)	Wind protection Very high +++ (3) high ++ (2) rather high + (1) low – (0)	Dust filter Very high +++ (3) high ++ (2) rather high + (1) low – (0)
1	臭椿 Ailanthus altissima (M.) Swing.  	0.23	1.43	1.38	1.75
2	沙枣 Elaeagnus augustifolia L.  	0.13	2.43	2.63	2.38
3	核桃 Juglans regia L. 	0.57	1.71	2	2.13

Generating conditional probability tables by expert elicitation

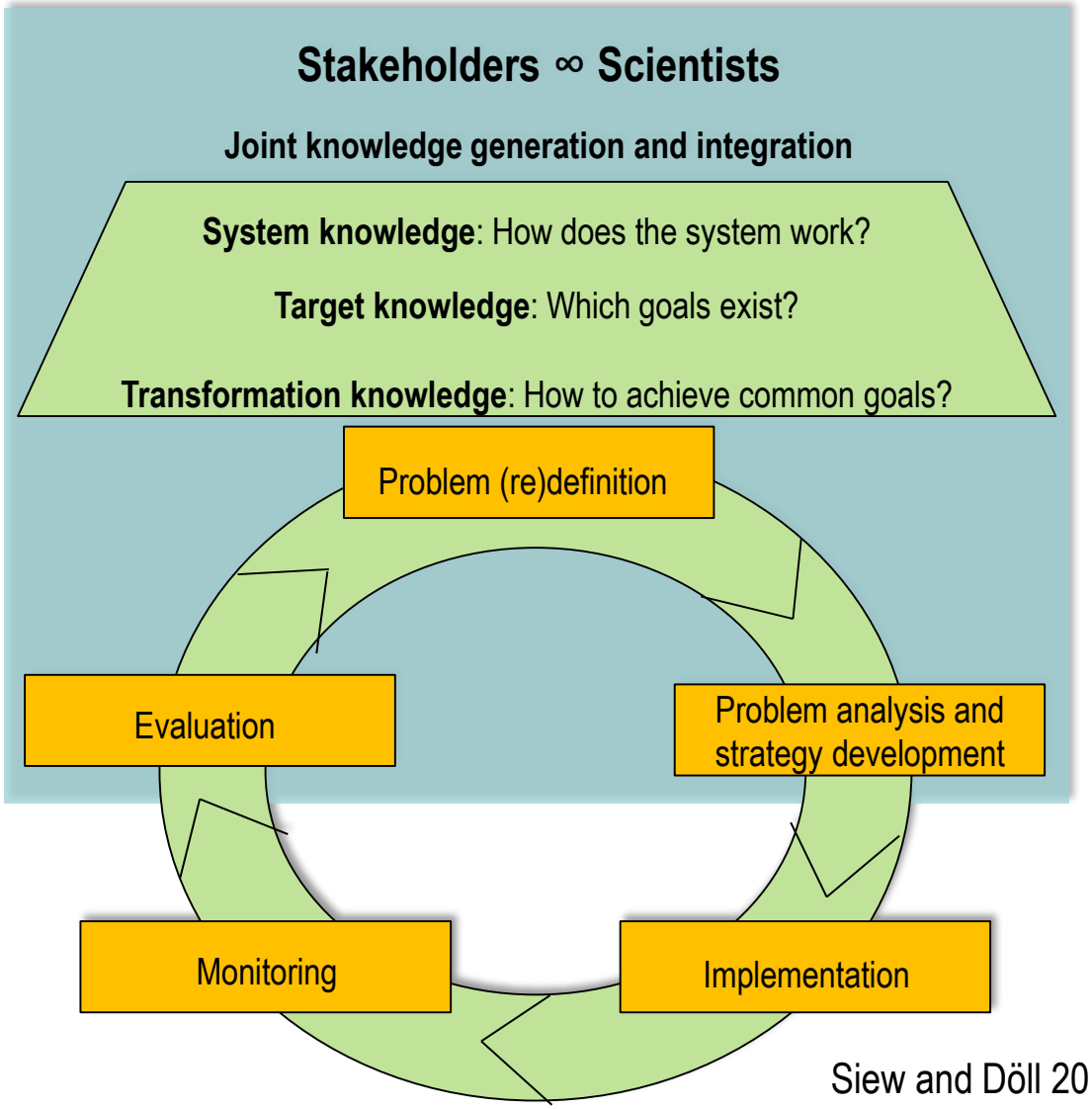
	very low (0-0.20)	low (0.21-0.40)	medium (0.41-0.60)	high (0.61-0.80)	very high (0.81-1)
0-0.1	90	10	0	0	0
0.11-0.2	80	15	5	0	0
0.21-0.3	15	80	5	0	0
0.31-0.4	5	80	15	0	0
0.41-0.5	0	15	80	5	0
0.51-0.6	0	5	80	15	0
0.61-0.7	0	0	15	80	5
0.71-0.8	0	0	5	80	15
0.81-0.9	0	0	5	15	80
0.91-1	0	0	0	10	90

		Irrigation needs of plants				
	Ø	very low (0-0.20)	low (0.21-0.40)	medium (0.41-0.60)	high (0.61-0.80)	very high (0.81-1)
Ailanthus altissima (M.) Swing.	0.23	15	80	5	0	0
Elaeagnus augustifolia L.	0.13	80	15	5	0	0
Fraxinus sogdiana Bunge.	0.56	0	5	80	15	0
Juglans regia L.	0.62	0	0	15	80	5
Lawn	1	0	0	0	10	90
Malus sieversii (Ledeb.) M. Roem.	0.8	0	0	5	80	15
Morus alba L.	0.38	5	80	15	0	0
Platanus orientalis L.	0.74	0	0	5	80	15
Populus alba L.	0.59	0	5	80	15	0
Populus euphratica Olivier	0.09	90	10	0	0	0
Robinia pseudoacacia L.	0.53	0	5	80	15	0
Salix alba L.	0.81	0	0	5	15	80
Sophora japonica L.	0.54	0	5	80	15	0
Tamarix ramosissima Ledeb.	0	90	10	0	0	0
Ulmus pumila L.	0.1	90	10	0	0	0
Zizyphus jujuba Mill.	0.51	0	5	80	15	0

Results

- We developed a new method for eliciting expert knowledge and for translating it into conditional probability tables for BNs that
  - accomodates difficulty for experts to provide CPTs
  - takes into account uncertainty of expert opinions
  - is transparent and replicable
- Causal network structure of BNs has helped experts to discuss, re-think and understand more deeply.
- Better results could be obtained in the future by
  - cooperating with the same group of experts throughout all workshops
  - by having access to some quantitative data

Transdisciplinary research (TDR) to support implementation of the ES concept into land and water management in the Tarim Basin

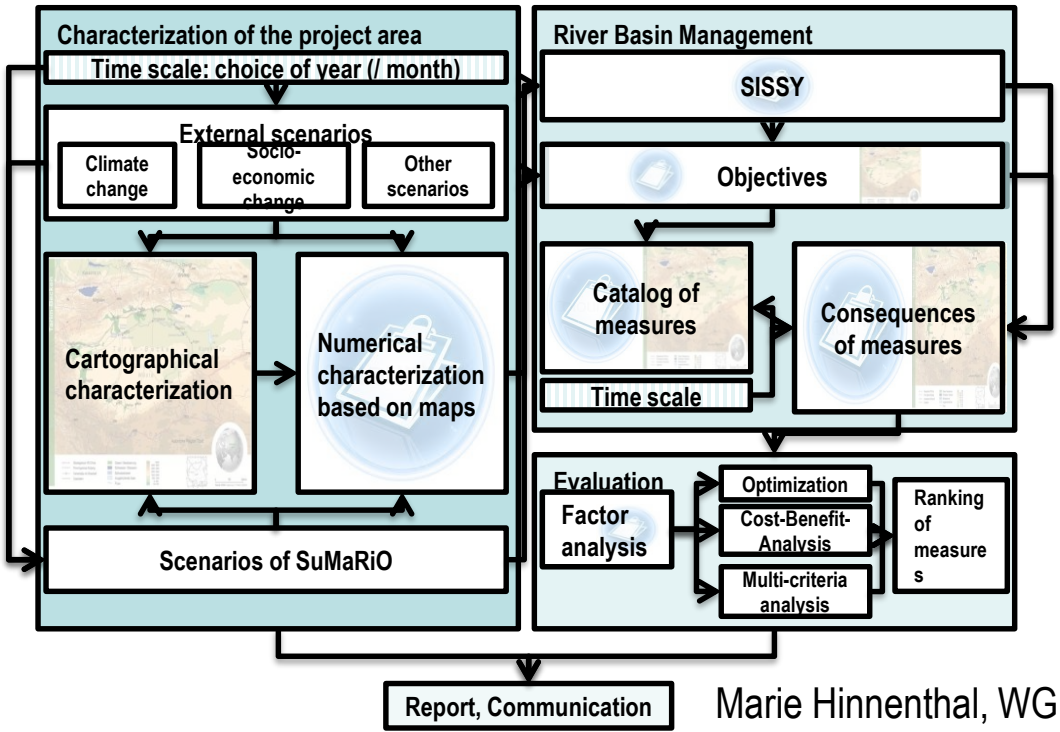


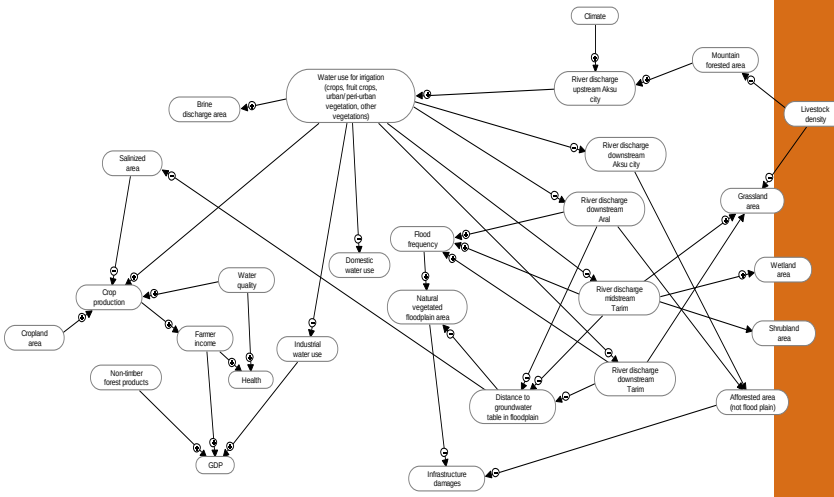
Siew and Döll 2012, JAL

Interdisciplinary knowledge integration

SuMaRiO DSS Meeting, February 2012

Goal: to jointly develop concept for the SuMaRiO indicator-based DSS.

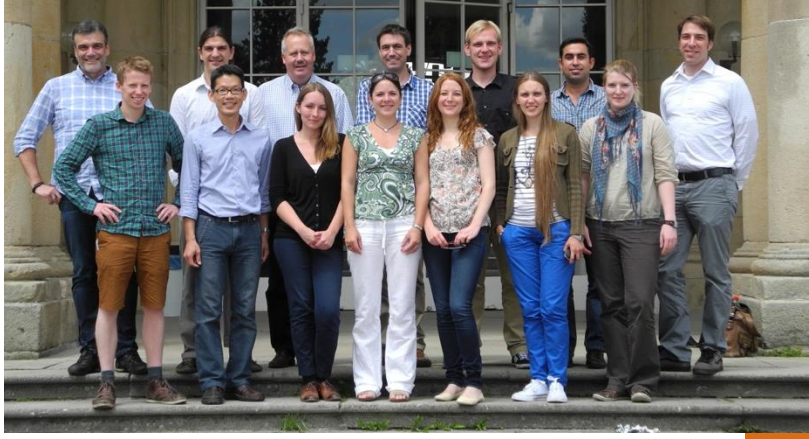




Causal network of indicators for IWRM in the Aksu-Tarim River Basin

Marie Hinnenthal, WG Brieden

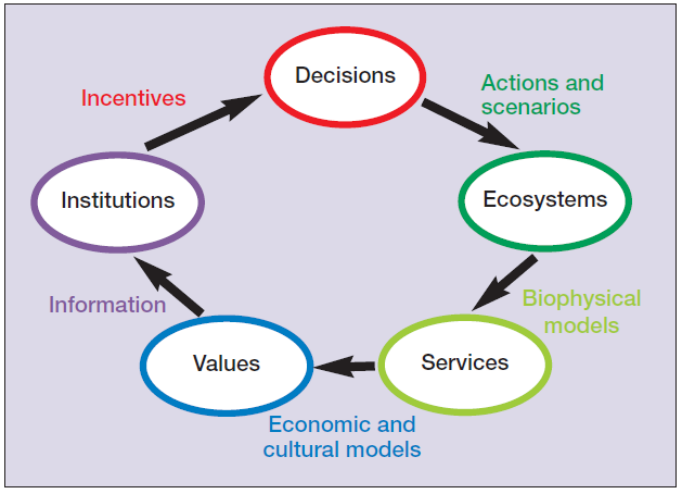
Interdisciplinary knowledge integration



SuMaRiO Scenario-ES-DSS Meeting, July 2012, with 14 SuMaRiO researchers from all five work block

Goal: to develop a common socio-economic-ecological/climate-run-off scenario framework and to identify input-output models and ES/non-ES indicators that could be included in the SuMaRiO indicator-based DSS.

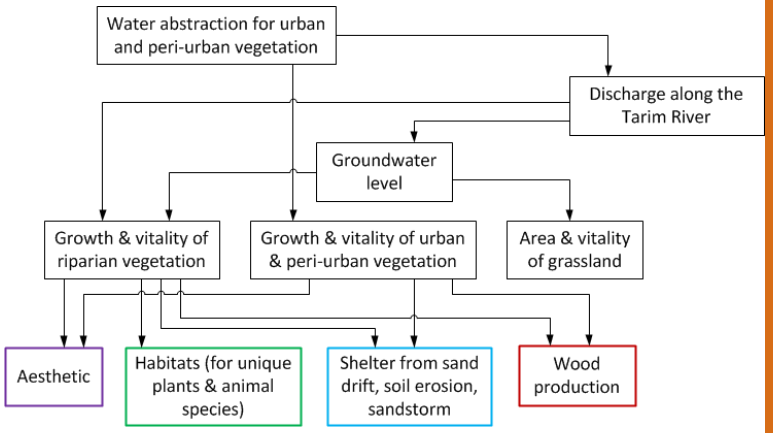
Taking into account input of stakeholders elicited by Tuck Fatt Siew in interviews and SDT workshop I



Interdisciplinary knowledge integration

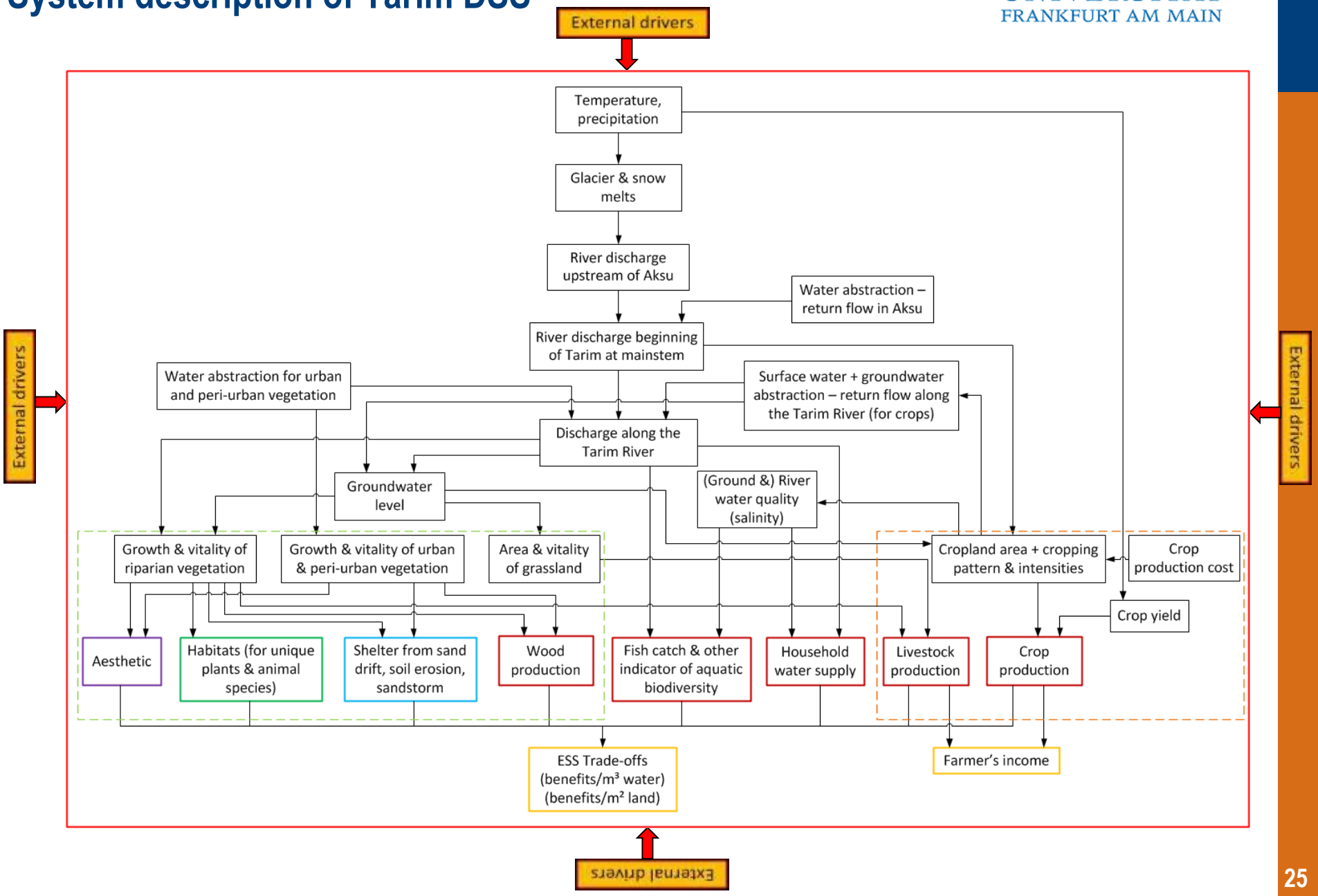
SuMaRiO DSS-Scenario-ESS Workshop, February 2013 (2 full days), with 31 SuMaRiO researchers from all five work block

Results: two qualitative storylines were developed, management measures were identified, variables and interlinkages of DSS identified, quantification by submodels discussed.



Interdisciplinary knowledge integration
System description of Tarim DSS

JOHANN WOLFGANG GOETHE
UNIVERSITÄT
FRANKFURT AM MAIN



Elements of participatory process implemented in Stakeholder Dialogue Tarim basin (interviews + 5 workshops)

JOHANN WOLFGANG GOETHE UNIVERSITÄT FRANKFURT AM MAIN

- **Stakeholder analysis** including identification of key stakeholder
- Interviews with stakeholders/scientists to generate **perception graphs** (basis of actor modelling)
- Joint development of **causal networks**
- Participatory generation of **qualitative scenarios**

Criteria for suitable participatory methods (Düspohl and Döll 2015): They

1. map the diversity of stakeholders' perspectives,
2. reflect appropriately the complexity of the problem,
3. take into account the uncertainty in the problem field,
4. support the identification of mutually agreed, implementable and coherent strategies.
5. Enhance social learning (= change cognition of the participants and the relationships they have with one another)

Challenges for TDR in Xinjiang/China

- Less experience with interdisciplinary and multi-sectoral knowledge exchange and integration exists in Xinjiang/China than in Germany.
- Not all relevant stakeholders can be integrated in stakeholder dialogue due to the sociopolitical situation in Xinjiang.
- Stakeholders were reluctant to participate (lack of authorization or trust?)
- Data access (not only for foreigners) is difficult, sometimes impossible even if stakeholders are interested in cooperation.
- In both stakeholder dialogues, the composition of the participant groups varied strongly from workshop to workshop (e.g. due to sudden other commitments)
- Ways of communication in Chinese culture(s) are different from western culture(s).
- Language barrier

Adaptation of TR methods for China

- Workshops adapted to Chinese communication preferences
  - Open discussions are scheduled only within groups of up to 6 participants
  - Individual questionnaires, filled out during the workshop, serve for knowledge elicitation
  - Cooperative tasks for groups of 2-3 workshop participants allow knowledge elicitation and integration.
  - Stakeholder input to scenario frameworks/storylines is achieved by having them comment on proposals of scientists, instead of doing direct participatory scenario development
- Actor(-based) modeling with DANA, with modeling of actor/stakeholder perceptions and actions, is not feasible in Xinjiang (if done openly and used for communication purposes). Stakeholder representatives do not wish to explicitly present the problem perception of the stakeholder, and see it documented by a perception graph. Causal networks that scientists and stakeholders have agreed on are more suitable.

Conclusions on methods of transdisciplinary knowledge integration

Qualitative methods, i.e. perceptions graphs PG, causal networks CN, and scenario development SD, are very good methods for transdisciplinary knowledge integration

- They are efficient: relatively simple, low cost, well-understood by participants, achieve the goal of knowledge integration
- PG: target and transformation knowledge explicitly elicited
- CN: joint problem perspective developed, system knowledge increased
- SD: thinking about the future increases system and transformation knowledge, in particular regarding the differentiation of external drivers and internal management options and grasping uncertainties
- They form the basis for more sophisticated (semi)quantitative modelling approaches, which should be applied depending on the level of existing knowledge and time constraints.

Evaluation of four BMBF TDR projects in China and Southeast Asia (Siew et al. submitted)

- SuMaRiO, SURUMER, LEGATO, LUCCi
- Recommendations developed for doing TDR in Asia

SuMaRiO

Sustainable Management of River Oases along the Tarim River / China

Proposal for the design of participatory processes in Xinjiang: A six-step approach

1. Identify key stakeholder as well as scientific facilitator/analyst of participatory process
2. Perform stakeholder analysis and identify stakeholders and their representatives to be invited to the process (interviews and workshops)
3. Elicit and analyze stakeholder problem perspectives by interviewing stakeholders (and scientists)
4. Develop joint problem perception in workshop(s) with stakeholders (and scientists)
5. Systematically think about the future as the basis for identifying sustainable management options, possibly supported by quantitative modeling
6. Derive strategies/management measures with stakeholders (and scientists)

Federal Ministry of Education and Research

新疆师范大学 Xinjiang Normal University

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

JOHANN WOLFGANG GOETHE UNIVERSITÄT FRANKFURT AM MAIN

SuMaRiO

中国塔里木河流域沿河绿洲的可持续管理

新疆环境可持续管理建议：参与式方法的应用

（一）确定关键利益相关者和参与过程的主持人/分析员。

（二）进行利益相关者利益分析，确定将被邀请加入参与过程（访谈和讨论会）的部门、机构和其代表。

（三）访问参与的代表，分析各领域利益相关者和科学家对环境问题的看法（或观点）。

（四）在讨论会上确定各领域利益相关者和科学家对环境问题的共同看法。

（五）在系统思考未来情景的基础上，确定环境可持续管理方案（可以通过模型进行定量式情景模拟）。

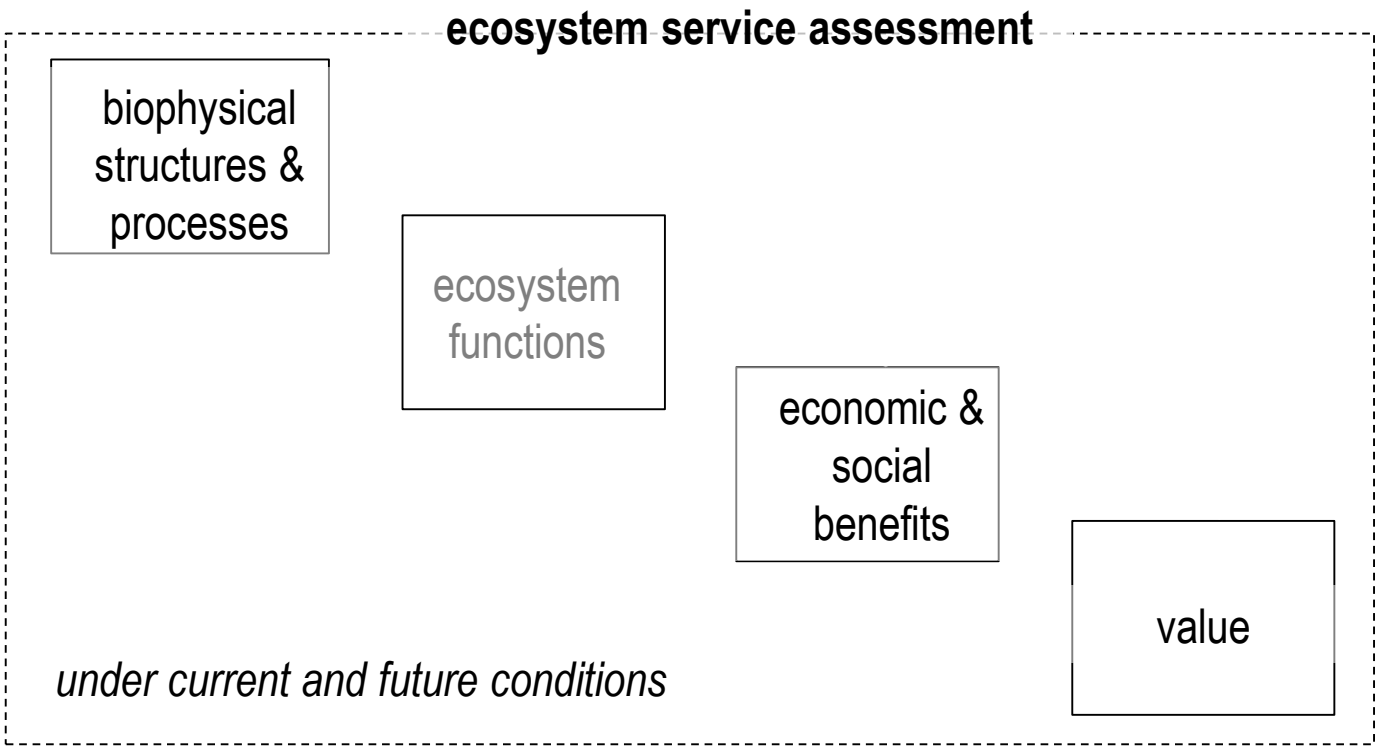
（六）各领域利益相关者和科学家共同确定战略/管理措施。

Federal Ministry of Education and Research

新疆师范大学 Xinjiang Normal University

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

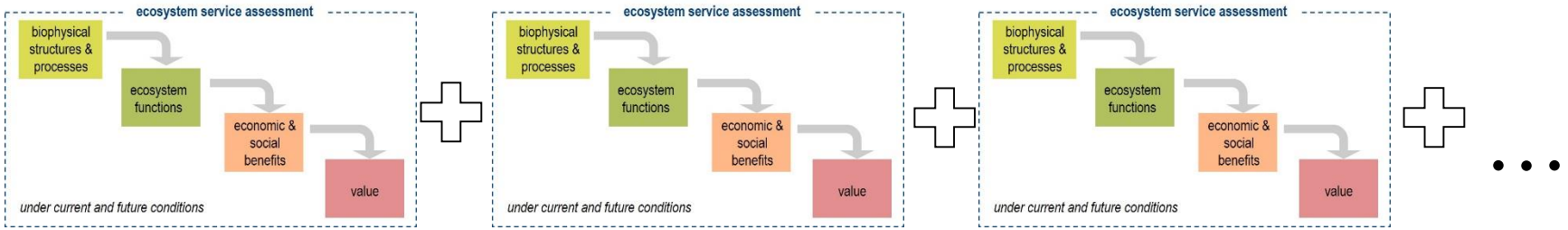
Workflow for assessing an ecosystem service
(interpreting the cascade models of Haines-Young and Potschin (2009, 2010), and TEEB (2010))



Barth and Döll, submitted (modified)

Assessment of all relevant ES

Step 1



Step 2

Determine management options for maximizing value of bundle of all relevant ES, taking into account trade-off among individual ES

Overall participatory process does not only aim at knowledge integration but also at broader "social learning"

- Social learning: A series of semi-facilitated and semi-structured interactions between a heterogeneous group of stakeholders resulting in a change in social cognition of the participants and the relationships they have with one another (Düspohl et al. submitted).
- Seven components relevant for the social-cognitive and social-relational dimension of social learning, selected from Pahl-Wostl and Hare (2014) (Düspohl et al. submitted)
  - awareness of each other's sometimes different goals and perspectives (sc)
  - shared problem perspective (sc)
  - understanding of the actors' interdependence (sc)
  - understanding the system complexity (sc)
  - learning to work together (sr)
  - trust (sr)
  - the creation of informal as well as formal relationships (sr)