Ecosystem services and alternative concepts of human-nature relationship: stakeholders' perspectives on their relevance in river landscape management

Dissertation
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Submitted by

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Preface

This dissertation is submitted as cumulative thesis, consisting of five published research articles that are included as original reprints, one forthcoming article, one accepted article and two submitted manuscripts that are currently in review. The introduction and the synthesis aim to set the frame and summarize the findings that are discussed in more detail in the papers.

The thesis was composed in the frame of the Doctoral School of Sustainable Development (dokNE) at the University of Natural Resources and Life Sciences Vienna. The doctoral school was funded by the University of Natural Resources and Life Sciences Vienna, the City of Vienna, the Ecosocial Forum Vienna, the Province of Lower Austria, the Federal Ministry of Science, Research and Economy and Billa.

Contents

Abstract

Various anthropogenic uses lead to changes of river landscapes that have an effect on the availability of landscape functions provided by the river system. This interaction between the bio-physical and the socio-cultural system is increasingly being described by the ecosystem services (ES) concept.

Despite its' growing importance in research, the practical relevance of this concept for river management is lacking behind. To investigate potential reasons for this science-practice gap and ways to move the concept's application in practice forward a survey among different stakeholder groups was conducted and their perceptions regarding the ES concept were analyzed. The potential for its application in river landscape management practice was also investigated by conducting a survey on different stakeholders' perceptions of the availability and importance of ES. Thereby the concept's applicability as communication and education instrument as well as potential approach to assess the success of river restoration was identified.

Consideration is also being given to the fact that stakeholders' behavior and their perceptions regarding river landscapes may be influenced by different concepts of human-nature relationships (HNR). To investigate this linkage between HNR and environmental behavior a scale was developed and tested at two case studies in the context of river landscape management and in the frame of student surveys in the US and in Austria.

The thesis' results show that despite a limited integration of the ES concept in the practice of river landscape management stakeholders from different fields perceive it as practicable. It was particularly seen as useful to aid planning and decision making and as communication and education tool. The case study based applications of the ES concept proved its usefulness to draw a comprehensive picture of the functions and services that are of importance for different stakeholder groups. Moreover it can be beneficial in illustrating the societal benefits of river restoration and to foster environmental awareness and literacy. In order to improve the ES concept's application in practice a need for further development was identified. This could be done through a better integration of practice experts, downscaling to local levels and further developing alternative assessment methods.

Results of the investigation regarding human-nature relationships on the individual level revealed that people hold multiple and often even conflicting human-nature relationships. This confirms findings in literature that HNRs are not mutually exclusive and context dependent. Furthermore a clear correlation between people's HNR and their environmental behavior was identified which supports the assumption that considering the relationship humans have with nature assists in understanding human behavior. Another finding out of these studies was the little identification of interviewees with the concept of human mastery over nature. This was found to be due to differences between the professional and the private sphere of a person, a social desirability bias and a partly insufficient wording of the applied narratives.

Study participants showed a strong interest in discussing and reflecting on human-nature relationships and highlighted its potential applicability in future governance processes. Further research is needed to provide a structured, easily comprehensible tool to be applied in this context. A first step towards that goal is the development of an add-on module for existing frameworks of human-environment interactions that also considers relations between people's values, attitudes and understandings of human-nature relationships as well as environmental behavior. To be able to better rebalance the relationship humans have with nature future research should also focus on the question on how to activate or strengthen HNRs by governance strategies and communication framings.

The thesis' findings shall serve as a basis for future management and conservation programmes. Moreover they are meant as a contribution to further scholarly discussions on the issues addressed.

Kurzfassung

Flusslandschaften erfahren durch verschiedene menschliche Nutzungen Veränderungen, die sich auf die Verfügbarkeit der vielfältigen Funktionen von Fließgewässersystemen auswirken. Diese Interaktion zwischen dem biophysikalischen und dem soziokulturellen System wird in zunehmendem Maße durch das Konzept der Ökosystemleistungen (ÖSL) beschrieben.

Trotz der zunehmenden Bedeutung dieses Konzepts in der Forschung ist dessen praktische Relevanz für das Fließgewässermanagement gering. Um mögliche Gründe für diese Unterschiede zwischen Wissenschaft und Praxis zu erheben und Wege zu erforschen, um die Anwendung des Konzepts in der Praxis voranzutreiben wurde eine Befragung verschiedener Stakeholdergruppen durchgeführt und deren Wahrnehmungen hinsichtlich des Konzepts der Ökosystemleistungen analysiert. Die Anwendungsmöglichkeiten dieses Konzepts in der Praxis des Fließgewässermanagements wurden auch durch eine Befragung verschiedener Stakeholdergruppen zur Wahrnehmung der Verfügbarkeit und Bedeutung von Ökosystemleistungen von Flusslandschaften erhoben. Vor allem die Anwendbarkeit des Konzepts als Kommunikations- und Bildungsinstrument sowie als möglicher Ansatz zur Untersuchung des Erfolgs von Fließgewässerrevitalisierungen wurde in diesem Rahmen ermittelt.

Berücksichtigung fand auch die Tatsache, dass das Verhalten unterschiedlicher Stakeholder und deren Wahrnehmung in Bezug auf Flusslandschaften durch verschiedene Konzepte der Mensch-Natur Beziehung beeinflusst sein könnten. Um diese Verbindung zwischen der Mensch-Natur Beziehung und dem Umweltverhalten zu untersuchen, wurde eine Skala entwickelt und in zwei Fallstudien im Kontext Fließgewässermanagement und im Rahmen von Studierendenbefragungen in den USA und in Österreich getestet.

Die Ergebnisse der Arbeit zeigen, dass das Konzept der ÖSL trotz einer begrenzten Integration in der Praxis des Flusslandschaftsmanagements von Stakeholdern aus verschiedenen Bereichen als praktikabel wahrgenommen wird. Es wurde als besonders hilfreich zur Unterstützung von Planungs- und Entscheidungsprozessen sowie als Kommunikations- und Bildungsinstrument wahrgenommen. Die fallstudienbasierten Anwendungen bestätigen, dass mit Hilfe des Konzepts der ÖSL verschiedenen Stakeholdergruppen die Bedeutung von Funktionen und Leistungen vermittelt werden können. Darüber hinaus kann es hilfreich sein, um die gesellschaftliche Bedeutung von Fließgewässerrevitalisierungen aufzuzeigen. Zur Förderung der praktischen Anwendung des Konzepts ist dessen Weiterentwicklung erforderlich. Dies könnte durch eine bessere Einbindung von PraxisexpertInnen, ein Herunterstufen auf eine lokale Ebene sowie eine Weiterentwicklung alternativer Bewertungsmethoden erfolgen.

Die Ergebnisse der Untersuchung der Mensch-Natur Beziehung auf der individuellen Ebene zeigen, dass Menschen mehrere und oft miteinander in Widerspruch stehende Beziehungen zur Natur haben. Dies deckt sich auch mit anderen Ergebnissen in der Literatur, wonach sich die verschiedenen Beziehungsformen zwischen Mensch und Natur nicht gegenseitig ausschließen und kontextabhängig sind. Weiters konnte ein klarer Zusammenhang zwischen der Mensch-Natur Beziehung und dem Umweltverhalten festgestellt werden. Dies bestärkt die Annahme, dass die Berücksichtigung des Verhältnisses, das Menschen zur Natur haben, zum Verständnis des menschlichen Verhaltens beitragen kann. Eine weitere Erkenntnis, die aus dieser Untersuchung gezogen werden konnte war die geringe Identifikation der befragten Personen mit dem Konzept des „Masters“: Dies hängt unter anderem mit Unterschieden zwischen dem beruflichen und dem privaten Bereich einer Person, sozial erwünschten Antwortmustern sowie einer teilweise unzureichenden Formulierung der verwendeten Narrative zusammen.

Die UntersuchungsteilnehmerInnen zeigten ein starkes Interesse in der Diskussion und Reflexion der Mensch-Natur Beziehung und unterstrichen dessen potentielle Anwendbarkeit in zukünftigen Management- und Steuerungsprozessen. Es braucht weitere Forschung um ein strukturiertes und einfach anwendbares Instrument zu entwickeln, das in diesem Kontext angewendet werden kann.

Ein erster Schritt hin zu diesem Ziel ist die Entwicklung eines Zusatzmoduls für bestehende Modelle der Mensch-Umwelt Interaktionen, die auch die Beziehungen zwischen menschlichen Werten und Haltungen, das Verständnis der Mensch-Natur Beziehung sowie das Umweltverhalten berücksichtigen. Zukünftige Forschung sollte ihren Schwerpunkt auf die Frage richten, wie die Mensch-Natur Beziehung durch verschiedene Management- und Steuerungs-Strategien sowie Kommunikationsrahmen aktiviert oder gestärkt werden kann.

Die Ergebnisse der Arbeit sollen eine Grundlage für zukünftige Management- und Schutzprogramme bilden und einen Beitrag zu zukünftigen fachlichen Diskussionen bezüglich der angesprochenen Themen liefern.

1 Introduction

1.1 Dissertation outline

This dissertation consists of an introduction, nine research articles (a mixture of thematic and methodic articles, listed by date of publication) and a synthesis that aims to address the overall objectives and to display a summary of the gained results. Articles 1-5 have already been published, Article 6 is available online, Article 7 is accepted with minor revisions and currently being revised and Articles 8 and 9 are submitted and currently under review.

- ***Article #1: Böck, K.**, A. Muhar, J. Oberdiek, S. Muhar. 2013. Die Wahrnehmung von fließgewässerbezogenen „Ökosystemleistungen" und Konfliktpotenzialen am Fallbeispiel „Flusslandschaft Enns". Österreichische Wasser- und Abfallwirtschaft 65: 418–428. (published)*
- ***Article #2: Böck, K.**, S. Muhar, A. Muhar, R. Polt. 2015. The Ecosystem Services Concept: Gaps between science and practice in river landscape management. GAIA 24/1: 32-40. (published, SCI listed)*
- ***Article #3:** Vermaat, J.E., A.J. Wagtendonk, R. Brouwer, O. Sheremet, E. Ansink, T. Brockhoff, M. Plug, S. Hellsten, J. Arovvita, L. Tylec, M. Gielczewski, L. Kohut, K. Brabec, J. Haverkamp, M. Poppe, **K. Böck**, M. Coerssen, J. Segersten, D. Hering. 2015. Assessing the societal benefits of river restoration using the ecosystem services approach. Hydrobiologia. DOI 10.1007/s10750-015-2482-z. (published, SCI listed)*
- ***Article #4:** Walker-Springett, K., R. Jefferson, **K. Böck**, A. Breckwoldt, M. Cottet, G. Hübner, S. Shaw, K. Wyles. 2016. Ways forward for aquatic conservation: applications of environmental psychology to support management objectives. Journal of Environmental Management 166: 525-536. (published, SCI listed)*
- ***Article #5:** Poppe, M., **K. Böck**, A. Zitek, S. Scheikl, A. Loach, S. Muhar. 2016. Was? Wie? Warum? Jugendliche erforschen Flusslandschaften – Förderung des Systemverständnisses als Basis für gelebte Partizipation im Flussgebietsmanagement. Österreichische Wasser- und Abfallwirtschaft. DOI 10.1007/s00506-016-0325-4. (published)*
- ***Article #6:** Braito, M., **K. Böck,** C. Flint, A. Muhar, S. Muhar, M. Penker. Human-Nature Relationships and Linkages to Environmental Behaviour. Environmental Values. (available online, SCI listed)*
- ***Article #7:** Muhar, A., **K. Böck**. Mastery over Nature as a Paradox: Societally Implemented but Individually Rejected. Journal of Environmental Planning and Management. (accepted with minor revisions, SCI listed)*
- ***Article #8:** Muhar, A., C.M. Raymond, R.J.G. van den Born, N. Bauer, **K. Böck**, M. Braito, A. Buijs, C. Flint, W.T. de Groot, C.D. Ives, T. Mitrofanenko, T. Plieninger, C. van Riper, C. Tucker. A Model integrating Social-Cultural Concepts of Nature into Frameworks of Interaction between Social and Natural Systems. Journal of Environmental Planning and Management. (submitted, SCI listed)*
- ***Article #9: Böck, K.**, R. Polt, L. Schülting. Ecosystem services in river landscapes. In: Riverine ecosystem management. Science for governing towards a sustainable future. Springer Aquatic Ecology Series. (submitted)*

2 Human-nature relationships as a basis for environmental planning and management

2.1 Concepts of the human-nature relationship on the societal level

Various concepts have been developed for the scientific analysis of the nature-society-interplay and its practical application in sustainability processes. Prominent examples are the cause-effect approach applied in the DPSIR framework (driving forces - pressures - state - impact - responses) (Agu 2007), the Socio-Ecological Systems Framework (Ostrom 2007; Ostrom 2009) and the Millennium Ecosystem Assessment Framework (MEA 2003) that fostered the development of the nowadays widely applied ecosystem services concept.

2.1.1 The ecosystem services concept

Today's understanding of the link between the biophysical and the socio-cultural system is characterized by the concepts of "ecosystem- or landscape functions" and that of "ecosystem services" (ES). They link the concepts of ecology and economy: landscape functions describe the capacity to provide goods and services for society. As soon as there is an actual demand for these goods the extent of ES and finally the benefit for humans result.

According to the Millennium Ecosystem Assessment Report (MEA 2003), an important milestone in the development of the ES concept, the term "ES" describes "benefits people obtain from ecosystems". These include provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling and cultural services such as recreational, spiritual, religious, and other nonmaterial benefits.

Since the 1990s the ES concept has gained importance as it allows a better quantification and assessment of human-induced ecosystem losses and allows a holistic management approach. The focus of the assessment of ES in the last few years has been at a global level; e.g. the Millennium Ecosystem Assessment report (MEA 2003) provided an assessment of ecosystem change due to anthropogenic pressures and examined the effects on human well-being. Moreover it included global scenarios explaining future changes of the availability and distribution of ES.

In a more recent global study hosted by the United Nations Environment Program the economic value of biodiversity and ES was identified. The resulting TEEB-report (The Economics of Ecosystems and Biodiversity) emphasized the costs of biodiversity loss and ecosystem degradation (TEEB 2010). The establishment of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES 2015) aims to serve as an addition to previous approaches through acting as an interface between science and policy makers.

2.1.2 Integration of the ES concept in river landscape management

River landscapes have served as areas for settlements, infrastructure facilities and production areas for several thousand years. Together with an increasing intensification of land use numerous rivers were channelized, dams separated floodplains from the rivers and radical changes were induced through operation of hydropower plants (Jungwirth et al. 2003). In addition to negative consequences for the ecological, physico-chemical and hydromorphological status of riverine ecosystems, these ecosystem changes and impairments lead to a shift of the available functions and the related services of river landscapes.

The close relationship between different forms of influences on ecosystems and the availability of their functions and the related provision of their services is often not recognized in ecosystem management. Consequently, a lack of awareness of stakeholders that are either directly (e.g. water managers, decision makers) or indirectly (e.g. users, residents) involved in decision making processes regarding these complex coherences can be identified (Finlayson, D'Cruz, and Davidson 2005).

In this context, the ES concept can be useful e.g. in the pursuit of documenting the benefits of river restoration projects for the provision of ecosystem functions and services (Vermaat et al. 2015). It can also be an assistance in the course of balancing public interests e.g. in hydropower projects (Getzner et al. 2011) and for displaying trade-offs between conservation needs and management decisions (Ormerod 2014). Fostering awareness is particularly possible through mapping approaches as for instance shown by Stürck, Poortinga, and Verburg (2014) at the example of flood regulating services.

2.1.3 Ecosystem service assessment

Due to the fact that only a small part of society is aware of ES at rivers or is responsible for maintaining them, the value of these services and the benefits we derive from them are often underestimated or even overlooked (Aronson, Gidda et al. 2009). In order to improve understanding, reduce the "invisibility" of ecosystem values and enhance their importance in decision making processes, appropriate tools are needed. In addition to already existing methods for data collection such as mapping and monitoring activities, (expert) interviews or statistical analyses (Grunewald and Bastian 2013), several quantitative, qualitative, monetary and non-monetary ES assessment methods have been developed (Schröter-Schlaack et al. 2014).

It needs to be considered that from the full range of ES only a small part can be assessed in monetary terms while other quantitative and qualitative assessment approaches allow to assess a wider spectrum. River landscapes for instance provide a wide range of functions that do not have any market price, e.g. the opportunity to use the river as recreational area. In these cases assigning monetary values to ES is less meaningful (Daily et al. 2009). Therefore, in order to gain a comprehensive picture, monetary assessment approaches need to be combined with other quantitative and qualitative assessments (ten Brink and Bräuer 2008).

Several authors also argue that the approach of monetizing ES is based on unsustainable economic thinking and therefore not suitable for assessing the benefits for humans (Kienast 2010). Moreover, complexities cannot be apprehended through application of economic valuation methods (Kumar and Kumar 2008).

2.2 Concepts of human-nature relationships on the individual level

In the course of cultural history humankind developed different views of the relationship between humans and nature. Traditional understandings of the human-nature relationship (HNR) describe humans as beneficiaries of the fruits of Mother Earth, as creatures that are at Gods' and demons' mercy, as creatures that resolve themselves from nature's forces or as dominator of nature (Heiland 1992).

In the scientific discourse several theories to explore the relationship between humans and nature have been developed, all of which can be understood as subsets of wider socio-cultural concepts such as values, worldviews, beliefs and attitudes (Muhar et al. in review).

Conceptualizations of the HNR are found in philosophical as well as social science literature. Despite the large variety of typologies Flint et al. (2013) found that they are based on three broad dimensions:

- Positionality dimensions – anthropocentric/ecocentric polarity, hierarchical relation of humans above nature or vice versa, humans as part of or separate from nature
- Character of bond dimensions – intentions underlying humans' interaction with nature, biophilia vs. biophobia, responsibilities for nature and rights of nature, preferred roles of technology in nature, spirituality or religiosity, instrumental to intrinsic values, and a gradient from connectedness to apathy which refers to a distance from or lack of attention to nature.
- Understanding of nature dimensions - dimensions related to notions of nature as fragile or resilient, the predictability of nature and modes of learning

Individuals' perceptions towards nature are influenced by a large number of factors that result from the social and cultural environment (e.g. religious community) and the personal history (education, tradition, life experience). While in the Western history the perspectives on the HNR range from the domination of nature to the notion of "stewardship", oriental religions follow a more holistic view through seeing humans as an integral part of nature (Bourdeau 2004; Flint et al. 2013).

Literature furthermore suggests that HNRs are contextual (Daugstad, Svarstad, and Vistad 2006), that they change over time (Schroeder 2007) and that they are not mutually exclusive but that people are likely to hold multiple and even competing HNR concepts (Teel and Manfredo 2010; van den Born 2008). Moreover it needs to be considered that they are often not even recognized or important to people (Chan, Satterfield, and Goldstein 2012).

2.2.1 Understandings of human-nature relationships in river landscapes

Understanding the relationship humans have with nature is described as playing an important role in environmental management (Bauer, Wallner, and Hunziker 2009). In particular in water management the importance of integrating the human dimension is underlined due to the strong linkage between the social and ecological system that emerged from anthropogenic influences in the past (Gonzalez et al. 2009). Braden, Jolejole-Foreman, and Schneider (2014) (p.2) support the interlinkage between nature and humans by stating that "…'Water problems" are fundamentally human problems" and highlighting the need to consider human perceptions, motivations and behaviour when addressing water challenges.

In particular with regard to the ongoing paradigm shift in river management that follows more sustainable and participative approaches and aims on integrating society's needs (Gonzalez et al. 2009) understanding the relationship humans have with nature can be relevant. It can assist in dealing with divergent opinions of local stakeholders (Jacobs and Buijs 2011). and support in identifying priority targets for management (Gonzalez et al. 2009).

3 Research questions and objectives

The thesis can roughly be divided into the following parts:

- an analysis of different stakeholders' groups perceptions of ecosystem services (ES) at two river landscapes in Austria,
- an investigation of stakeholders' awareness of the ES concept, the observed practicability and concerns regarding its implementation
- case study based applications of the ES concept in the context of river management
- an investigation of stakeholders' perceptions regarding concepts of human-nature relationship (HNR)
- an investigation and further development of an adequate method to operationalize HNR

Following research questions and objectives were formulated as guidelines for the thesis:

RQ #1: *Which perception and estimation do different stakeholders groups have regarding river landscape functions and services?*

The objective was to determine which ES are perceived by different stakeholder groups and which values are assigned to them. Subsequently, the relationship between differently assigned values to river landscape functions and services, and the stakeholder groups to which they belong was investigated.

Based on a general overview on ES in river landscapes given in **Article #9**, this specific issue is addressed in **Article #1**.

RQ #2: *How is the ES concept perceived by different stakeholder groups in river management?*

Although this question was not part of the research project from the beginning, it has become one of the central issues in the course of the fieldwork phase. Since many interviewees had difficulties in understanding what was meant by the concept, the focus shifted to possible knowledge gaps with regard to the ES concept. The objective was to determine whether or not stakeholders in river management are aware of its various possible applications and which role this model actually plays in their working environment; and whether a willingness to apply this concept in the stakeholders' working environments exists.

An analysis and discussion of this question can be found in **Article #2**.

Going beyond this more theoretical question, **Articles #3 and #5** deal with the actual application of the ES concept in the specific context of river landscape management.

RQ #3: *Which understanding of HNR can be determined in different case studies within different stakeholder groups?*

In connection with the previous research question, consideration was being given to the fact that the perceptions of river landscapes are possibly influenced by different understandings of and attitudes towards nature. The goal was to assign the individuals in the various stakeholder groups to the various HNR types that have been developed.

An analysis of HNR perspectives among stakeholders in river landscape management can be found in **Article #4. Article #7** puts a specific focus on the Mastery Concept towards nature.

RQ #4: *How can different types of HNR be operationalized?*

Article #8 sets a frame for this question through the development of a model that integrates Social-Cultural Concepts of Nature into Frameworks of Interaction between Social and Natural Systems. The development of a scale to assess concepts of HNR in individuals is described in **Article #6**. This scale is

also used to assess individuals' relationship with nature and it is investigated whether such relationships correlate with environmental behaviour.

Figure 1 displays a systematic overview of the research project and the topics that are addressed in the research articles.

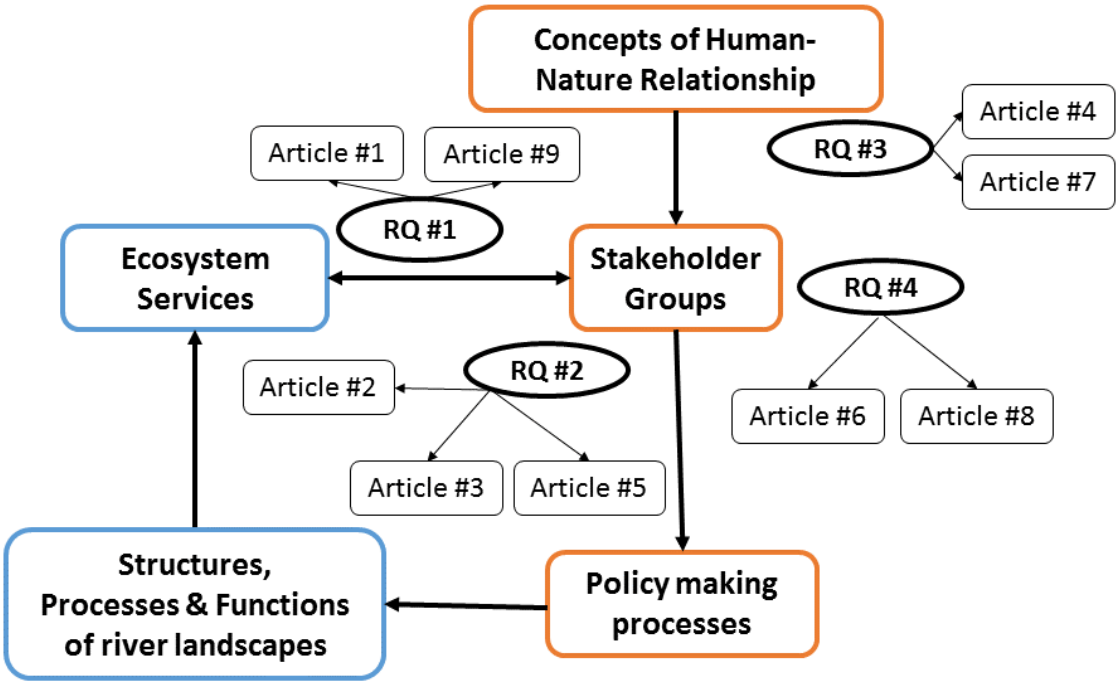

Figure 1: Systematic overview on the research project, corresponding research questions & related articles

4 Research articles

In this chapter, following research articles that were developed in the frame of the thesis are included as original reprints.

Article #1 – Page 16ff

> ***Böck, K.**, A. Muhar, J. Oberdiek, S. Muhar. 2013. Die Wahrnehmung von fließgewässerbezogenen „Ökosystemleistungen" und Konfliktpotenzialen am Fallbeispiel „Flusslandschaft Enns". Österreichische Wasser- und Abfallwirtschaft 65: 418–428. (published)*

Article #2 – Page 27ff

> ***Böck, K.**, S. Muhar, A. Muhar, R. Polt. 2015. The Ecosystem Services Concept: Gaps between science and practice in river landscape management. GAIA 24/1: 32-40. (published, SCI listed)*

Article #3 – Page 36ff

> *Vermaat, J.E., A.J. Wagtendonk, R. Brouwer, O. Sheremet, E. Ansink, T. Brockhoff, M. Plug, S. Hellsten, J. Arovvita, L. Tylec, M. Gielczewski, L. Kohut, K. Brabec, J. Haverkamp, M. Poppe, **K. Böck**, M. Coerssen, J. Segersten, D. Hering. 2015. Assessing the societal benefits of river restoration using the ecosystem services approach. Hydrobiologia. DOI 10.1007/s10750-015-2482-z. (published, SCI listed)*

Article #4 – Page 51ff

> *Walker-Springett, K., R. Jefferson, **K. Böck**, A. Breckwoldt, M. Cottet, G. Hübner, S. Shaw, K. Wyles. 2016. Ways forward for aquatic conservation: applications of environmental psychology to support management objectives. Journal of Environmental Management 166: 525-536. (published, SCI listed)*

Article #5 – Page 63ff

> *Poppe, M., **K. Böck**, A. Zitek, S. Scheikl, A. Loach, S. Muhar. 2016. Was? Wie? Warum? Jugendliche erforschen Flusslandschaften – Förderung des Systemverständnisses als Basis für gelebte Partizipation im Flussgebietsmanagement. Österreichische Wasser- und Abfallwirtschaft. DOI 10.1007/s00506-016-0325-4. (published)*

Article #6 – Page 75ff

> *Braito, M., **K. Böck,** C. Flint, A. Muhar, S. Muhar, M. Penker. Human-Nature Relationships and Linkages to Environmental Behaviour. Environmental Values. (available online, SCI listed)*

Article #7 – Page 104ff

> *Muhar, A., **K. Böck**. Mastery over Nature as a Paradox: Societally Implemented but Individually Rejected. Journal of Environmental Planning and Management. (accepted with minor revisions, SCI listed)*

Article #8 – Page 130ff

*Muhar, A., C.M. Raymond, R.J.G. van den Born, N. Bauer, **K. Böck**, M. Braito, A. Buijs, C. Flint, W.T. de Groot, C.D. Ives, T. Mitrofanenko, T. Plieninger, C. van Riper, C. Tucker. A Model integrating Social-Cultural Concepts of Nature into Frameworks of Interaction between Social and Natural Systems. Journal of Environmental Planning and Management. (submitted, SCI listed)*

Article #9 – Page 159ff

***Böck, K.**, R. Polt, L. Schülting. Ecosystem services in river landscapes. In: Riverine ecosystem management. Science for governing towards a sustainable future. Springer Aquatic Ecology Series. (submitted)*

4.1 Article #1

Originalarbeit

Österr Wasser- und Abfallw (2013) 65:418–428
DOI 10.1007/s00506-013-0116-0

Die Wahrnehmung von fließgewässerbezogenen „Ökosystemleistungen“ und Konfliktpotenzialen am Fallbeispiel „Flusslandschaft Enns“

Kerstin Böck · Andreas Muhar · Jan Oberdiek · Susanne Muhar

Online publiziert: 26. Oktober 2013

Zusammenfassung Das Konzept der „Ökosystemleistungen“ ist, vor allem im wissenschaftlichen Kontext, in den letzten Jahrzehnten zu einem sehr intensiv behandelten Thema geworden. Die möglichen Anwendungsgebiete dieses Konzepts sind vielfältig und reichen von der Nutzung als Kommunikationsinstrument bis hin zum Einsatz als Bewertungsinstrument für verschiedene Entwicklungsszenarien.

Im steirischen Ennstal wurden qualitative und quantitative Befragungen unterschiedlicher Akteursgruppen mit beruflichem oder persönlichem Interesse an der Flusslandschaft durchgeführt. Es wurde erfasst, wie verschiedene Leistungen der Flusslandschaft wahrgenommen werden und zwischen welchen Konfliktpotenziale gegeben sind.

Die unterschiedlichen Akteursgruppen kamen zu durchaus ähnlichen Einschätzungen. Sowohl von PraxisexpertInnen verschiedener Fachrichtungen als auch von Laien wurde eine recht große Bandbreite an Ökosystemleistungen als solche auch wahrgenommen. Als Konfliktpunkte wurden vor allem die Bereiche Energiewirtschaft und Landwirtschaft genannt.

Dieses homogene Ergebnis lässt sich vermutlich auf die Vielzahl an Partizipationsprozessen in der Vergangenheit zurückführen, durch welche sowohl eine gemeinsame Wissensbasis als auch ein Verständnis für unterschiedliche Perspektiven und Interessen geschaffen werden konnte.

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Perceptions of river-based “ecosystem services” and conflict potential in the case of the “river landscape Enns”

Abstract The "ecosystem service" concept has become an intensely discussed issue over the last few decades, foremost in the scientific context. The concept has a broad range of applications, from communication instrument to a tool for assessing various development scenarios.

In the Enns Valley in the Austrian state of Styria, qualitative and quantitative surveys were conducted among various groups of actors with a professional or personal interest in the river landscape. It was assessed how various services provided by the river landscape are perceived, and where there are potentials for conflict.

The different groups surveyed produced largely uniform statements. Expert practitioners from various disciplines and non-experts alike listed a broad range of ecosystem services and primarily saw conflict potential with regard to the energy and agriculture sectors.

These homogeneous results are most likely due to the various participation processes in the past, which produced both a shared basis of knowledge and an acceptance of different perspectives and interests.

1. Einleitung und Problemstellung

1.1. Partizipationsprozesse im Gewässermanagement

Entsprechend den Vorgaben der EU-Wasserrahmenrichtlinie (WRRL) umfasst ein modernes Fließgewässermanagement alle Aufgabenbereiche, die sich im Zusammenhang mit der Nutzung und Sicherung von Gewässern ergeben (Muhar et al. 2003). Diese Vielfalt an abzudeckenden Themenbereichen und die damit zusammenhängende Komplexität erfordern neue Ansätze zur Problemlösung. Das Erfordernis, möglichst unterschiedliche Perspektiven in Managementprozessen zu berücksichtigen, umfasst in hohem Maße auch die Einbindung unterschiedlicher betroffener Stakeholdergruppen (Pahl-Wostl 2008).

Die dabei zu berücksichtigenden Herausforderungen ergeben sich aufgrund eines sehr unterschiedlichen Problemverständnisses und der Tatsache, dass in vielen Fällen der eigentliche Kern eines Problems nicht erkannt wird (Pahl-Wostl 2002). Außerdem kann vor allem zu Beginn eines solchen Partizipationsprozesses eine fehlende Bereitschaft zur Kompromissfindung bestehen. Ein gemeinsames Verständnis von Flusslandschaften und deren vielfältigen Funktionen ist die Basis für ein nachhaltiges Flussgebietsmanagement und verhindert, dass Funktionen, die einzelnen Fachbereichen wichtig sind, im Rahmen von Entscheidungsprozessen übersehen werden (Dunn 2004).

Die im Sinne der Nachhaltigkeit erforderliche und auch von der WRRL explizit geforderte Einbindung der organisierten und nicht organisierten Öffentlichkeit sowie der damit einhergehende Aufbau von Dialogstrukturen unterstützen ein gemeinsames Verständnis (Muhar et al. 2003). Der Prozess, diesen Zustand zu erreichen, kann sich als sehr aufwendig erweisen und erfordert ein hohes Maß an Engagement sowie eine strukturierte methodische Herangehensweise. Im Flusslandschaftsmanagement geht der Trend dahin, immer mehr unterschiedliche Fachbereiche und Perspektiven in Entscheidungsprozesse mit einzubeziehen.

Ein mögliches Instrument, diese Vielschichtigkeit an Nutzungen anzusprechen und greifbarer zu machen, ist das Konzept der Ökosystemleistungen (ÖSL).

1.2. Grundlegendes zum ÖSL-Konzept

Ökosysteme bilden die Grundlage für menschliches Leben und menschliche Aktivitäten. Die von ihnen bereitgestellten Güter und Leistungen sind eine lebenswichtige Grundlage und Voraussetzung für eine funktionierende Gesellschaft und Wirtschaft. Vielerorts stiften diese einen Nutzen für den Menschen und tragen damit zu ihrem Wohlbefinden, ihrer Gesundheit und ihrer Sicherheit bei (EU 2010).

Abbildung 1 soll den Zusammenhang zwischen Ökosystemen und menschlichem Wohlbefinden verdeutlichen.

Die Auseinandersetzungen zu einem ökosystembasierten Ansatz reichen bis in die 1960er-Jahre zurück (Hein et al. 2006). Sowohl im englisch- als auch im deutschsprachigen Kontext wurde begonnen, Funktionen bzw. Leistungen von Ökosystemen für Managementüberlegungen heranzuziehen. Während in der Nachhaltigkeitsdebatte vorrangig das Konzept der „Ökosystemleistungen" (Ecosystem Services) breite Anwendung fand, setzte sich in der Landschaftsforschung eher das Konzept der „Landschaftsfunktionen und -dienstleistungen" durch (Kienast 2010). Ohne hier auf die Unterschiede, Vor- und mögliche Nachteile der jeweiligen Konzepte einzugehen, wird im Folgenden für die Nutzungsmöglichkeiten, die ein Ökosystem bietet, der Begriff „Ökosystemleistungen" (ÖSL) verwendet.

Im Jahr 2005 wurde eine umfassende Bewertung von Ökosystemen auf Basis der von ihnen zur Verfügung gestellten Leistungen durchgeführt. Der resultierende „Millenium Ecosystem Assessment"-Bericht (MEA 2005) ist diesbezüglich die bis heute wohl am meisten zitierte Literaturquelle und hat die Diskussionen zu dieser Thematik nachhaltig geprägt. Der Bericht macht darauf aufmerksam, dass 60 % der weltweiten Ökosysteme in ihrer Funktionsfähigkeit beeinträchtigt sind, was sowohl ökologische als auch soziale Folgen nach sich zieht (Haines-Young und Potschin 2010).

Im weltweiten Kontext werden der Fischfang und die Trinkwasserversorgung als bedeutendste Ökosystemleistungen von Gewässern genannt (Finlayson et al. 2005). Abhängig von naturräumlichen und regionsspezifischen Bedingungen stehen allerdings in verschiedenen Ländern unterschiedliche ÖSL im Vordergrund. Das können Wasserreinigung, Klimaregulierung, Hochwasserschutz oder auch kulturelle Leistungen sein.

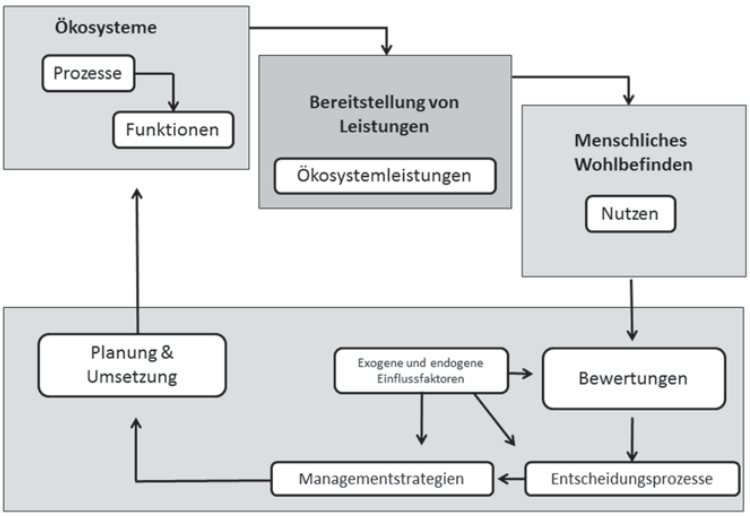

Abb. 1 Zusammenhang zwischen Ökosystemleistungen und menschlichem Wohlbefinden nach Van Oudenhoven, Petz et al. (2012)

Um die Vielzahl an Leistungen differenziert behandeln zu können, wird als Basis für den vorliegenden Artikel die im Millenium Ecosystem Assessment vorgenommene Einteilung der ÖSL in *„Versorgungsleistungen"* (z. B. Trink- und Brauchwasser, Möglichkeit zur Stromerzeugung), *„Regulierungsleistungen"* (z. B. Hochwasserrückhalt), *„kulturelle Leistungen"* (z. B. Möglichkeiten für Erholung und Tourismus) sowie *„Basisleistungen"* (z. B. Resilienz) herangezogen.

1.3. Das ÖSL-Konzept als integratives Bewertungsinstrument

Die möglichen Anwendungsgebiete des ÖSL-Konzepts sind vielfältig. Sie reichen von der Nutzung als Kommunikationsinstrument für Umweltschutzbelange, um komplexe Zusammenhänge für verschiedene Stakeholdergruppen und EntscheidungsträgerInnen in transdisziplinären Prozessen zu veranschaulichen, bis hin zur Anwendung als Bewertungsinstrument (MEA 2005; Aronson et al. 2009).

Vor allem im Zusammenhang mit der Quantifizierung und (monetären) Bewertung von menschlich verursachten Beeinträchtigungen oder Verlusten von Ökosystemen hat das Konzept an Bedeutung erlangt und hat sich im wissenschaftlichen Kontext in den letzten Jahrzehnten zu einem sehr intensiv behandelten Thema entwickelt (Finlayson et al. 2005; TEEB 2010). Zahlreiche ÖSL-Bewertungsrahmen wurden entwickelt, wobei jener der TEEB-Studie (TEEB 2010) als einer der umfassendsten bezeichnet wird (Van Oudenhoven et al. 2012).

Im Zusammenhang mit der Einbindung des ÖSL-Konzepts in die EU-Biodiversitätsstrategie (Europäische Kommission 2011) sowie Aktivitäten der Vereinten Nationen hinsichtlich der Erstellung einer zwischenstaatlichen Plattform zu Biodiversität und Ökosystemleistungen (Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES)) haben einige Länder mit ökosystemaren Bewertungen auf Basis des ÖSL-Konzepts begonnen (Jax et al. 2013). Beispielsweise wurde in Großbritannien in Zusammenarbeit von Regierungs- und Nicht-Regierungsorganisationen, akademischen Einrichtungen und WirtschaftsvertreterInnen eine integrative Studie zur Untersuchung des Nutzens von Ökosystemen für die Gesellschaft durchgeführt. (UK National Ecosystem Assessment 2011). In den USA wird derzeit unter Leitung der „Environmental Protection Agency" (EPA) ein nationaler Atlas zu Ökosystemleistungen entwickelt, der als Grundlage für Entscheidungen auf unterschiedlichen räumlichen Ebenen dienen soll (Boykin et al. 2013).

Aufbauend auf einem Verständnis von nachhaltiger Entwicklung als langfristiger Sicherung der natürlichen Lebensgrundlagen wird im Rahmen des ÖSL-Konzepts versucht, eine integrative Sicht auf Ökosysteme zu erreichen, um damit Entscheidungen auf einer fundierteren Basis zu treffen. Ähnliche Herangehensweisen

finden sich auch in Beiträgen von Ömer et al. (2003), wo auf Basis von ExpertInneneinschätzungen und Indikatoren zu unterschiedlichen flusslandschaftsrelevanten Themenbereichen Managementaussagen zu unterschiedlichen Maßnahmenszenarien getroffen werden.

Eine rein ökosystemleistungsbasierte Bewertung im Kontext Fließgewässer wurde in Österreich bis dato allerdings erst ein einziges Mal für das Fallbeispiel Mur durchgeführt (Getzner et al. 2011).

1.4. Zielsetzung

Im Zusammenhang mit der Diskussion um unterschiedliche Bewertungsverfahren von Ökosystemleistungen beschreibt dieser Artikel eine auf das ÖSL-Konzept ausgerichtete Untersuchung der Flusslandschaft Obere Enns in der Steiermark/Österreich. Da das ÖSL-Konzept unterstützend wirken kann, um eine Vielzahl an Aspekten mit zu berücksichtigen, soll dieses konzeptuelle Modell in den Kontext praktischer Planung gestellt werden.

Ausgehend von dem Wissen über zahlreiche im Untersuchungsgebiet stattgefundene Partizipationsprozesse in der Vergangenheit galt es, (1) Übereinstimmungen bzw. Differenzen in der Wahrnehmung unterschiedlicher Funktionen bzw. Leistungen der Flusslandschaft sowie (2) potenzielle Konflikte zwischen ÖSL durch verschiedene Akteursgruppen im Fließgewässermanagement zu erforschen.

Es sollte außerdem ermittelt werden, ob über den eigenen Wirkungskreis der Akteursgruppen hinausgehende Nutzungsinteressen überhaupt wahrgenommen werden, und wenn ja, wie stark.

Um zu beurteilen, ob Partizipationsprozesse in der Vergangenheit eine Entwicklung hin zu synergistischen Lösungen gefördert haben, sollen entlang der im ÖSL-Konzept behandelten Kategorien die Chancen und Herausforderungen, die partizipative Prozesse mit sich bringen, diskutiert werden. Außerdem soll analysiert werden, ob sich das Konzept als methodisches Hilfsmittel zur Veranschaulichung unterschiedlicher Interessen eignet und Empfehlungen zur zukünftigen Verwendung im integrativen Flusslandschaftsmanagement gegeben werden.

2. Methode

Um möglichst viele verschiedene Sichtweisen im Bereich des Flusslandschaftsmanagements in die Analysen einzubeziehen, wurde ein interdisziplinärer Projektansatz gewählt. Es kam ein Methodenmix aus qualitativen und quantitativen Befragungen zur Anwendung. Ziel dabei war es, zu ermitteln, wie die von der Flusslandschaft Enns bereitgestellten ÖSL wahrgenommen werden und welche Sichtweisen zum Konzept der ÖSL bestehen. Die wichtigsten methodischen Schritte sind in Abb. 2 ersichtlich.

Abb. 2 Methodische Herangehensweise

2.1. Auswahl des Untersuchungsgebiets

Untersuchungsgebiet für die vorliegende Untersuchung war die Flusslandschaft Enns in der Steiermark im Bereich zwischen Mandling und Gesäuse. Diese Auswahl ergab sich aus der bereits umfangreichen Datenmenge und guten Gebietskenntnis aus vorangegangenen Projekten (z. B. Hohensinner et al. 2008).

Basierend auf der Arbeit von Chiari (2010) wurden Standorte identifiziert, bei welchen von einer hohen Anzahl an

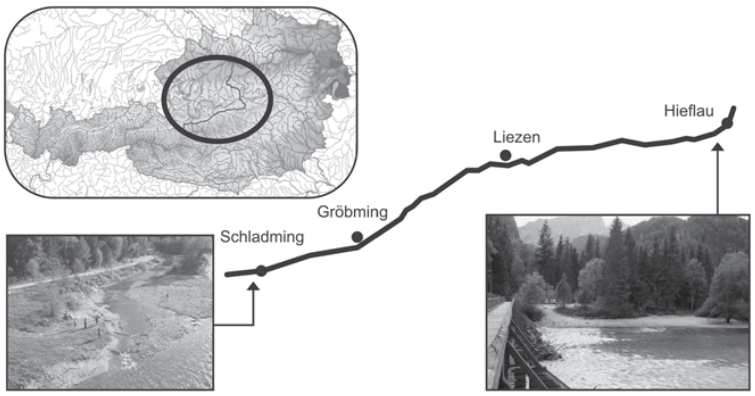

Abb. 3 Untersuchungsgebiet Enns, die Bilder zeigen die beiden primären Befragungsstandorte (BMLFUW/IHW-BOKU 2007; Bilder: IHG)

BesucherInnen - und damit potenziellen InterviewpartnerInnen - auszugehen war (siehe Abb. 3).

2.1.1. Charakterisierung der Flusslandschaft

Bis zur Mitte des 19. Jahrhunderts war das Ennstal durch Versumpfungen und Überschwemmungen gekennzeichnet. Der Talboden war nicht für die Errichtung von Siedlungen geeignet und nur an sehr wenigen Stellen konnte Landwirtschaft betrieben werden. Zur Verbesserung dieser Bedingungen wurde Mitte des 19. Jahrhunderts mit Regulierungsmaßnahmen wie Ufersicherungen und Sohleintiefungen begonnen. Heute sind vom ehemaligen Fluss-Auen-Lebensraum der Enns in weiten Abschnitten nur noch das regulierte Flussbett und die direkten Uferbereiche verblieben, was auch große Veränderungen der Fauna und Flora mit sich brachte (Jungwirth et al. 1996).

In den 1950er-Jahren begann der Ausbau der Enns zur Wasserkraftnutzung. Die Schluchtstrecke des Gesäuses und die anschließende Durchbruchstrecke der Enns durch die Kalkalpen werden durch Ausleitungskraftwerke energiewirtschaftlich genutzt. Flussab folgt eine - mit Ausnahme einer kurzen Strecke oberhalb der Stadt Steyr - durchgehende Kraftwerkskette bis zur Mündung der Enns in die Donau. Durch die Schwallwasserabgaben der Kraftwerke ist das Abflussverhalten der Enns in diesen Abschnitten wesentlich verändert (Jungwirth et al. 1996; Muhar et al. 2011). Bei dem im Rahmen dieser Studie untersuchten Flussabschnitt handelt es sich allerdings um eine freie Fließstrecke. Hier werden nur die Nebengewässer der Enns teilweise energiewirtschaftlich genutzt.

Trotz der Vielzahl an anthropogenen Veränderungen bestehen an der steirischen Enns einige Gebiete mit hoher naturräumlicher Wertigkeit. Es finden sich hier sieben Naturschutzgebiete gemäß EU-Vogelschutz- und EU-Flora-Fauna-Habitat-Richtlinie. Acht Bereiche sind als Naturschutzgebiete deklariert, es besteht ein Landschaftsschutzgebiet und ein Ramsar-Gebiet. Die Wildflusslandschaft im Gesäuse ist Teil des dort ausgewiesenen Nationalparks (Muhar et al. 2011).

2.1.2. Partizipationsprozesse im steirischen Ennstal

Im steirischen Ennstal fand in der Vergangenheit eine Vielzahl an Partizipationsprozessen statt, vor allem im Zusammenhang mit der Umsetzung von LIFE-Natur- bzw. LIFE+-Projekten. Da die Ausweisung von Natura-2000-Schutzgebieten auf Basis der Flora-Fauna-Habitat- und Vogelschutzrichtlinie teilweise mit zahlreichen öffentlichen Auseinandersetzungen verbunden war, wurde bzw. wird großer Wert auf laufende Bürgerinformationen gelegt. So wurden zahlreiche Informationsveranstaltungen abgehalten. Außerdem können sich Interessierte und betroffene GrundeigentümerInnen bei Natura-2000-Sprechtagen über Ziele und Konsequenzen von Natura 2000 informieren (Kofler 2012).

Im Rahmen des LIFE+-Projekts „Flusslandschaft Enns", das von 2011 bis 2015 läuft, soll mittels verschiedener Maßnahmen eine Verbesserung der Auen- und Flusslandschaft Enns und des passiven Hochwasserschutzes erreicht werden (Hornich et al. 2013). Um die Öffentlichkeit bestmöglich zu informieren, ist neben der regelmäßigen Berichterstattung in Medien und der Projekt-Homepage sowie Foldern die Produktion eines Films über den Lebensraum Enns und die Maßnahmen des Projektes Flusslandschaft Enns geplant.

Auch im Rahmen der Erstellung der Leitlinie Enns (Hohensinner et al. 2008) als zentrale Planungsgrundlage für die Entwicklung der Enns-Flusslandschaft kam ein partizipativer Arbeitsansatz zur Anwendung. Mit betroffenen Gemeinden, VertreterInnen aus der Verwaltung (Wasserwirtschaft/-bau, Naturschutz, Raumplanung) und VertreterInnen der ÖBB wurden Standpunkte zu unterschiedlichen fließgewässerrelevanten Themenbereichen und zukünftigen raumrelevanten Vorhaben diskutiert.

2.2. Explorative Interviews

Im Rahmen der Themenspezifikation und Entwicklung der Befragungsunterlagen wurden sechs Interviews mit ExpertInnen unterschiedlicher Fachbereiche und organisatorischer Ebenen geführt. Dies diente unter anderem auch dazu, die für die Flusslandschaft Enns relevanten ÖSL auszuwählen, welche anschließend in die Befragung Eingang finden sollten.

Basis dafür bildeten die im Millenium Ecosystem Assessment Report (MEA 2005) vorgeschlagenen Kategorien und Subkategorien. Da die Auswahl bezogen auf die naturräumlichen Bedingungen des Ennstals getroffen wurde, variiert die jeweilige Anzahl der ÖSL innerhalb der verschiedenen Kategorien (vergleiche auch Abb. 4).

2.3. InterviewpartnerInnen

Ausgehend von der Prämisse, dass die befragten Personen ein berufliches oder persönliches Interesse an der Flusslandschaft haben sollten, wurden die in Abb. 2 ersichtlichen Akteursgruppen einbezogen. Diese Auswahl basierte auf Online-Recherchen und Nutzung von bestehenden Kontakten. Um auch potenziell interessierte Personen zu erreichen, die keiner dieser Gruppen angehören, wurden auch von den ausgewählten InterviewpartnerInnen zusätzlich genannte sowie direkt in der Flusslandschaft angetroffene Personen in die Befragung mit einbezogen.

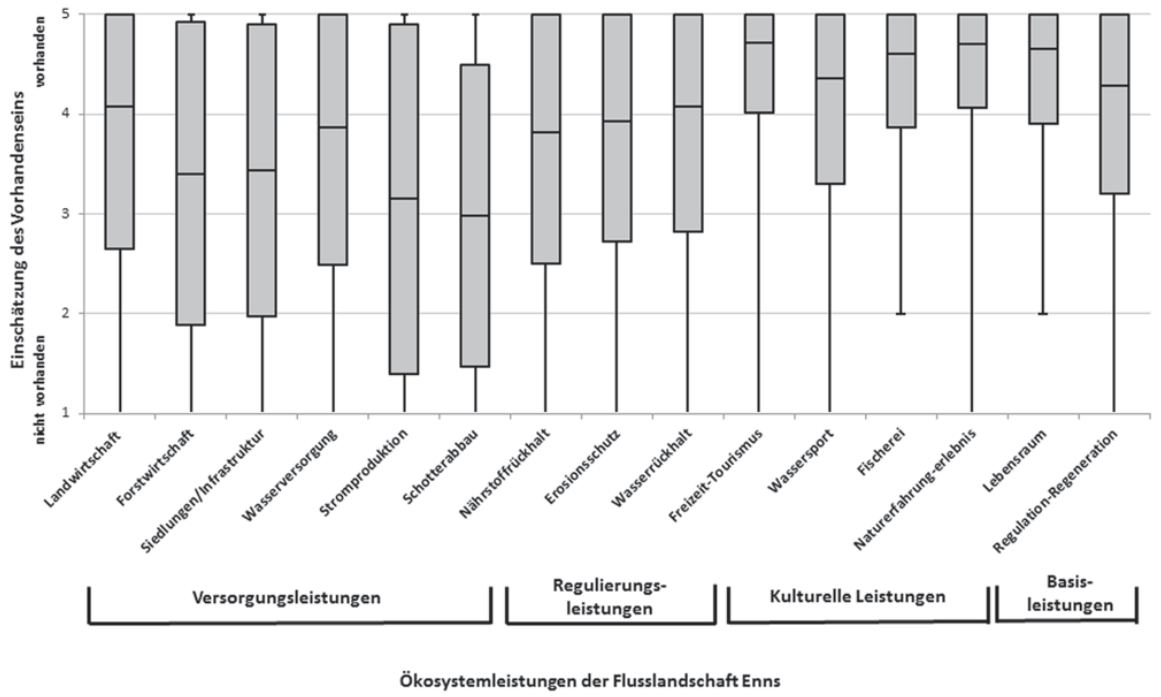

Abb. 4 Einschätzung des Vorhandenseins von ÖSL der Flusslandschaft Enns (Darstellung der Mittelwerte, Streuung, Minimum und Maximum); $n = 165$ Befragte

2.4. Quantitative und qualitative Befragung

Bei der Datenerhebung kam ein halbstandardisierter Fragebogen zum Einsatz. Mittels einer fünfstufigen Skala wurde die Wahrnehmung der Befragten hinsichtlich der Verfügbarkeit und Relevanz ausgewählter ÖSL der Flusslandschaft Enns erfasst. Außerdem wurde auf die möglichen Konflikte zwischen unterschiedlichen ÖSL eingegangen.

Ergänzend dazu wurden qualitative Interviews geführt, die darauf abzielten, die auf den quantitativen Daten basierenden Ergebnisse zu untermauern und zu vertiefen. Es wurden dabei Trends in der Nutzung von Fließgewässern, die Berücksichtigung von ÖSL in Planungs- und Entscheidungsprozessen sowie die praktische Anwendbarkeit des ÖSL-Konzepts im Gewässermanagement angesprochen.

Eine detaillierte Aufstellung der InterviewpartnerInnen der qualitativen Befragungen zeigt Tab. 1. Zur besseren Nachvollziehbarkeit der in diesem Artikel eingefügten Statements wurde den InterviewpartnerInnen jeweils eine fortlaufende Nummer (P01, P02 etc.) zugewiesen.

Tab. 1 In die Untersuchung einbezogene InterviewpartnerInnen (P), klassifiziert nach räumlicher und thematischer Ebene

		Räumliche Zuordnung			
		National	Bundesland	Bezirk	Gemeinde
Thematische Zuordnung	Bildung/ Forschung	P04, P21, P66	P73, P76, P78	P53	
	Energiewirtschaft	P22, P77, P81		P32, P35	P17
	Fischerei/ Jagdwirtschaft	P21	P07, P78	P27	P31, P44, P54
	Forstwirtschaft	P40			P37, P44
	Infrastruktur			P51, P61	
	Landwirtschaft			P56	P44
	Naturschutz	P28, P38	P11, P14, P41, P63, P70, P72, P73, P74, P76, P78	P18, P24, P29, P53, P57, P84	P59
	Planung	P16	P13, P39, P42, P43	P67	
	Politik		P15, P25	P64, P71	P20, P49, P50, P59, P62, P69
	Tourismus		P52	P06, P65, P75	P48
	Wassersport	P08	P12	P01, P10, P60	
	Wasserwirtschaft	P23, P79	P02, P19, P26, P36, P47, P58, P68	P30, P45, P80	
	Wildbach- und Lawinenverbauung		P03	P46, P55	

2.5. Auswertung

Die erhobenen quantitativen Daten wurden in einer webbasierten Applikation gesammelt und anschließend mittels der Statistik-Software SPSS und MS Excel analysiert. Zur Auswertung der Daten wurden vorrangig Cluster und Antwortprofile gebildet, Korrelationen errechnet sowie Häufigkeitsverteilungen ermittelt.

Die qualitativen Interviews wurden auf Tonband aufgenommen und anschließend mithilfe der Software „f4" protokolliert. Die thematische Auswertung erfolgte mit der Software „Atlas.ti". Die dabei verwendeten Codes wurden aus den Forschungsfragen, den Interviewfragen sowie direkt aus den Aussagen der InterviewpartnerInnen abgeleitet. Beispiele dafür sind die Codes „Konflikte", „Trends", „wichtige Nutzungen", „wenig berücksichtigte Nutzungen" sowie die von den InterviewpartnerInnen genannten ÖSL.

3. Ergebnisse

3.1. Wahrnehmung von Ökosystemleistungen an der Flusslandschaft Enns

Von den abgefragten ÖSL wurde die Gruppe der *kulturellen Leistungen* und ökologischen *Basisleistungen* am stärksten wahrgenommen (vgl. Abb. 4). Hier ist auch die geringste Streuung erkennbar. Von den abgefragten *kulturellen Leistungen* wurde an erster Stelle die Naturerfahrung als mögliche Nutzungsform der Flusslandschaft Enns genannt, danach folgten knapp hintereinander Freizeit und Tourismus, Fischerei und Wassersport. Bei den *Basisleistungen* wurde vor allem der Lebensraumfunktion der Flusslandschaft Enns Bedeutung zuerkannt.

Aus der Gruppe der *Regulierungsleistungen* wurde insbesondere der Funktion „Wasserrückhalt" (also der Hochwasserschutz durch Bereitstellung von Retentionsräumen) Bedeutung zugemessen. Diese wird auch im Rahmen von Managementüberlegungen (z. B. gemäß Gewässerentwicklungskonzepten) oft an erster Stelle betrachtet.

Es fällt auf, dass im Bereich der *Versorgungsleistungen* die Antworten stärker streuen, dies ist besonders bei der Wahrnehmung der Möglichkeit zur Stromproduktion und beim Schotterabbau der Fall. Am stärksten wurde aus dieser Kategorie der Bereich Landwirtschaft wahrgenommen.

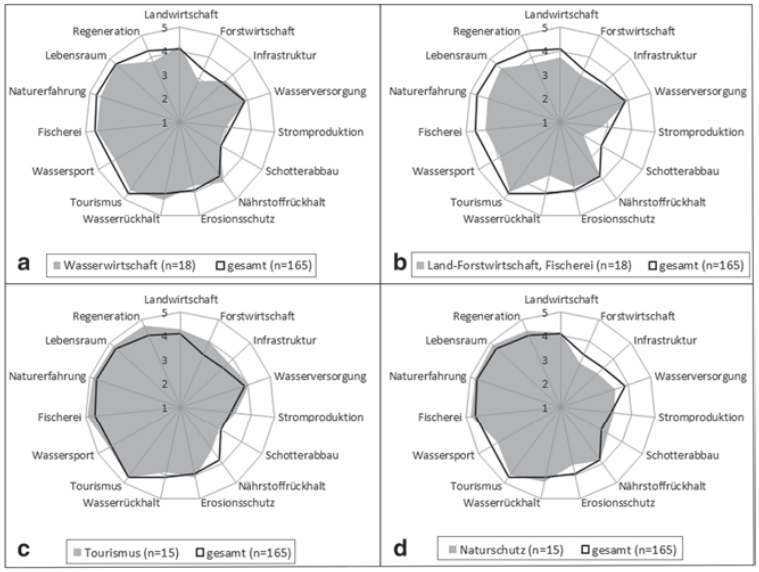

Abb. 5 Wahrnehmung von ÖSL in der Flusslandschaft Enns durch InterviewpartnerInnen verschiedener Tätigkeitsfelder: **a** Wasserwirtschaft, **b** Land-/Forstwirtschaft, Fischerei, **c** Tourismus, **d** Naturschutz (1 = nicht vorhanden, 2 = eher nicht vorhanden, 3 = neutral, 4 = eher vorhanden, 5 = vorhanden)

Die Einschätzung des Vorhandenseins von ÖSL korrelierte signifikant mit der wahrgenommenen Wichtigkeit und wird in diesem Rahmen daher nicht zusätzlich dargestellt. Unterschiede zeigten sich hier lediglich zwischen *kulturellen* und *Basisleistungen*. Erstere wurden zwar als stark vorhanden empfunden, sehr hohe Wichtigkeit war nach Einschätzung der InterviewpartnerInnen allerdings eher für zweitere gegeben.

Um zu ermitteln, ob Unterschiede hinsichtlich der Wahrnehmung von ÖSL durch verschiedene Stakeholdergruppen gegeben sind, wurden die InterviewpartnerInnen nach ihren beruflichen bzw. ehrenamtlichen Tätigkeitsfeldern eingeteilt und die Daten bezogen auf diese Gruppierungen ausgewertet. Abb. 5 zeigt die Einschätzung unterschiedlicher Fachbereiche im Vergleich mit der Gesamtauswertung auf Basis der errechneten Mittelwerte. Die Darstellung lässt eine starke Übereinstimmung in der Wahrnehmung der ÖSL durch die verschiedenen FachbereichsvertreterInnen erkennen. Geringe Unterschiede sind nur bei einzelnen ÖSL gegeben. So finden beispielsweise beim Sektor Wasserwirtschaft die Ökosystemleistungen „Forstwirtschaft" und die „Regeneration des Ökosystems" weniger Berücksichtigung als bei der Gesamtgruppe der InterviewpartnerInnen. Von VertreterInnen der Land- und Forstwirtschaft erfahren tendenziell alle ÖSL eine geringere Berücksichtigung, wohingegen bei VertreterInnen aus dem Tourismussektor diese größtenteils über der Einschätzung der Gesamtzahl an InterviewpartnerInnen liegt. Von VertreterInnen aus dem Naturschutz werden *ökologische Basisleistungen* sowie *kulturelle Leistungen* besonders betont.

Es zeigt sich also, dass nicht nur die für den jeweiligen Fachbereich relevanten, sondern offensichtlich ein breites Spektrum an ÖSL von InterviewpartnerInnen aus unterschiedlichen Fachbereichen wahrgenommen und ebenso als wichtig erachtet wird.

Im Kontrast zur wahrgenommenen Wichtigkeit *kultureller Leistungen* der Enns stand die seitens der Befragten empfundene Berücksichtigung dieser Leistungen im Gewässermanagement. Dies wurde u. a. auch damit argumentiert, dass speziell ökonomisch weniger relevante Nutzungsformen (InterviewpartnerP5), wie beispielsweise das Flussbaden, bei Projektentscheidungen oftmals ins Hintertreffen gelangen. Außerdem wird der Wert des Bewegens in einer Flusslandschaft als ein Beitrag zum Wohlbefinden laut Meinung mehrerer InterviewpartnerInnen (P 16, P 19, P 22) von vielen nicht wahrgenommen.

Vor allem von Seiten des Naturschutzes bestand der Wunsch, Initiativen zur

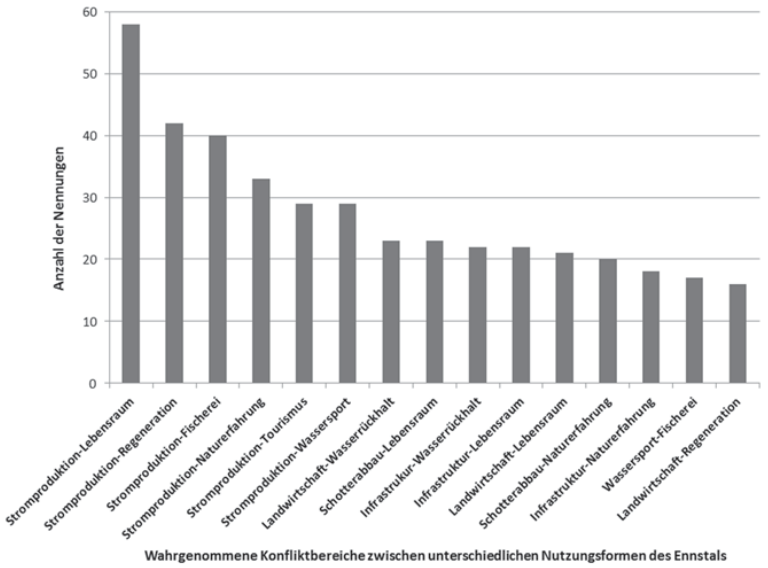

Abb. 6 Wahrgenommene Konfliktbereiche sortiert nach Häufigkeit der Nennung durch die InterviewpartnerInnen (n = 165 Befragte)

Stärkung des Bewusstwerdens und der Bedeutung auch anderer, ökonomisch schwieriger erfassbarer Funktionen (wie Freizeitnutzung oder ökologische Funktionsfähigkeit) zu fördern. Es wurde angenommen, dass vor allem das zu gering ausgeprägte Wissen über die vielfältigen Nutzungsmöglichkeiten von Flusslandschaften den Trend in Richtung Nutzung von *Versorgungsleistungen* von Fließgewässern, speziell der Wasserkraft, fördern. Dort, wo bereits Möglichkeiten der Gewässerzugänglichkeit und des Gewässererlebens geschaffen wurden, kann allerdings laut Angaben der Befragten bereits ein Trend in Richtung Bewusstsein für den Fluss als Lebensraum für Menschen wie auch für Flora und Fauna in der Bevölkerung festgestellt werden (P 19, P 30).

3.2. Wahrgenommene Konflikte

In der Flusslandschaft Enns wurden von den befragten Personen vielfältige Konfliktbereiche wahrgenommen (vgl. Abb. 6). Wie es ein Interviewpartner (P 2) formulierte, sind also offensichtlich „optimale Mehrfachnutzungen an Fließgewässern generell schwierig umzusetzen."

Vor allem der Bereich der *Versorgungsleistungen* stand in der Wahrnehmung der befragten Personen in Konkurrenz zu anderen Nutzungsformen der Flusslandschaft Enns. Insbesondere dem Faktor „Stromproduktion" wurde in diesem Zusammenhang besondere Bedeutung zugemessen.

Bei der nach Akteursgruppen getrennten Betrachtung der genannten Konfliktfelder (Abb. 7) lassen sich nur geringfügige Unterschiede erkennen. Das Ergebnis ähnelt der zuvor dargestellten Wahrnehmung der einzelnen ÖSL. Die von der Gesamtzahl der InterviewpartnerInnen als wichtig genannten Konflikte erfuhren auch bei den ausgewählten Gruppen die größte Berücksichtigung. Lediglich in der jeweiligen Reihung sind gewisse Unterschiede erkennbar. So ist beispielweise aus Sicht der Wasserwirtschaft die Landwirtschaft der bedeutendste Konfliktfaktor. Aus der Perspektive der Land- und Forstwirtschaft sowie des Tourismus weisen, neben dem Faktor Stromproduktion, Siedlungen und Infrastruktur ein hohes Konfliktpotenzial auf.

Aufgrund der geringen Stichprobenzahl (n jeweils < 25) sollten daraus keine verallgemeinernden Schlüsse gezogen werden. Für das Fallbeispiel Flusslandschaft Enns zeigen sich allerdings doch relativ übereinstimmende Aussagen.

Die beiden von InterviewpartnerInnen verschiedener Fachbereiche am häufigsten genannten Konfliktfelder waren die Energienutzung und die Landwirtschaft, auf die im Folgenden detaillierter eingegangen werden soll.

3.2.1. Konfliktfeld Energienutzung

Die Auswertung der Aussagen der InterviewpartnerInnen zu den wahrgenommenen Konfliktpotenzialen zeigt, dass die *Basisleistungen* des Ökosystems (ökologische Leistungen) sowie die *kulturellen Leistungen* in der Wahrnehmung der InterviewpartnerInnen stark im Widerspruch zu der derzeitigen Nutzung des Gewässers für energiewirtschaftliche Zwecke stehen. Im Bereich *kulturelle Leistungen* wurde eine durch Wasserkraftnutzung bedingte Verschiebung der Leistung genannt. So kann auch ein Rückstauraum für Zwecke der Erholung genutzt werden, allerdings werden diese Nutzungen ein ganz anderes Naturerlebnis mit sich bringen als der Aufenthalt an einem naturbelassenen Fließgewässer (P 16, P 18). Laut Aussage eines Interviewpartners werden diese Nutzungen wie z. B. Wasserskifahren oder Motorbootfahren mitunter sogar höher bewertet als das einfache „Sich Bewegen in der Landschaft" (P 16). Es wurde allerdings von anderer Seite auch angeführt, dass intakte Fließgewässer speziell in Zukunft, wo diese vermutlich seltener zu finden sein werden, das Potenzial hätten, touristische Funktionen (vor allem im Bereich naturnaher Tourismus) zu erfüllen (P 19, P 28).

Für den Bereich *ökologische Basisleistungen* wurde von verschiedenen Seiten angemerkt, dass der steigende Energiebedarf in Österreich dazu führt, dass durch Kraftwerksbauten und Aufstau von Fließgewässern andere, vorrangig nicht dynamische Ökosysteme entstehen und es notwendig wäre, Fließgewässerbereiche zu erhalten, in denen auf Eingriffe bewusst verzichtet wird (P 14). Das wäre auch in Zusammenhang mit der Erhaltung dynamischer Aubereiche sowie potenzieller Renaturierungsstandorte relevant (P 38), um die Erhaltung von ÖSL auch zukünftig zu gewährleisten. Eine verträgliche Nutzung, die verschiedene Interessen berücksichtigt und die Rücksicht auch auf ökologische Aspekte nimmt, wurde jedenfalls von verschiedenen Seiten als wünschenswert erachtet (P 25, P 26). Das wäre u. U. auch durch eine gemeinsame Umsetzung von Projekten durch Energieunternehmen und Naturschutz/Ökologie möglich (P 25, P 32).

3.2.2. Konfliktfeld Landwirtschaft

Auch im Bereich Landwirtschaft ist laut Aussagen mehrerer InterviewpartnerInnen der größte Konflikt mit dem Naturschutz gegeben. Dies ist vor dem

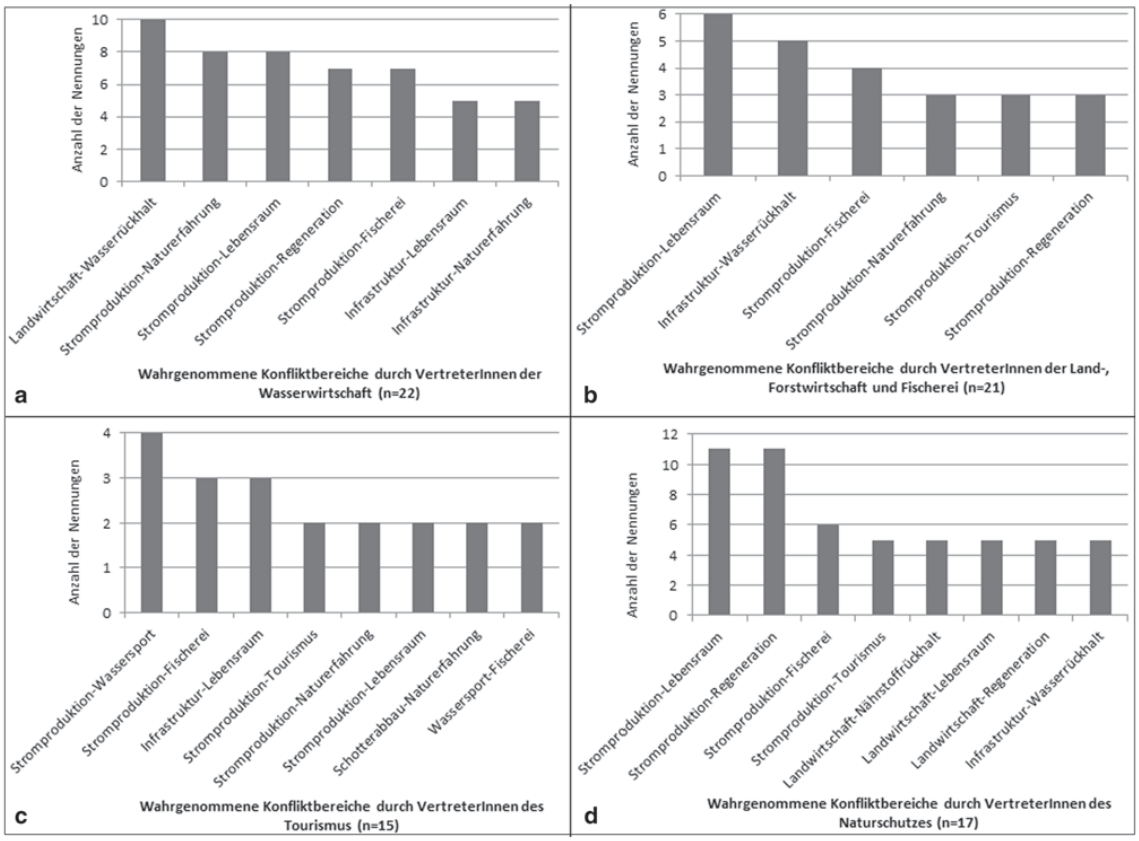

Abb. 7 Am häufigsten genannte Konfliktbereiche durch VertreterInnen unterschiedlicher Fachbereiche (**a** Wasserwirtschaft, **b** Land-/Forstwirtschaft, Fischerei, **c** Tourismus, **d** Naturschutz), sortiert nach Anzahl der Nennung

Hintergrund der in Kap. 2.1 genannten großflächigen Ausweisung von Natura-2000-Gebieten in der Vergangenheit zu betrachten. Naturschutzfachlich hochwertige Lebensräume in Aubereichen stehen oft im Besitz der Landwirtschaft und werden meist nur ungern abgetreten. Ähnlich ist die Situation bei – oftmals in Zusammenhang mit Naturschutzprojekten – umgesetzten Maßnahmen des passiven Hochwasserschutzes (P 11). Einerseits ist dieses Konfliktfeld durch wirtschaftliche Überlegungen begründet: Die Flächen an der Enns sind oft die einzigen ebenen Bereiche und daher für die landwirtschaftliche Nutzung am besten geeignet (P 21, P 25, P 30, P 32). Außerdem besteht die Befürchtung, dass durch Revitalisierungsmaßnahmen auch Vollertragsflächen extensiviert werden müssten und damit Nachteile für die Bewirtschaftung entstünden (P 25, P 32). Andererseits spielen hier auch emotionale Gründe eine Rolle; Befinden sich Flächen schon seit mehreren Generationen in Familienbesitz, wird versucht, dies auch in Zukunft aufrecht zu erhalten.

Revitalisierungen haben in vielen Fällen auch eine vermehrte Freizeitnutzung der betroffenen Bereiche zur Folge. Seitens eines Landwirtschaftsvertreters besteht hier dahingehend ein Vorbehalt, dass der Aufenthalt von FreizeitnutzerInnen eine effiziente Bewirtschaftung der angrenzenden Flächen behindert (P 30).

Von Seiten des Naturschutzes bzw. der Gewässerökologie wurde außerdem die Belastung des Grundwassers durch diffuse Einträge aufgrund fehlender Gewässerrandstreifen als Problemfeld genannt (P 11, P 23).

4. Diskussion und Schlussfolgerung

In früheren Untersuchungen zur Wahrnehmung von Flusslandschaften lag der Fokus eher auf Einzelaspekten, wie beispielsweise dem ökologischen Wert, der auf Basis von Befragungen ermittelt wurde (Dunn 2004). Im Rahmen der vorliegenden Studie wurde hingegen versucht, ein umfassenderes Bild zu zeichnen, indem die Wahrnehmung eines weiten Spektrums an Leistungen der Flusslandschaft ermittelt wurde.

Im Folgenden sollen die Ergebnisse auch in Hinblick auf die mögliche Verwendbarkeit des ÖSL-Konzepts für ähnliche Prozesse in der Zukunft diskutiert werden.

4.1. Wahrnehmung von Ökosystemleistungen und Konfliktpotenzialen

Wie die Ergebnisse (Kap. 3) zeigen, konnte eine generell hohe Einschätzung der Wichtigkeit *ökologischer Basisleistungen* und *kultureller Leistungen* der Flusslandschaft durch die *Gesamtheit der Befragten* belegt werden.

Aus Sicht der InterviewpartnerInnen liegt somit ein starker Fokus auf der nicht primär monetär verwertbaren Nutzung

der Flusslandschaft. Dies steht im starken Widerspruch zur geringen Berücksichtigung dieser Leistung in der Praxis, wo den Versorgungsleistungen, nicht zuletzt auch aufgrund der besseren Quantifizier- und Monetarisierbarkeit der Vorrang gegeben wird (Daniel et al. 2012; Schaich, Bieling et al. 2010).

Dieses Resultat ist auch vergleichbar mit einer ähnlichen Studie von Hauck et al. (2013), in der besonders kulturellen Leistungen eine hohe Bedeutung zukommt. In diesem Zusammenhang ist auch die Wahrnehmung der Landwirtschaft als wesentlichste Kategorie der Versorgungsleistungen zu nennen. Hauck et al. (2013) merken dazu an, dass die Landwirtschaft nicht unbedingt nur im Zusammenhang mit Versorgungsleistungen zu sehen ist, sondern hier auch eine starke kulturelle Komponente mitschwingt. Es wird hier also auch der Landwirtschaft Bedeutung als landschaftsbildendes Element zugesprochen.

Die starke Wahrnehmung *kultureller Leistungen* stimmt gut mit den Ergebnissen von Chiari (2010) überein. Auch bei diesen Befragungen wurde die Bedeutung intakter Gewässer- und Uferstrukturen an der Enns von befragten FlussbesucherInnen als sehr hoch eingeschätzt. Der Vergleich mit der tatsächlichen Flächenverfügbarkeit solcher naturnaher Gewässerabschnitte zeigte jedoch, dass die Enns insgesamt über weite Strecken monoton reguliert ist und daher eine eher geringere Funktionalität für fließgewässergebundene Freizeitnutzungen aufweist. Dem steht ein hohes Besuchsaufkommen in der Flusslandschaft, speziell in den restaurierten Bereichen der Enns gegenüber.

Das sich aus der hohen Nachfrage nach nur eingeschränkt verfügbaren Flächen ergebende *Spannungsfeld* zwischen Freizeitnutzung und Naturschutz konnte von Chiari (2010) anhand von ornithologischen Kartierungen und Besucherzählungen dargestellt werden. Da sich an der Enns nur wenige Flächen als Kiesbrüterhabitate eignen und diese dann durch WassersportlerInnen und Erholungssuchende stark frequentiert werden, ist hier ein besonders hohes Konfliktpotenzial gegeben.

Interessanterweise wird dieses von den befragten Personen nicht primär wahrgenommen; anderen Konfliktfeldern zwischen den *Versorgungsleistungen* Energiewirtschaft bzw. Landwirtschaft und der *Basisleistung* Ökologie wird eine höhere Bedeutung zugemessen. Dieses Ergebnis ist vergleichbar mit Aussagen von Rodriguez et al. (2006), wonach zu den wichtigsten Konfliktbereichen zwischen ÖSL jener zwischen Landwirtschaft und Ökologie zählt.

Die Wahrnehmungen der InterviewpartnerInnen decken sich auch stark mit der – speziell im Zuge des verstärkten Ausbaus der Wasserkraftnutzung – medial geführten Debatte und sind vermutlich auch stark von dieser beeinflusst. Gerade in der Steiermark, wo die Diskussionen um die energiewirtschaftliche Nutzung mehrerer Fließgewässer zur Zeit der Befragungen intensiv geführt wurden, ist dies sehr wahrscheinlich.

Die Wahrnehmung von ÖSL nach *unterschiedlichen Stakeholdergruppen* aufgetrennt zeigen im Wesentlichen stark übereinstimmende Einschätzungen. Von allen VertreterInnen wird eine große Bandbreite an ÖSL der Flusslandschaft Enns genannt. Damit liegt die Interpretation nahe, dass die befragten Personen nicht nur ihrem eigenen Wirkungsbereich Bedeutung zumessen, sondern auch andere Standpunkte und Nutzungsinteressen berücksichtigen. Diese Entwicklung eines gemeinsamen Problemverständnisses wird von Hauck et al. (2013) als notwendiger Schritt für die Durchführung eines ÖSL-basierten Bewertungsverfahrens genannt.

Im Folgenden sollen zwei mögliche Erklärungen für dieses Ergebnis ausgeführt werden:

Da die Befragung ohne konkreten Projektbezug (z. B. Umsetzung eines Kraftwerksprojekts, Ausweisung von Naturschutzflächen o. Ä.) durchgeführt wurde, war es für die unterschiedlichen FachbereichsvertreterInnen vermutlich von geringerer Bedeutung, das „eigene" Thema als zentral und vorrangig zu nennen und damit die „eigenen" Nutzungsinteressen zu vertreten. Dass sich diese Situation bei einem konkreten Projektvorhaben ändern könnte, wird von einem Interviewpartner aus der Wasserwirtschaft (P 2) angemerkt. Laut dessen Einschätzung stehen je nach durchgeführtem Projekt immer andere Gruppierungen und damit auch ÖSL im Vordergrund. Dieser Erklärungsversuch wäre mit Aussagen von Hauck et al. (2013) vergleichbar, die den *Kontext* als wesentlichen Einflussfaktor für die Bewertung von ÖSL und möglichen Konfliktfeldern nennen.

Die Miteinbeziehung und Berücksichtigung der jeweils anderen Fachbereiche bzw. deren Interessen betreffend die ÖSL kann allerdings auch im Kontext mit den langjährigen Partizipationsprozessen in der Vergangenheit gesehen werden. Im Rahmen dieser integrativen Planungsformen konnte offenbar bereits eine Gesprächsbasis geschaffen und Verständnis für die Sichtweisen von VertreterInnen anderer Fachrichtungen aufgebaut werden. Von den InterviewpartnerInnen wird in diesem Zusammenhang von einem „Sinneswandel", „großem Verständnis" und „gutem Einvernehmen" mit anderen Bereichen gesprochen (P 7). Eine positive Entwicklung sei hierbei insbesondere im Bereich „Schutzwasserwirtschaft" festzustellen. Früher gab es speziell zwischen diesem und dem Bereich „Ökologie" divergierende Interessen. Heute funktioniert die Zusammenarbeit in diesem Bereich schon recht gut (P 19). Auch der Energiewirtschaft wird in diesem Zusammenhang Potenzial zur Kooperation mit der Ökologie durch das gemeinsame Erarbeiten von Lösungen zugeschrieben (P 22).

4.2. Generalisierbarkeit der Ergebnisse

Die vorliegende Studie wurde in einem klar definierten geografischen Kontext durchgeführt. Die Bewertung der einzelnen Ökosystemleistungen bezieht sich daher auf die konkrete räumliche Situation im steirischen Ennstal. Hauck, Görg et al. (2013) weisen darauf hin, dass große Unterschiede zwischen lokalen und generellen Bewertungen der Bedeutung einzelner Kategorien von ÖSL bestehen können. Diese Kontextabhängigkeit ist aber auch eine wesentliche Begründung für die Einbeziehung von Fallbetroffenen in Entscheidungsprozesse. Diese wird auch von Opdam et al. (2013) als wesentliches Kriterium im Rahmen von Untersuchungen auf Ebene lokal abgegrenzter Räume genannt.

Der gewählte Methodenmix von qualitativen und quantitativen Ansätzen liefert ein sehr plausibles Bild, da die quantitativen Ergebnisse durch qualitative Aussagen gestützt und erläutert werden, was die Interpretation vereinfacht. Andererseits schränkt die geringere Anzahl an Fällen die Möglichkeiten einer detaillierteren statistischen Auswertung hinsichtlich signifikanter Unterschiede zwischen einzelnen Gruppen stark ein.

Es ist evident, dass jede Auswahl von InterviewpartnerInnen, sofern sie nicht streng nach dem Zufallsprinzip erfolgt, immer eine gewisse Verzerrung der Ergebnisse bewirkt. Im vorliegenden Fall stammen die Einschätzungen von Personen, welche ein Interesse an der Flusslandschaft haben und meist auch entsprechendes Fach- oder Erfahrungswissen

zu den Nutzungsmöglichkeiten besitzen. Vermutungen wie jene eines Befragten (P 16), wonach die Wahrnehmung kultureller Leistungen in der Gesamtbevölkerung geringer sei, konnten daher in dieser Studie nicht überprüft werden. Dazu bedürfte es einer umfassenden Quellgebietserhebung.

4.3 Anwendung des ÖSL-Konzepts im Gewässermanagement

Die in der Literatur genannten möglichen Anwendungsgebiete des ÖSL-Konzepts sind vielfältig. Als Kommunikationsinstrument kann es über die Darstellung komplexer Zusammenhänge zu einem besseren Verständnis von Nutzen und Werten von Ökosystemen bei verschiedenen Stakeholdergruppen und EntscheidungsträgerInnen beitragen (Spierenburg 2012). In der Anwendung als Bewertungsinstrument können mithilfe des Konzepts verschiedene Entwicklungsszenarien vergleichend beurteilt werden und darauf aufbauend Entscheidungen getroffen werden (Aronson et al. 2009). Dabei ist durch die höhere Transparenz und Nachvollziehbarkeit vor allem in transdisziplinären Prozessen eine höhere Akzeptanz bei Planungsentscheidungen zu erwarten. Allerdings muss hier eingeräumt werden, dass bis dato noch keine erprobte Methode zur Integration des ÖSL-Gedankens in Entscheidungsfindungsprozesse existiert, Bewertungen von Kosten und Nutzen sehr uneinheitlich erfolgen (Jax et al. 2013) und die praktische Umsetzung daher derzeit noch eine Herausforderung darstellt (Hauck et al. 2013).

Im Rahmen dieser Studie wurde das ÖSL-Konzept als Basis für die Ermittlung der Wahrnehmung der vielfältigen Nutzungsmöglichkeiten der Flusslandschaft Enns durch unterschiedliche Akteursgruppen herangezogen. Ob dieses Instrument auch für zukünftige (partizipatorische) Prozesse bei konkreten Projekten als Werkzeug zur Analyse unterschiedlicher Nutzungsinteressen Anwendung finden sollte, wurde von den InterviewpartnerInnen unterschiedlich eingeschätzt.

Es wird als sehr positiv beurteilt, wenn Instrumente zur Entscheidungsfindung auf einer „gewissen Systematik“ (P 22) beruhen und Entscheidungen anhand objektiver Kriterien statt subjektiver Interessen getroffen werden. Aufgrund der Möglichkeit zur Operationalisierung von Umweltleistungen wird das Konzept auch als sinnvoll im Zusammenhang mit der Möglichkeit zur Argumentation hinsichtlich der Bedeutung unterschiedlicher ÖSL gesehen (P 13). Damit könnte es als Ergänzung zu der „stark ökologisch ausgerichteten“ Wasserrahmenrichtlinie genutzt werden (P 16).

Konzepte, welche komplexe Zusammenhänge im Gewässermanagement gesamtheitlich darstellen, werden grundsätzlich begrüßt. Allerdings wird auch eingeräumt, dass das ÖSL-Konzept nicht das einzige dafür geeignete Konzept ist, das diesen Zweck erfüllen könnte (P 5). Zudem wird infrage gestellt, ob es nicht schon genug andere Instrumente gäbe, die auf das Gleiche abzielen. Wie auch von Hauck et al. (2013) angemerkt besteht außerdem gerade bei komplexen Fragestellungen die Gefahr zu starker Vereinfachung durch die Anwendung des ÖSL-Konzepts, speziell im lokalen und regionalen Kontext. Jedenfalls müsste es für eine praktische Anwendung nachvollziehbar und leicht verständlich sein (P 19).

Um diese Kriterien zu erfüllen, wird es vermutlich noch weiterer Bemühungen, auch von Seiten der Wissenschaft, bedürfen, um das Konzept praktikabler zu gestalten.

Das Konzept ist also grundsätzlich geeignet, die Funktionen und in weiterer Folge Leistungen von Gewässerökosystemen, an denen unterschiedliche Akteursgruppen interessiert sind, darzustellen. Laut Einschätzung eines Interviewpartners aus dem Bereich Forschung wird das Konzept zukünftig ein ganz wichtiges Planungs- und Bewertungsinstrument sein (P 21). Ob es auch in der Praxis – z. B. im Rahmen von Partizipationsprozessen oder transdisziplinären Projekten – zur Anwendung kommen wird, bleibt abzuwarten.

5. Danksagung

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4.2 Article #2

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The Ecosystem Services Concept: Gaps between Science and Practice in River Landscape Management

Kerstin Böck, Susanne Muhar, Andreas Muhar, Renate Polt

While the ecosystem services concept is currently referred to as "mainstream" in science, its practical application has not made much progress yet. In order to illustrate this gap, we use the example of river landscape management and focus on stakeholders' views of the concept.

The Ecosystem Services Concept: Gaps between Science and Practice in River Landscape Management
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Abstract
This paper investigates the imbalance between the significance of the ecosystem services concept in scientific literature and its actual implementation in processes of river landscape management. Particular attention has been paid to stakeholders' awareness of the concept, their perception of the practicability, and their concerns regarding implementation. In two Austrian river landscapes, qualitative interviews (n = 110) were conducted with decision makers, stakeholders in river landscape management processes, and other persons benefiting from landscape functions. There is little awareness of the concept in most stakeholder groups. Those who are already familiar with it reported that it currently only plays a minor role in their work. Nevertheless, they regarded the concept as a potentially relevant tool: not only for assessments of river ecosystems, but also for bolstering argumentation, communication, and education, as well as for minimizing redundancies with already implemented concepts such as landscape functionality.

Keywords
assessment tools, ecosystem services, interviews, river landscape, river management, science, stakeholders, values of nature

Rivers and their landscapes have influenced and framed societies by providing water, food or construction material, serving as a means of transport or as natural boundaries. In the scientific realm this "multifunctionality" of river landscapes is increasingly addressed with the ecosystem services (ES) concept (e. g., Nedkov and Burkhard 2012, Sanon et al. 2012, Gutiérrez and Alonso 2013, Vermaat et al. 2013).

"ES" are described as the benefits people obtain from ecosystems, a kind of interface between ecosystems and human well-being (Daily 1997, MA 2003). In contrast to other approaches in environmental management, this concept stresses the "win-win" situation (Miller and Spoolman 2011, p. 242, Rosenzweig 2003, p. 1) for nature and humans, trying thus to align the interests in usage of nature with the need to protect it. The *cascade model* (figure 1) originally published by Haines-Young and Potschin (2010) is commonly used in studies dealing with the ES concept (e. g., MA 2005, TEEB 2010) and also serves as a basis for the study at hand. The model displays the two ends of a "production chain", distinguishing between ecological structures and processes and benefits which people ultimately derive from them (Haines-Young and Potschin 2010, p. 115).

Ecosystem functions describe the capacity to provide goods or services for human society. The actual demand determines the extent of the ES and consequently the benefit for humans. ES can be divided into four categories: 1. provisioning services such as food and water; 2. regulating services such as regulation of floods, drought, land degradation, and disease; 3. supporting services such

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as soil formation and nutrient cycling; 4. cultural services such as recreational, spiritual, religious, and other nonmaterial benefits (MA 2005).

The underlying idea of the ES concept was already an issue in the late 1970s (Westman 1977) and 1980s (De Groot 1987). Viewing nature as a "productive force" attracted the public and policy makers, and subsequently led to the development of economic assessment methods (Grunewald and Bastian 2013b, p. 3). These methods can be relevant for decision-making processes by means of highlighting trade-offs among the choices or by modeling future scenarios to assess the long-term consequences of the actions taken (Ash et al. 2010). Cultural ES are insufficiently considered in monetary assessment frameworks (e.g., Chan et al. 2012a, b). Hence, non-economic assessment approaches of ES have advanced. These include the involvement of local stakeholders in the course of applying participatory techniques (Raymond et al. 2014).

In the field of landscape planning, the idea of human benefits from ecosystem processes – framed as "landscape functions" – has been an issue for decades (Kienast 2010, p. 7, Von Haaren and Albert 2011, p. 152, Grunewald and Bastian 2013a, p. 17). The concept emerged in national contexts and overlaps to a certain extent with the understanding of ES. Intended for practical use, the majority of publications was written in local languages (Von Haaren and Albert 2011). Thus, two parallel discourses have evolved. Yet, researchers in the field of ES assessments increasingly consider environmental planning and the methodological approaches applied (Von Haaren and Albert 2011).

Whereas in literature the ES concept attracts growing attention and is already regarded as "mainstream" (e.g., Braat and De Groot 2012, p. 5), its practical application in landscape planning and decision making is lacking behind (Portman 2013, Hauck et al. 2013c, Albert et al. 2014). This has been described in a similar way both in Europe and the USA. While some researchers highlight the potential benefit of the ES approach as a valuable addition to current river conservation strategies (Ormerod 2014), others point out that there are only few examples where ES research projects have resulted in the protection of ES (Cowling et al. 2008). Moreover, following Liu et al. (2010), the contribution of ES-based assessments to environmental management was not as widespread as originally hoped. While there are efforts at the global level toward integrating ES into policy directives (Luck et al. 2012), the discrepancy between theoretical knowledge and practical implementation seems to hold particularly true at the regional and local levels (Albert et al. 2014).

Possible reasons may be a lack of social embeddedness and the focus of most ES studies on monetary valuation (Cowling et al. 2008, Albert et al. 2014). Menzel and Teng (2010, p. 907) point to the fact that ES projects are "driven by biophysical data" and experts' perspectives, while stakeholders' views are not effectively included, leading ultimately to the tendency that their views are considered irrelevant for policy.

Implementing ES in practice thus requires focusing on stakeholder needs and collaboration (Termorshuizen and Opdam 2009, Cowling et al. 2008, Albert et al. 2014) as well as communicating ES information. It also requires resolving the persistent uncertainties and ambiguities held by general audiences (Carpenter and Folke 2006). However, only few earlier studies at the landscape level have considered the question of how the term "ES" is interpreted by stakeholders (Termorshuizen and Opdam 2009, Albert et al. 2014, Rewitzer et al. 2014) and how different actors perceive ES (e.g., Böck et al. 2013, Plieninger et al. 2013).

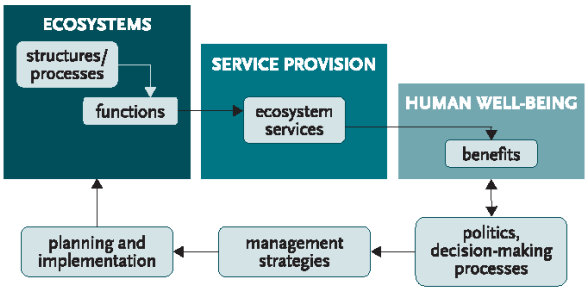


FIGURE 1: Cascade model showing the link between ecosystem services and human well-being (based on Haines-Young and Potschin 2010, De Groot et al. 2010 and Van Oudenhoven et al. 2012).

Based on discussions about the practicability of the ES concept at different scale levels or in the context of different research fields (e.g., geography, spatial planning, nature conservation; Portman 2013, Hauck et al. 2013b, c, Albert et al. 2014), this study deals with the implementation of the ES concept in Austrian river landscape management. In this specific context it can be particularly useful toward the pursuit of documenting the societal relevance of river restoration projects, improving thereby the political and public perception of restoration success (Vermaat et al. submitted). Getzner et al. (2011) describe the ES approach as useful in the course of balancing public interests, for example, in licensing procedures of infrastructure projects (e.g., building of hydropower plants). Ormerod (2014) highlights the potential gain to be had from displaying the trade-offs between management decisions in different ecosystems.

While the ES approach facilitates an assessment of multiple components of societal value, existing regulations and required management concepts rather contend with single river landscape uses. The *Austrian Water Act* (WRG 1959), for instance, addresses the ecological status of rivers, the protection of ground water, and the retention of floods and recreation. At the provincial level, nature protection laws primarily deal with supporting services, but also include some aspects of cultural services, especially recreational use of rivers (Chiari 2010).

Several initiatives at the EU level deal with the integration of ES in river landscape management, for example, *MARS – Managing Aquatic Ecosystems and Water Resources under Multiple Stress* (Hering et al. 2015) and *REFORM – REstoring Rivers FOR Effective Catchment Management* (Vermaat et al. 2013). At the national level there have been very few initiatives so far. In Austria the only known ES-based assessment with a river focus was conducted at the river Mur in Styria (Getzner et al. 2011). On a larger scale, the >

Austrian Federal Forests (ÖBF) are currently conducting a project on the economic assessment of their areas (including river landscapes) as a basis for decision making (ÖBF 2014).

The objective of this article is to contribute to the ongoing discussions on the practical relevance of the ES concept, focusing on the questions, 1. whether different actors in the context of river landscape management know about the concept and are aware of its various possible applications and limitations, 2. whether they apply it in their working environment, 3. whether they consider it practicable, and 4. what are their concerns regarding the concept's implementation.

Methods

Case Selection

Research was conducted in the two Alpine river landscapes Enns and Drau in Austria (figure 2).

These areas were selected as several transdisciplinary processes have been conducted there in the past, hence the reasonable assumption of stakeholders' willingness to cooperate. Furthermore, the familiarity with the area due to previous research projects (e.g., Hohensinner et al. 2008, Chiari 2010, Muhar et al. 2011), coupled with existing relationships with local experts served as a good starting point for this study.

The comparability of the selected case studies was ensured on account of their similar type and river-floodplain system dimensions. Both river landscapes show a wide variability regarding different forms of use and anthropogenic pressures and as a result yield different hydromorphological and ecological statuses.

Over recent years several restoration measures were implemented in the selected case study regions. Figure 3 shows a restored site at the river Drau that not only led to an improved ecological functioning and flood protection but also enhanced the recreational value of the river landscape. Through carrying out ex-post assessments as suggested by Vermaat et al. (submitted), the ES concept could improve visibility of restoration success.

Methods of Data Collection

As ES research claims to be a constituent part of sustainability science, it requires being "user-inspired, user-useful and user-friendly" (Cowling et al. 2008, p. 9483). We thus focus on how people in different positions encounter the ES concept and to what extent they integrate it in their working field.

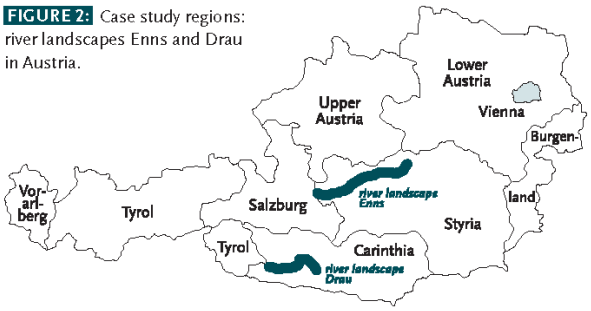


FIGURE 2: Case study regions: river landscapes Enns and Drau in Austria.

To address the stated objectives, a semi-quantitative survey using an interview guideline was conducted. The ES concept was introduced as a helpful tool in the framing of environmental discourse. In the course of the interviews, its practical application as a support mechanism for planning and decision-making processes was also discussed. Analysis categories were inductively derived from discussions with experts and pretests with a mixed group of stakeholders (n = 6). Based on experiences from the first case study (river landscape Enns, n = 84), certain aspects of the questions were slightly adapted to strategically gain even more specific information from the second case study (river landscape Drau, n = 26). The following questions were the core of the qualitative survey:

1. *Have you ever encountered the ES concept before?*
   - *If yes: In which context? In which form?*
2. *Does the ES concept play a role in your working environment or the management processes you carry out?*
3. *How do you evaluate the practicability of the ES concept?*
   - *Which reasons are there for and against the practical application of the concept from your point of view?*
   - *Could the ES concept serve as a support mechanism for future planning and decision-making processes?*
   - *Do you perceive it as redundant with regards to other concepts?*
4. *Would it make sense in your opinion to apply the ES concept as an assessment tool?*
   - *How do you evaluate the approach of a monetary assessment of ES?*

The first question on the knowledge of the ES concept was initially not an explicit part of the interview guide, rather asked in passing, but later on it was formally incorporated into the questionnaire based on the experiences from the first interviews. This explains why we do not have complete data for this question from all interviewees.

For those interviewees who had not heard of the ES concept before, we provided a short explanation, using the cascade model (figure 1) and a table indicating the ES relevant for the specific river landscapes (see table). Starting with the ES categories and sub-categories suggested in the *Millennium Ecosystem Assessment* report (MA 2005), the selection was based on explorative interviews with six experts from different disciplines and organizational levels who are familiar with the regions. As the final selection was influenced by the natural conditions in the Enns and Drau valley, the number of ES within the single categories shows variation.

From August 2012 to January 2014, 180 persons with a professional interest in the river landscapes Enns and Drau were approached via email and telephone. The selection was based on an internet search and personal contacts from earlier projects. Fol-

lowing recommendations from interview partners, the interviewee list was extended to also include affected people outside organizations. 50 persons explicitly refused participation due to a lack of time (n=20), interest (n=5) or perceived missing competence or relevance of the ES concept (n=25); 20 did not react. The final sample of 110 interviewees comprised persons at national, federal state and regional/municipality levels from the following thematic areas: agriculture (n=3), education/research (n=9), energy industry (n=8), forestry (n=4), infrastructure (n=3), nature protection (n=32), planning (n=8), politics (n=15), recreational fishery/hunting (n=10), tourism and water sports (n=12), and water management and torrent and avalanche control (n=19). The interviews lasted on average half an hour and were conducted in person or by telephone. They were recorded and transcribed, with significant parts of the audio content paraphrased.

Methods of Data Analysis

A qualitative content analysis was conducted using the software *Atlas.ti*.[1] The analysis categories from the interview guidelines were supplemented by categories inductively derived from the answers. Some codes were also assigned subcodes, designed for the purpose of differentiating between the positive or negative connotation of the interviewees' statements. This resulted in a hierarchical coding scheme.

The qualitative data collected do not allow detailed statistical analyses. Nevertheless, some variables were exported into spreadsheets for visualization. The main focus, however, remains on the interviewees' opinions and reasoning, rather than statistical representations.

The number of interviewees included for each question varies because not every interviewee answered every question. While the analysis of stakeholders' knowledge and awareness of the ES concept was based on the whole number of respondents, only the answers of those interviewees who had known about the ES concept already before were included for the further quantitative analysis on the relevance and practicability of the ES concept.

1 *Atlas.ti – the Knowledge Workbench. Version 6.2.28* (2014).

TABLE 1: Ecosystem services (ES) relevant for the river landscapes Enns and Drau.

ES category	selected ES
provisioning services	■ opportunities for agricultural use ■ opportunities for forestry ■ opportunities for settlements and infrastructure ■ provision of water for irrigation and for drinking ■ provision of energy through water power plants ■ opportunities for gravel mining
regulating services	■ retention of nutrients and pollutants (e. g., storage of N, P, CO_2) ■ erosion protection ■ flood control
cultural services	■ opportunities for tourism and recreational activities ■ opportunities for water sports (e. g., rafting, canoeing) ■ opportunities for recreational fishery and hunting ■ area for experiencing and discovering nature
supporting services	■ habitats for a diversity of aquatic/terrestrial animal and plant species ■ capability of the ecosystem to regulate and regenerate

FIGURE 3: Restored site at the river Drau in Dellach. The ecosystem services concept could be useful to raise public awareness of the restoration project's success.

Stakeholders' Views of the ES Concept

Knowledge and Awareness Regarding the ES Concept

Out of the 70 respondents who explicitly answered this question (see our explanation regarding the first question above), 37 had neither heard of the concept before nor knew what was meant by it. Also considering the 25 persons who had already refused participation in the survey due to a perceived missing competence or relevance of the ES concept, this indicates a rather low level of knowledge among potential users. Figure 4 (p. 36) reveals that people in education and research, spatial/landscape planning and nature protection showed a greater familiarity with the ES concept, while it was unknown by stakeholders from tourism and agriculture. >

The respondents with a close relationship to academia showed a particularly high level of familiarity with the concept, regarding it as a well-known and ubiquitous buzzword.

We conducted an additional analysis, comparing the perceptions towards the ES concept among those interviewees who were familiar with the ES concept (i. e., could explain its main characteristics and possible applications) and those who had not known about it. This analysis did not show significant differences. We therefore assumed that also those interviewees who were not well informed about the ES concept could, however, assess it realistically, hence we included their estimations in the qualitative part of the analysis as well.

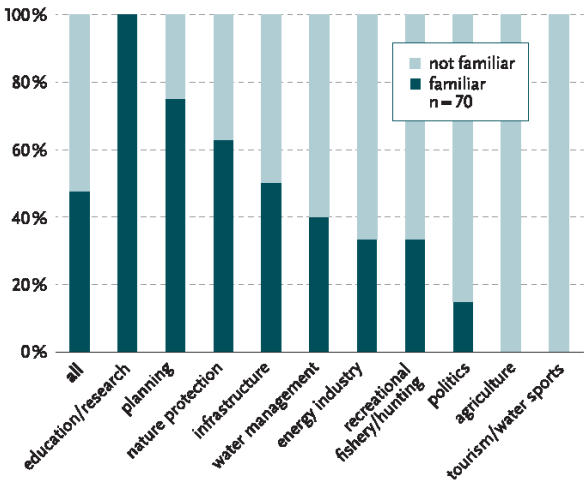
Practical Relevance of the ES Concept in the Interviewees' Working Environments

Half of the respondents who answered question 2 (n=23) indicated that the concept played some role in their working environments. This was particularly the case for assessment tasks, where the ES concept was described as offering a "broader approach". However, it was mostly observed as being addressed indirectly, for example, in the framework of environmental impact assessments or status assessments according to the *EU Water Framework Directive (WFD)* (Directive 2000/60/EC). Many interviewees considered the issue to be a question of terminology and stated that the term "ES" might not be relevant for them, but the idea behind it, in terms of similar concepts, had nevertheless been an issue which had surfaced in earlier approaches, such as landscape functionality or environmental and resource costs.

Figure 5 summarizes the views on the practical relevance of ES by those interviewees who were familiar with the ES concept.

About half of the respondents described the ES approach as practicable, in particular with regard to planning and decision-making processes and as a tool of communication and education.

FIGURE 4: Reported familiarity of interviewees from different stakeholder groups with the ecosystem services concept.



The ES Concept as Support for Planning and Decision Making

Three quarters of the interviewees who commented on the ES concept's usefulness as an assessment system (question 4) (n=28) regarded it as valuable. In particular, the integrative character of the ES concept and its approach of breaking down complexity into tangible units were described as helpful. The higher transparency and intelligibility attributed was regarded as a good basis for planning and decision-making processes. Furthermore, respondents considered the awareness of a wide variety of services instead of a single-use view on the river as being beneficial for integrative assessments.

What's more, representatives from the nature protection sector pointed out the concept's holistic approach and stressed its benefit toward fostering integrative thinking and analysis of the ecosystem as a whole. Representatives from the field of spatial planning and nature protection indicated that the instrument could help to substantiate the usefulness claim and to make its operationalization easier by moving the discussion to a more systematic and objective level.

The ES Concept as a Communication and Education Tool

The ES concept was also considered to be useful for communication and environmental education purposes. By raising awareness amongst both children and adults about the functions of river ecosystems and humans' strong dependence on them, it could enhance people's understanding about the connectedness of society with nature as well as create curiosity and foster interest on the subject. The concept was described as a chance to improve the traceability of ecological assessment processes, thereby increasing societal interest and acceptance toward the management measures conducted.

Concerns Regarding the Implementation of the ES Concept

Apart from several ideas for possible applications of the ES concept and many positive remarks from different stakeholder groups, certain limitations in applying the ES concept were identified as well.

Assessment Bias

Interviewees mentioned several general challenges in assessment processes such as possible political or financial influences on the assessment outcomes. More specifically, they were concerned that those things which are easy to assess (e.g., provisioning services) may be assessed more favorably than others (e.g., cultural services), thereby leading to a certain bias and consequently no improvement in the current assessment situation. Furthermore, the possibility of a false interpretation of the ES concept was raised, in the sense that humans would care for the provision of "ES" (e.g., through agriculture or the installation of a hydropower plant) instead of maintaining the original idea of nature being protected at the highest unimpeded level possible.

An ambivalent view could be detected regarding monetary assessments among the interviewees (n=32). Half of them perceived such an assessment rather negatively. This was mainly due to the

question of how to assign a monetary figure to intrinsic values and the concomitant fear of the commodification of nature.

Challenges for Administration

Interviewees in the field of water management saw the ES concept as redundant and described the *WFD* (Directive 2000/60/EC) and the *Austrian Water Act* (WRG 1959) as already sufficiently covering all relevant aspects (e.g., public interests, limitations of use).

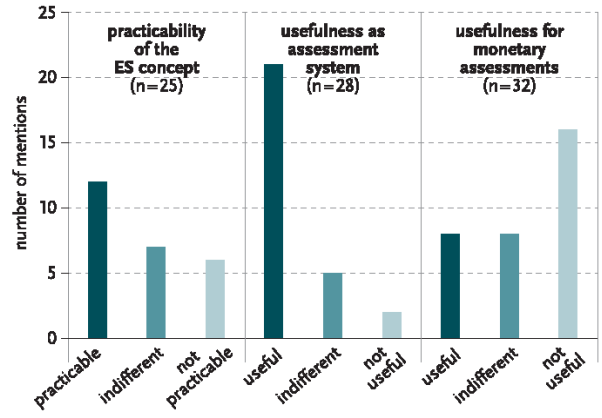
Based on experiences they had gained in former projects, representatives from nature protection expected that there would be too little time and money for implementing the ES concept in an optimized way. Coupled with limited acquaintance with the administrative personnel needed to help implement the concept, this was seen as a barrier for its actual application.

Opportunities and Challenges of the ES Concept

Opportunities for the ES Concept in River Landscape Management

Our study revealed that the concept has not yet taken off in the working environment of the various parties involved in Austrian river landscape management. Nevertheless, half of the interviewed stakeholders regarded it as practicable and even three quarters of them viewed it as a useful way to assess ecosystems. It was considered as an opportunity for gaining a comprehensive viewpoint, including the chance to embrace the societal value attached, as opposed to assessing individual components. Hence awareness about the manifold services of near-natural and restored river landscapes could be raised among society as a whole, as well as on the part of administrative actors and political representatives. Societal and political acceptance of river restoration projects could be improved (Vermaat et al. submitted). The potential of the ES concept for communication and education purposes, in particular, was considered to be high, which is much in line with results of a similar study in Germany (Rewitzer et al. 2014).

FIGURE 5: Practical relevance of the ecosystem services (ES) concept in the eyes of those stakeholders being familiar with it (questions 3 and 4).



Challenges in Practical Application

Limited Awareness of the ES Concept

Participants in the *6th World Water Forum* (Wallis et al. 2011, p. 96) discussed that "there is currently an extremely high gap in what the general public and water managers understand of ecosystem goods and services". We can corroborate this statement, contributing to comparable studies in Germany and France (Lamarque et al. 2011, Albert et al. 2014) which show a similar level of low familiarity with the ES concept as found in our study.

A reason for the limited awareness is presumably the unclear transmission of this scientifically driven concept to the stakeholders at the grassroots (Ghazoul 2007). Information and involvement in the field of ES mainly occurred at the global level, while there is still a need for better information among stakeholders at the local level (Turner et al. 2003). This requires more direct science-policy interaction between researchers and stakeholders (Neßhöver et al. 2013).

The work of the *Sub-Global Assessment (SGA) Network*[2] represents a first step in achieving this goal. It aims at capacity-building for carrying out ecosystem assessments and provides corresponding tools and resources to practitioners (e.g., Ranganathan et al. 2008, Ash et al. 2010, Tallis et al. 2011, WBCSD 2013).

In addition, a better communication of ES knowledge to stakeholders and the public can assist in overcoming challenges due to a lack of awareness (De Groot et al. 2009). Possible pathways are ES projects conducted and communicated to the public by nature conservation organizations, such as the *Danube PES (Payments for Ecosystem Services)* project,[3] or following interactive and integrative approaches as applied in the project *Natural Capital Germany – TEEB DE*.[4] In the Austrian context, this development could be supported by the ES assessment of ÖBF areas (ÖBF 2014) and a project at the river Traisen, which aims to raise consciousness in society about the various benefits of river landscapes (Poppe 2014).

Challenges with Regard to ES Assessments

Many challenges perceived by the interviewees seem to refer to experiences with assessment processes generally rather than ES assessments in particular. Still, the critical arguments regarding quantitative ES assessment were much in line with those discussed in literature, especially in the context of cultural ES (Schaich et al. 2010, Chan et al. 2012a, Daniel et al. 2012, Satz et al. 2013, Jax et al. 2013): these are difficult to distinctly classify and measure, and thus tend to be given less consideration in environmental assessments where the focus lies rather on biophysical or economic metrics (Satz et al. 2013).

The argument of non-transparent weighting processes in ES assessments found in our study also applies to other contexts. Respondents in a study conducted by Albert et al. (2014, p. 1308) stated "that integrating ES information in general would make an >

2 *www.ecosystemassessments.net*
3 *wwf.panda.org/what_we_do/where_we_work/black_sea_basin/danube_carpathian/our_solutions/green_public_funds/pes/the_danube_pes_project*
4 *www.naturkapital-teeb.de*

already complex planning approach even more non-transparent for decision makers".

Half of the interviewees who had known about the concept before (n=32) had a negative view towards a monetary assessment of ES. Many of them voiced the fear of a commodification of nature, an argument which is also intensively discussed in literature (e.g., De Groot et al. 2009, Spierenburg 2012, Albert et al. 2014). Kosoy and Corbera (2010) highlight technical difficulties and ethical implications. The notion "that nature is only worth conserving when it is, or can be made, profitable" (McCauley 2006, p. 28) is most frequently rejected. However, other authors point to the fact that "the ES concept is not meant to replace biocentric arguments" (Schröter et al. 2014, p. 515) but instead to act as contribution to a better understanding of the impact of ecosystem change on human welfare (Chan et al. 2012b). Demonstrating the importance of wetlands, furthermore, should serve to widen people's horizons and help them overcome the fears and challenges attached to ES. On another note, Redford and Adams (2009, p. 785) suggest that a monetary approach should be characterized by "a set of tools used in pursuit of conservation," as this would also increase the resilience and persuasive power on the part of conservation arguments. Russi et al. (2013) additionally suggest a combination of different assessment methods to ultimately reflect all values embedded in water and water-related ES. An interviewee framed it aptly like this: "an immaterial, argumentative approach to reach people's hearts and a rational approach for the correct, expertise-based valuation".

Redundancies with Other Approaches

Many stakeholders pointed to a certain redundancy of the ES concept with regards to existing guidelines and legal frameworks. Our findings correspond with statements cited by Hauck et al. (2013a). In the eye of stakeholders, the *EU Floods Directive* (Directive 2007/60/EC) or the *WFD* (Directive 2000/60/EC), for instance, were already implicitly addressing ES. A similar survey of landscape planners in Germany (Albert et al. 2014) found that their needs are nearly covered by existing landscape plans and that adding ES does not seem feasible in the already highly complex landscape planning practice. The additional workload posed by the framework of the study at hand was also an issue there.

Despite several similarities between approaches used in ES assessments and those applied in environmental planning (Von Haaren and Albert 2011), the aspect of multifunctionality in the context of river landscape management, as addressed by the ES concept, has not yet been directly included in any legal framework. Interviewees may not have realized yet the opportunity for operationalizing this aspect through the ES concept. A further key aspect that other approaches neglect is the strong connection between the environmental system, the political decision-making process, and finally the realization process of the integrated and transdisciplinary approaches which biodiversity issues call for (Neßhöver et al. 2013, Schröter et al. 2014). Moreover, the ES concept makes a valuable contribution to already available management approaches because its application in environmental planning helps to gain insights (Von Haaren and Albert 2011) and evaluate policy impacts comprehensively (Hauck et al. 2013a). Finally, implementing the ES concept into existing frameworks such as the *WFD* (Wallis et al. 2011, Vlachopoulou et al. 2014), the *Floods Directive* (COWI 2014) or environmental impact assessments (Karjalainen et al. 2013) promises good prospects for capturing side benefits.

Where the ecosystem services concept is implemented in Austrian river landscape management, it proves its practical relevance for planning and communication processes and could improve societal and political acceptance of river restoration projects.

The ES Concept's Potential in Future River Landscape Management

Despite the concerns and critical issues mentioned by the interviewees, the potential benefits which stand to be gained by the ES concept should hardly be disregarded. On the contrary, its potential contribution is outstanding. ES could be of particular value, for example, in the context of river management (Ormerod 2014): it can foster understanding of the functions and related services and therein serve as vital support to stakeholders and decision makers in the pursuit of improving governance processes (Russi et al. 2013). Concrete recommendations for action and assessment methods adapted to the Austrian context may specifically help to implement the concept in the case of the management of river landscapes. Projects currently being conducted (ÖBF 2014, Poppe 2014) could serve to assist in their development. However, only time will tell whether the ES concept will in fact form the integral part of future river landscape management which it has the real potential to be.

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4.3 Article #3

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RIVER RESTORATION EFFECTS

Assessing the societal benefits of river restoration using the ecosystem services approach

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Abstract The success of river restoration was estimated using the ecosystem services approach. In eight pairs of restored–unrestored reaches and floodplains across Europe, we quantified provisioning (agricultural products, wood, reed for thatching, infiltrated drinking water), regulating (flooding and drainage, nutrient retention, carbon sequestration) and cultural (recreational hunting and fishing, kayaking, biodiversity conservation, appreciation of scenic landscapes) services for separate habitats within each reach, and summed these to annual economic value normalized per reach area. We used locally available data and literature, did surveys among inhabitants and visitors, and used a range of economic methods (market value, shadow price, replacement cost, avoided damage, willingness-to-pay survey, choice experiment) to provide final monetary service estimates. Total ecosystem service value was significantly increased in the restored reaches (difference 1400 ± 600 € ha^{-1} $year^{-1}$; $2500 - 1100$, $p = 0.03$, paired t test). Removal of one extreme case did not affect this outcome. We analysed the relation between services delivered and with floodplain and catchment characteristics after reducing these 23 variables to four principal components explaining 80% of the variance. Cultural and regulating services correlated positively with human population density, cattle density and

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agricultural N surplus in the catchment, but not with the fraction of arable land or forest, floodplain slope, mean river discharge or GDP. Our interpretation is that landscape appreciation and flood risk alleviation are a function of human population density, but not wealth, in areas where dairy farming is the prime form of agriculture.

Keywords Nutrient retention · River corridor · Wetlands · Flood control · Biodiversity · Economic valuation

Introduction

Over the past decades, rivers have been restored for a range of purposes, such as flood mitigation, habitat and biodiversity enhancement and water quality improvement (Bernhardt et al., 2005; Benayas et al., 2007; Jähnig et al., 2011). Purpose and success of restoration often have been reported with limited rigour (Bernhardt et al., 2005, Bernhardt & Palmer, 2011; Jähnig et al., 2011), as in other ecosystems (Zedler & Kercher, 2005; Benayas et al., 2007). In addition, indicators of success used vary widely, ranging from geomorphological elements in the floodplain landscape and water quality parameters to the presence of characteristic biota in different species groups as well as aggregate biodiversity indicators. This variation can be due to the purpose of restoration, the scale of the assessment and the institutional context (Hering et al., 2015; Jähnig et al., 2011; Morandi et al., 2014). The combination of poor documentation and variable indicators is at odds with standards for study design (Underwood, 1996). It also complicates a comparative analysis across larger numbers of cases at a later stage (Benayas et al., 2007; Morandi et al., 2014), which is an important tool for policy evaluation (Turner et al., 2000).

This study is an attempt to carry out such a comparative analysis across eight European rivers using the ecosystem services approach as an integrating framework (cf Acuña et al., 2013). We will first argue why the ecosystem services approach could be fit for this purpose and address the issue of spatial scale and resolution, then specify our underlying hypothesis on how ecosystem services could be affected by river restoration and conclude with our research questions.

The concept of ecosystem services has been advocated by the Millennium Ecosystem Assessment (MEA, 2005) as a means to integrate all possible direct and indirect benefits that accrue from an ecosystem to human society, including those that are not straightforwardly monetized. It has been further developed into a well-specified typological catalogue with three main categories, i.e. provisioning, regulating and cultural services (e.g. Wallace, 2007; Bateman et al., 2010; Watson & Albon, 2011; Weber, 2011; see below, "Methods" section). The ecosystem services approach is applied increasingly (Fisher et al., 2009; report an exponential increase in publications) to include all these potential benefits in comprehensive decision-making and planning efforts (e.g. Carpenter et al., 2009; Nelson et al., 2009; Bateman et al., 2010; De Groot et al., 2010; Acuña et al. 2013). Ecosystem services depend on a variety of intermediate ecosystem processes and states, but their societal value ultimately depends on the use (and non-use) by humans in their final form. A particular habitat can provide several services simultaneously, such as mineable sand, the retention of nutrients, the accumulation of carbon in wood, the excitement of angling and the enjoyment of the scenic beauty of the riverine landscape. Briefly, our quantification was carried out in three steps. First, services are quantified in their final form (in biophysical units; Wallace, 2007; Bateman et al., 2010), a form which is measurably beneficial to society and is not intermediate leading to

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yet another ecosystem process or service. An example of a final regulating service is nutrient retention in kg of phosphorus retained ha^{-1} $year^{-1}$. Then all final services are valued separately using a range of economical methods. Finally, these monetary values are summed for the ecosystem. Since restoration measures can affect a wide range of processes and conditions in river and floodplain, comprehensive evaluation of their success should integrate all aspects considered potential benefits to society. We understand that the summation of ecosystem services is essentially anthropocentric through its focus on societal benefit (Westmann, 1977), but argue that the estimated economic value offers a useful though imperfect common yardstick, which is expressed in tangible units that are understandable to the general public and decision makers.

Ecosystem services quantification is spatially bound by the extent of the providing ecosystem, which is inherently unspecific. River restoration efforts are geographically limited to banks and floodplains, but may still differ widely in spatial extent (Bernhardt et al., 2005). Overall, restoration is thought to be more successful when longer stretches of river are restored, and the landscape setting is incorporated, particularly for larger and longer-lived organisms, such as fish and macrophytes (e.g. Lorenz & Feld, 2013). In contrast, however, Hering et al. (2015) observed that intensity of habitat modification in the restoration effort had a far more pronounced effect than extent of the restoration (i.e. km of river length restored). This suggests that intensity and extent of restoration are different dimensions, and that the landscape and catchment perspective is important. Most restoration projects are carried out at the reach scale (a length of several river widths up to 20 km; Bernhardt et al., 2005; Brierley & Fryirs, 2005). This was also the case for the study sites in our project (Muhar et al., introduction to this special issue). Reaches are viewed as comparatively homogeneous stretches of landscape in the river network draining a catchment (Skøien et al., 2003). Reach-scale floodplain stretches, however, consist of mosaics of different habitats, such as woodland, grassland, marshes or gravel beds. Within-reach variability in these habitats can be considerable, and these different habitats can differ markedly in service provision, such as sedimentation and nutrient retention (Olde Venterink et al., 2006). Therefore, where reaches are the spatial unit of comparison, internal habitat constellation at the local scale, as well as arrangement of reaches at the wider landscape and catchment scale, the regional scale, are both important in determining the potential for of service provision.

Gilvear et al. (2013) stress that the 'degraded, unrestored' state is the result of previous, anthropogenic 'improvement', which also had a distinct, societally recognized purpose, such as drainage, flood protection and navigation. Only the policy perspective has changed with time, and restoration implies that a river has been converted into a state that more closely resembles a historical form and functioning, and is appreciated more highly. Therefore, a 'no measurable effect' zero hypothesis is appropriate. The alternative hypothesis can be a compounding of regulating and cultural services, because specific restoration purposes often relate to these two categories (Bernhardt et al., 2005; Jähnig et al., 2011). Overall, we expect that regulating as well as cultural services related to habitat structure and dynamics of the river channel and floodplain, including an appreciation of increased scenic beauty of the landscape, are enhanced by river restoration at the reach scale. The main questions of this study are (1) Do we find significantly higher societal appreciation of restored as compared to unrestored reaches using an ex-post economic quantification of ecosystem services? (2) Is this difference related to regulating and cultural services? (3) Can we identify underlying geographic differences in the patterns of service provision and valuation for these Central and Northwestern European rivers?

Methods

Studied reaches

Seven out of the eight studied pairs of river reaches (Fig. 1a; Table 1, see also Muhar et al., introduction to this special issue) were studied in the field by two or more of our co-authors, often assisted by local colleagues. For the Skjernå in Denmark, we could depend on the exhaustive documentation of Dubgaard et al. (2005), which includes the economic assessment of cultural services (Table 1). The teams collected local information on all possible forms of ecosystem services provided by the river corridor in both the restored and unrestored reach. We assumed that the

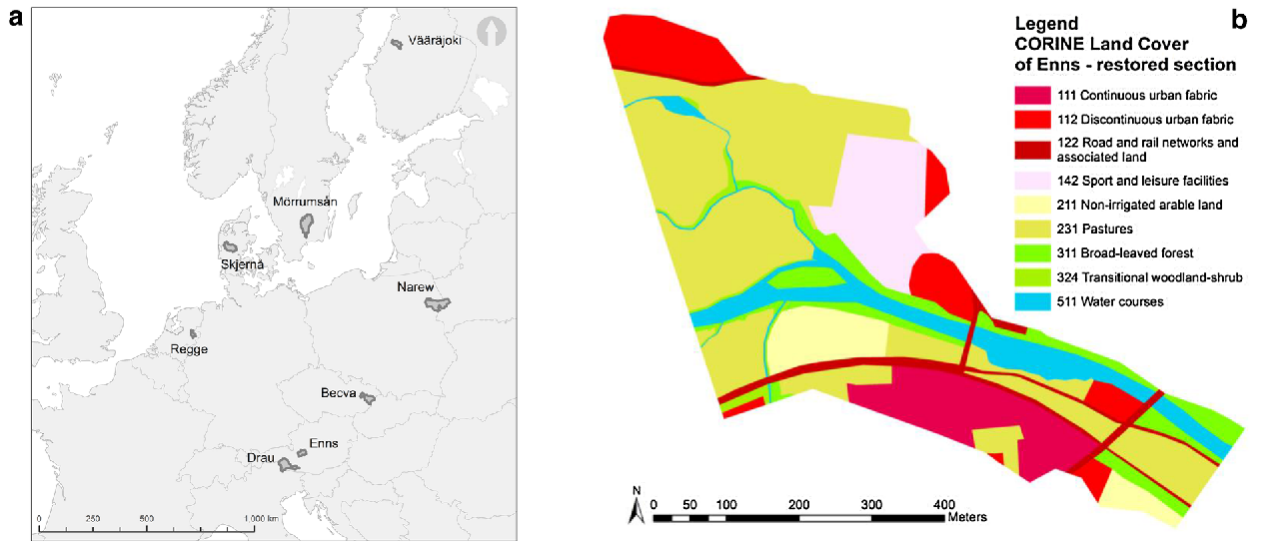

Fig. 1 **a** Location of the study sites across Europe. Indicated are the catchments above the lowest point of the restored or control reach, whichever was further downstream. **b** CORINE habitat map of one of the studied reaches, here the restored reach of the Enns in Austria (from Haverkamp, 2014). The legend provides the CORINE three-level classification used (see also Vermaat et al., 2013)

floodplain corresponded to the spatial extent of each river corridor and determined it with GIS from historical flood maps (see references in Table 1). River corridors of restored and unrestored reaches in a pair varied in length, area and habitat provenance. We have not normalized habitat provenance to a standard proportion across all reaches (for example all normalized to 50% woodland, 40% grassland and 10% marshland) prior to our analyses, because restoration involves a purposeful alteration of habitats, for example, by the re-establishment of marshes and open water.

Quantification of ecosystem services

We applied the methodological framework of Vermaat et al. (2013), which allocates different habitat patches in a reach to uniformly classified units (EUNIS-CORINE, example in Fig. 1b; Davies et al., 2004) and quantitatively accumulates the different services provided by each habitat unit in a reach (Table 2). We first expressed all final services in biophysical units in the form they are utilized by society, then monetized these using one of several economic methods available (see below), and finally summed these per reach. Thus, our service accumulation is a simple summation of total ecosystem service delivery across habitats in a reach as annualized monetary value (Fig. 3), which is normalized to reach area.

Environmental economists have developed a range of methods to estimate the economic value of ecosystem services (Bouma & Van Beukering, 2015). They have reviewed applicability and error components (Brouwer et al., 1999, 2008; Turner et al., 2000; Brander et al., 2006; Bateman et al., 2010; Watson & Albon, 2011), and have aggregated estimates derived from different methods (Dubgaard et al., 2005; Acuña et al., 2013, Martin-Lopez et al., 2014). We based our choice of method on a decision tree from DEFRA (2007) and data availability (Tables 1, 2; Fig. 2, Vermaat et al. 2013). Since we aimed to integrate over different services and compare between reaches, we chose to express all services in monetary units. We did not distinguish other value domains for service appreciation beyond our monetary assessment for two reasons: First, we are convinced that a limitation to final provisioning, regulating or cultural services should account for all underlying supporting services. This implies that a separate distinction of 'habitat provision' (De Groot et al., 2010) or the 'biophysical domain' (Martin-Lopez et al., 2014) is redundant at the final service level as these are already included as supporting services contributing to final services.

Table 1 Characterization of the studied restoration sites along 9 European rivers

River	Regge (The Netherlands)	Skjernå (Denmark)	Mörrumsån (Sweden)	Vääräjoki (Finland)	Narew (Poland)	Becva (Czech Republic)	Enns (Austria)	Drau (Austria)
Coordinates (°′N, E)	52.30, 6.23	55.54, 8.23	56.18, 14.43	63.11, 24.02	53.08, 22.52	49.27, 17.28	47.25, 13.49	46.45, 13.19
Mean annual discharge ($m^3\ s^{-1}$)	11	35	25	10	17	18	22	63
Floodplain slope (m km^{-1}, linear, upstream of reach, r^2 indicates goodness of linear fit)	−0.207 ($r^2 = 0.15$)	−0.604 ($r^2 = 0.78$)	−0.872 ($r^2 = 0.65$)	−0.376 ($r^2 = 0.20$)	−0.255 ($r^2 = 0.56$)	−1.565 ($r^2 = 0.58$)	−2.882 ($r^2 = 0.48$)	−5.392 ($r^2 = 0.79$)
surrounding landscape	Mainly flat, sandy dairyland with glacial moraine ridges	Extensive sandy flat plateaus dissected by broad periglacial tunnel valleys, mainly under agriculture	Forested bedrock hills with interspersed bogs and river valley under agriculture	Forested bedrock hills with interspersed bogs and river valley under agriculture	Gently rolling plateaus under agriculture of variable underlying geology interspersed by marshy, wide periglacial river valleys	Floodplains and foothills largely agricultural, upslope Carpathian mountains under forest	Comparatively broad alpine valley with agriculture at the bottom and forest and rangelands higher up	Comparatively broad valley with agriculture at the bottom and forest and rangelands higher up
Restoration measures	Re-meandered, re-landscaped and lowered the floodplain	Re-meandered, re-connected old arms, reduced depth in main channel, re-landscaped and lowered the floodplain	Enhanced minimal flow with hydraulic measures, added gravel beds, facilitated upstream fish migration	Returned large boulders into the river bed, reconstructed gravel beds for spawning salmonids	Floodplain re-wetting with a downstream weir, reconnect side arms,	Allow natural channel development and migration after unprecedented flood event in summer 1997	Stream bed widened and side arm re-opened,	Stream bed widened and side arm re-opened,
Length restored–unrestored (km along main stream axis)	1.1–0.7	2.6 (in a much larger project)–1.5	3.1–2.4	16–30	4–5	7 (part of a much larger project)–7	0.7–0.8	2–1
Number of interviewed people, % visitors, % willing to respond	100, 30%, not recorded	None (benefit transfer)	47, 23%, 20%	67, 14%, not recorded	100, 14%, 30%	27, 44%, 30%	71, 10%, 50%	112, 20%, 51%

Table 1 continued

River	Regge (The Netherlands)	Skjernå (Denmark)	Mörrumsån (Sweden)	Vääräjoki (Finland)	Narew (Poland)	Becva (Czech Republic)	Enns (Austria)	Drau (Austria)
Estimated resident population represented by the interviewed sample	8400[a]	–	31,000	6010	130,000	74,000	3351	5446
Choice experiment design, attributes and associated range of additional annual water tax payment per household[b]	Accessibility (3 levels), flood risk (1 in 10, 25, 100 y), water quality (3); 0–25€	–	Accessibility (3), hydropower (3), presence migrant salmonids (3), 0–20€	Landscape aesthetics (3), length restored (3), ecological status (3), 0–70€	Landscape quality (3), biodiversity (3), water quality (3), 0–60 PLN	Landscape aesthetics (3), flood risk (3), biodiversity (3), 0–150 CZK	Accessibility (3), flood risk (3), ecological quality (3), length restored (3), 0–30€	As Enns
Period interviews	April 2013	–	May 2014	May 2013	August 2013	September 2014	April–May 2014	May–June 2014
Main source	Brockhoff (2013)	Dubgaard et al. (2005), Pedersen et al. (2007)	Coersen (2015)	Plug (2014)	Gradzinski et al. (2003), Gielczewski (2003), Banaszuk et al. (2005), Banaszuk & Kamocki, (2008), Tylec (2013)	Kohut (2014)	Haverkamp (2014)	Haverkamp (2014)

Underlined references are our own local case studies a.o. containing the wtp-surveys. The Regge is locally known as Beneden Regge

[a] Estimated from the percentage willing to be interviewed, the percentage residents in the sample and the most recent reported population of the riparian municipality. Brockhoff (2013) estimated the existence value of the biodiversity component of cultural service from the wtp and the total visits of 8400 during the tourist season of 7 months; he did not estimate the percentage of non-respondents, and adjacent villages have a population of 14,000, which is not so high that we considered it necessary to include an extra value due to non-visiting residents

[b] Each choice experiment compared two alternatives with the status quo in 6 or 8 choice cards. Card combination allocation was either optimized or fully random (Vääräjoki, Narew). Water quality and ecological status were chosen to correspond with status levels of the European Water Framework Directive

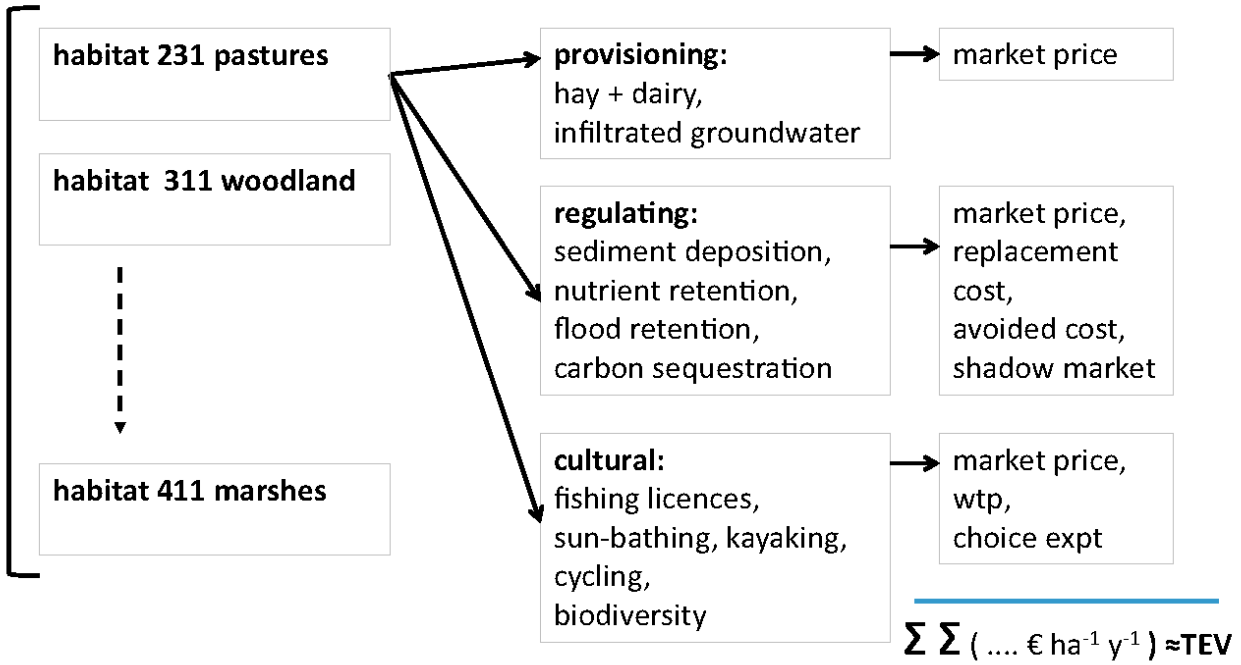

Fig. 2 Flow scheme of the valuation procedure followed for habitats within reaches. Habitat coding is according to CORINE, but only three habitats are displayed for illustrative purpose. Different services and economic methodology are illustrative, not exhaustive. *TEV* total economic value, *wtp* willingness to pay (see text)

Second, a monetary quantification may not grasp the fullness and diversity of societal appreciation (Westmann, 1977), but it does provide a harmonized means to compare, evaluate trade-offs and inform policy makers. An overview of services evaluated and economic methods applied is given in Table 2. Reference to literature and further details on these methods can be found in Vermaat et al. (2013) and the case study reports (Table 1) available on the project website (www.reformrivers.eu).

Local willingness-to-pay (wtp) surveys followed a general structure but were geared to the local conditions, pre-tested locally, and set in a choice-experiment design (Table 1). Each also included an open-ended wtp-question regarding river restoration. Where the choice experiments allowed breakdown of the willingness to pay for restoration into separate components, we used the value reflecting non-use of biodiversity and/or scenic landscape beauty because we have separate estimates for recreational use. Other final services due to biodiversity, such as pollination or enhanced pest control (Cardinale et al., 2012), have not been quantified. Respondents have been classified as local inhabitants or tourists from elsewhere in- or outside the country. We consider local respondents to represent the human population of the adjacent riparian administrative unit(s), which was municipality or one administrative level higher (Denmark, Poland). The percentage of cooperative respondents was included to correct the number of households and tourist visitors possibly willing to pay for river restoration. Since Dubgaard et al. (2005) used the value of the euro for the year 2000, it was adjusted by 1.45 to correspond to the August 2013 euro values applied for all others in this study. For the sampling periods between April 2013 and September 2014 (Table 1) the value of the euro differed by 4% at most, so we did not adjust it.

Statistical analysis

We quantified land use, intensity of agricultural use, human population density and economic indicators of the upstream catchment of a reach from various European spatial databases (supplementary material Table S1). Where relevant we included both the mean and standard deviation for each catchment variable. The difference in estimated value between restored and unrestored reaches was analysed with a paired t-test followed by linear regression of restored versus

Table 2 Approaches to estimate the different specific ecosystem services. Different local market price estimates are in the case study reports (see row 'main source' in Table 1 for references)

Service category	Quantification in biophysical units	Monetary valuation
Provisioning	Hay, grass, fodder (crops year ^{1})	Local market price (following Dubgaard et al., 2005 and Brander et al., 2006)
	Dairy, meat (production year ^{1})	Local market price
	Arable crops, vegetables, fruit (crops year ^{1})	Local market price
	Wood harvested for construction, paper or fuel (production year ^{1}, artisanal firewood collection not included)	Local market price
	Reed crop for thatching (crops year ^{1}, only Skjernå)	Local market price
	Drinking water production after bank infiltration or deep infiltration to aquifer (m^3 year ^{1})	Local market price
	Hydropower is generated along the Austrian Enns and Drau and in the Swedish Morrumsån. Hydropower provision was not affected by the restoration measures carried out in Austria and the estimated reduction due to restoration in the Morrumsån was hard to verify. A difference in service delivery therefore has not been estimated	Not valued
	Commercial fish catch: not valued, only recreative fishing occurs in the studied rivers, which is valued as cultural service	Not valued
Regulating	Avoided in-reach and downstream flood damage: area flooded times crops lost, reduced forest tree growth, property damage	Local market value or damage scanner (Bubeck & De Moel, 2010), using conservative median damage per CORINE land use category and discounting for the flood interval available in the local flood statistics
	Sediment retention may contribute to downstream sediment fill-up, riverbed silting and hydropower impediment. It has not been valued separately since data availability was insufficient	Not valued
	Nutrient retention. Either phosphorus or nitrogen mass removed during flooding (kg ha ^{1} year ^{1}), to prevent double counting. Retention estimated from concentrations, flow volumes, flood duration, area flooded and habitat-specific retention rates (Olde-Venterink et al., 2003, 2006), and a generic in-stream retention estimate from De Klein & Koelmans (2011)	Local fertilizer market price or annualized marginal cost of the least expensive eutrophication abatement measure (Skjernå)
	Carbon sequestration in forest wood and marshland peat: annual accumulation from conservative estimates of aboveground accumulation: (0.1 and 2 ton C ha ^{1} year ^{1} for wetlands and woodlands, respectively, Nabuurs & Schelhaas, 2002; Von Arnold et al., 2005)	Low-end shadow market carbon credit estimate (19 € ton ^{1}, from Derwisch et al. 2009).
	Reduced pumping costs to drain floodplain for agricultural exploitation (Skjernå only)	Directly taken from Dubgaard et al. (2005)
Cultural services	Hunting, fishing	Local numbers of licences issued times licence fee
	Kayaking, rafting	Local rental fees
	Sun-bathing, cycling	Not valued, considered free
	Existence value, increased water quality, scenic beauty and biodiversity	From different local wtp-questionnaires and choice experiments (see Table 1 for key references, design summary and response rates)

unrestored values, where a significant intercept and slope higher than 1 indicate that restored and unrestored values differ. Robustness of the regression was inspected by the change in parameters after leaving out the most extreme data pair. We analysed the possible relationship between service delivery of a reach as dependent variable and reach land use, as well as catchment geographic data, as explanatory variables using a general linear model (GLM). We had no a priori assumptions on geographical hierarchy of the explanatory variables. Covariance among the possibly underlying geographic pattern in catchment (regional) and floodplain (local) variables was first addressed in a principal components analysis (PCA). The significant principal components explaining more than 10% of the variance were used as explanatory covariates in a GLM-ANOVA with restored-unrestored as fixed factor. This assesses whether restoration has a significant impact on service delivery over and above the different covariates grasping geographical variability at local reach and regional catchment scale. PCA and GLM were done with SPSS; exploratory data analysis was done with PAST (Hammer et al., 2001).

Results

Despite considerable variability in the relative importance of provisioning, cultural or regulating services among paired reaches (Fig. 3a, also Fig S1), restored reaches and their floodplains provided a significantly higher total value. Also, higher values of unrestored reaches correlated with higher values of restored reaches, with the exception of the Becva (Fig. 3b). This river is an outlier because of the substantial and frequent flood damage (also in recent years; Kohut, 2014) in the unrestored reach, which is largely prevented after restoration. The net sum of regulating services in this unrestored reach was negative, but its exclusion did not lead to a major change in outcome of the paired t test (difference reduced from 1384 to 840 €, $p = 0.04$).

The studied reaches and their catchments differed considerably in land use and human population density (Fig. 4). Covariance among the 23 catchment and floodplain variables was reduced by retaining only the four principal components together explaining 80% of the total variance (Fig. 5a). Intensity of dairy farming and arable agriculture each correlated highly

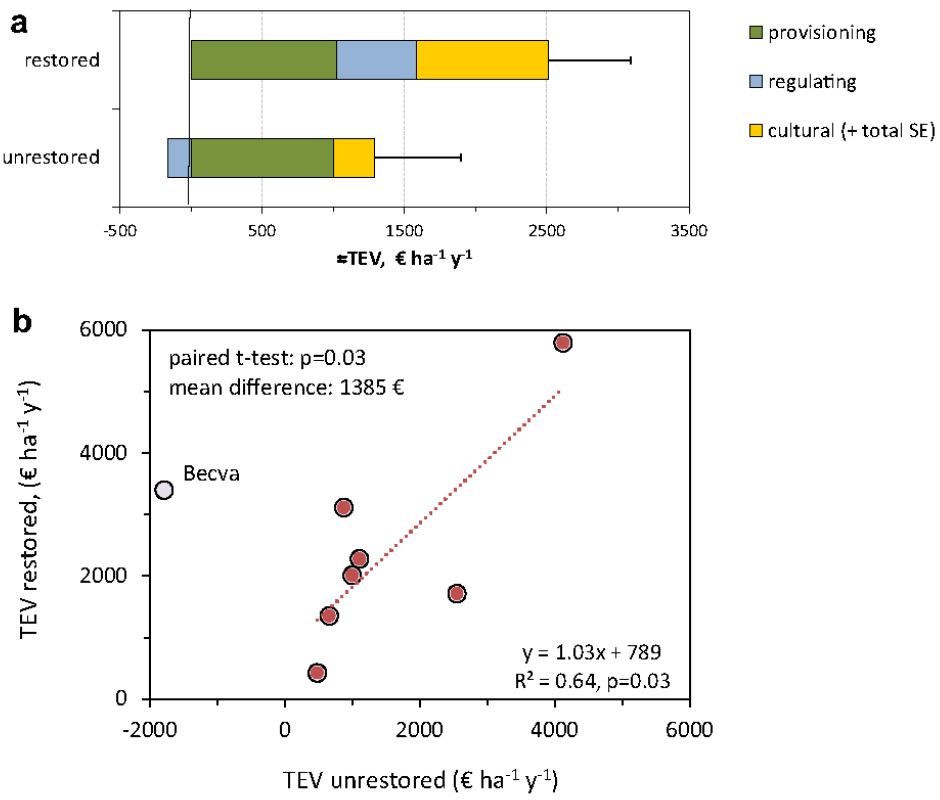

Fig. 3 Overall difference in estimated service delivery between restored and unrestored reaches. **a** Overall stacked means plus 1 standard error of total services (similar *bar charts* for individual rivers are in the supplementary material S1 **b** Scatter plot of restored versus unrestored total services. If the Becva is excluded, the regression is significant. Similar separate regressions for all 8 pairs were made for provisioning services (not significant), regulating services ($p < 0.05$, but not significant without the Becva) and cultural services (slope 1.5, $p < 0.01$)

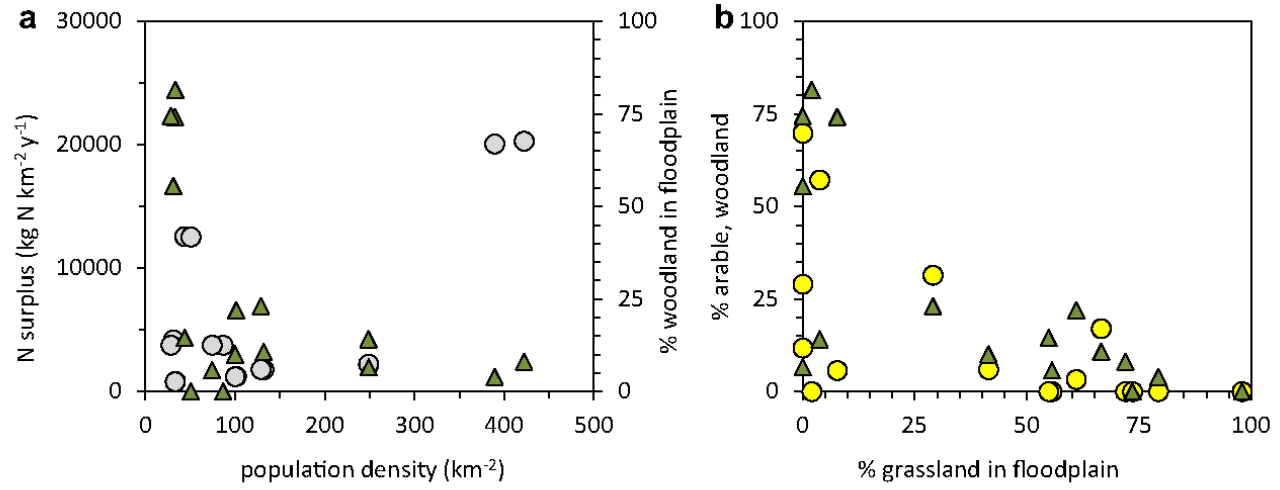

Fig. 4 **a** Variability in catchment human population density versus catchment Nitrogen surplus of agriculture (*circles*) and percentage woodland in the floodplain (*triangles*); **b** percentage woodland (*triangles*) and arable land (*circles*) versus grassland in the studied floodplains

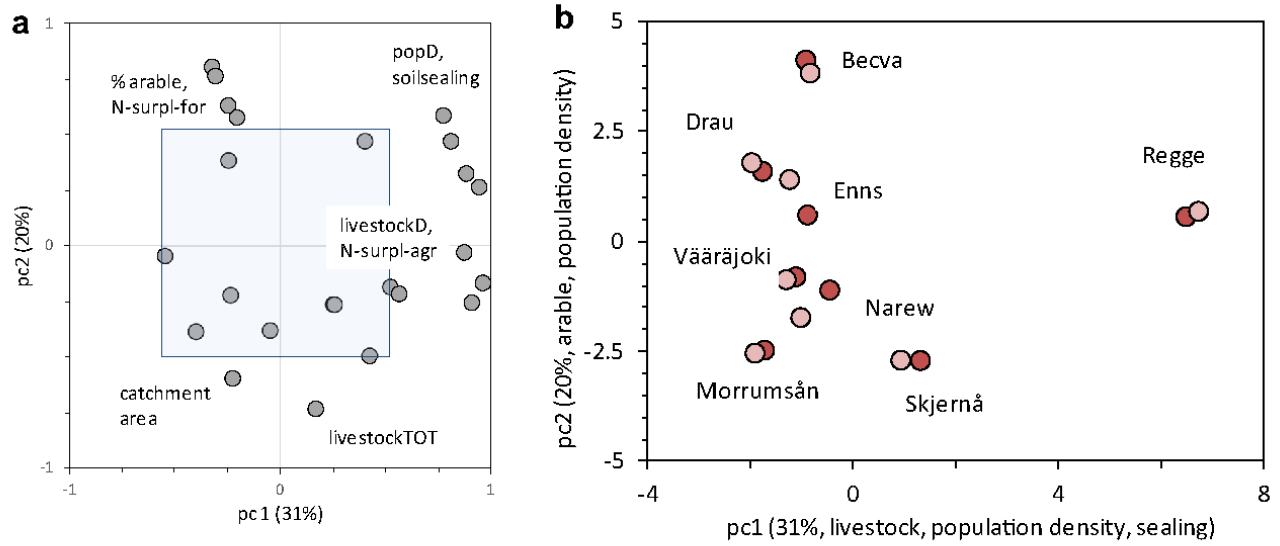

Fig. 5 Principal components analysis of 23 catchment and river corridor variables. **a** Correlations of the original variables versus the first two principal components are plotted. Four principal components explained more than 10% of the variance, together 82%. The transparent *blue square* depicts the area where $r < 0.5$, corresponding to $p > 0.05$ for pairwise linear regressions, within this area we consider the variables to be not correlated with either principal component. Variable labels: *% arable* percentage arable land in the floodplain, *N-surpl-for* nitrogen surplus in the forested part of the catchment, *popD* human population density in the catchment, *soilsealing* the proportion of the catchment area paved, livestockD is cattle density, *N-surpl-agr* nitrogen surplus in the agricultural part of the catchment, *livestockTOT* total livestock number in the catchment, *catchment area* the area upstream of the reach. Note that we used both mean and standard deviation of a catchment variable, the latter to grasp variability within a catchment. These, however, were almost always very closely correlated. **b** Plot of the 8 pairs of restored and unrestored reaches versus the first two principal components (see Fig. 4), *darker symbol* unrestored, *lighter symbol* restored

with a different principal component (respectively, pc1 and pc2, Fig. 5a). Both co-varied significantly with human population density and soil sealing in the catchment. Nitrogen surplus on agricultural land varied parallel with livestock density (pc1). Nitrogen surplus on forested land appeared to correlate with %

Table 3 Relation between ecosystem service value estimates and catchment and river corridor characteristics

Factor	Provisioning	Regulating	Cultural	Total
pc1	0.157	0.219	**0.000**	**0.002**
pc2	0.685	0.761	0.479	0.727
pc3	0.720	0.923	0.989	0.833
pc4	0.123	0.641	0.835	0.131
Restoration (yes/no)	0.871	**0.074**	**0.006**	**0.027**
Adjusted r^2	0.03	0.05	0.73	0.57

The latter are represented by the first four principal components to accommodate for considerable covariance among the 23 variables (Fig. 4). Presented are the levels of significance (p) for each of the four principal components as covariates and restoration (yes, no) as fixed factor in four separate GLM-ANOVAs with type III sums of squares. Also given is the explained variance (adjusted r^2) of each of the full models. All $p < 0.1$ are printed bold

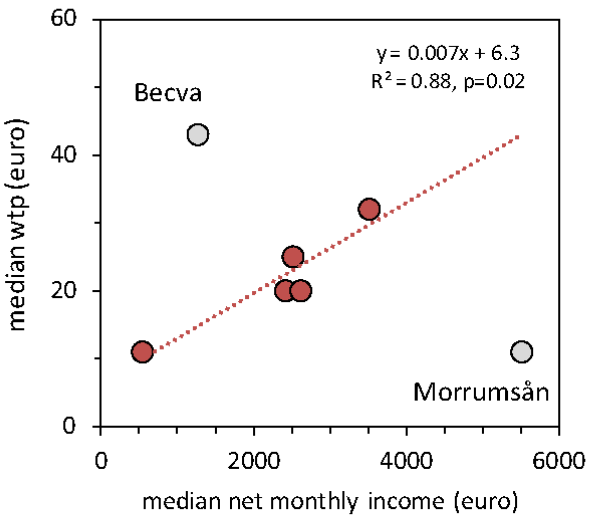

Fig. 6 Median willingness-to-pay per household for river restoration from the seven field surveys versus median reported net monthly income. Displayed regression fit without the data from Becva and Morrumsån

arable land, and was negatively correlated with total catchment area and total numbers of livestock in a catchment (pc2). GDP differed greatly among our study rivers, yet pc3 (which was correlated with GDP, data not shown) was not correlated with any ecosystem service. The pairs of restored–unrestored reaches plotted near to each other across the first two principal components (Fig. 5b), suggesting that the paired reaches indeed are comparable in floodplain and catchment geography.

Catchment and floodplain land use were related to ecosystem service delivery in a GLM-ANOVA with the four principal components as covariates (Table 3). Consistent with the paired t-test, but now without potential confounding from geographic floodplain and catchment variability, restoration had a significant effect on total service delivery and cultural services. We found a marginally significant effect ($p < 0.10$) of restoration on regulating services. However, only cultural services co-varied significantly with pc1. Thus, cultural services are valued higher in areas of higher human population density and more intensive agriculture (pc1), rather than, for example, in wealthier areas with higher GDP. GDP did not correlate significantly with the first two principal components. This corresponds with the absence of a significant relation between respondents' willingness to pay for river restoration and reported net monthly income (Fig. 6): we had to remove two outliers of the seven cases to find a positive relation as is typically found in valuation studies. The fact that respondents along the Becva are willing to pay considerably more and those along the Morrumsån much less suggests important site-specific factors. Along the Becva, inhabitants and visitors alike have lively memories of recent catastrophic floods and high expectations of the new floodplain landscape, which is frequently used. In stark contrast, the respondents along the Morrumsån appreciated only a limited tax increase for river restoration, and only 20% of the interviewed people were willing to cooperate.

Discussion

Increased societal benefits due to river restoration

Our analysis of ecosystem services indeed suggests that river restoration enhances societal benefits:

averaged across all 8 rivers we found a significantly higher service delivery (Fig. 3; Table 3). This appears to be primarily due to an increase in cultural services, and less distinctly to an increase in regulating services (Table 3), whereas provisioning services were not affected by restoration. Our interpretation is that landscape appreciation and flood risk alleviation are a function of human population density, but not wealth, in areas where dairy farming is the prime form of agriculture. At the same time, variability among rivers was substantial. In one case, the Finnish Vääräjoki, the restoration was limited to the stream bed but this led to a reduction of the already low agri- and silvicultural production (provisioning services), and it slightly enhanced flood risk via an increased frequency of ice dams on restored rapids. In another case, the Czech Becva, agricultural provisioning value was nullified by the high risk of flood damage in the unrestored reach.

When we sought for underlying physical or social geographic factors in floodplain and surrounding catchment characteristics, we found a distinct correspondence of higher societal restoration benefits with a higher human population density and cattle density. Willingness to pay of the respondents as well as their net income and overall wealth expressed as GDP differed greatly among our study rivers, yet pc3 (which was correlated with GDP) was not correlated with any ecosystem service. We interpret this to imply that rather more people appreciate the enhanced cultural services provided by a restored reach than that a more wealthy population is individually willing to pay more for restoration, which is in line with findings of Brander et al. (2013). The correspondence of regulating and cultural services with pc1 suggests that restoration to a 'more natural' flooding regime of the corridor has led to an increased appreciation by inhabitants and tourists of the scenic beauty of these landscapes. This translated into increased revenues in the recreation sector, notably in the Narew, Regge, Vääräjoki, Skjernå and Morrumsån (Supplementary material S2).

Methodology, uncertainty and implications

Since our aggregation across habitats and potential services uses a wide range of data sources and local as well as literature-based estimates, an estimate of potential systematic and random error is difficult to give. Instead, we will briefly discuss several limitations and aspects of uncertainty related to our estimates. First, we have willingly restrained ourselves and used a single, convergent economic dimension of value for the reasons outline in the introduction. Second, some components of total ecosystem service delivery were not quantified (reduced downstream sedimentation, effects on hydropower delivery, pollination) or may have been overlooked. Others have been estimated conservatively in a systematic way, so we probably have underestimated total ecosystem service delivery, but we see no reason that this may have been biassed towards favouring restoration. Third, our selection of restored cases may have been subject to selection bias. Although this is hard to verify in a formal way (see Bernhardt et al., 2005), we may have unknowingly taken early 'easy success' cases. This calls for a cautious extrapolation of our findings, with due attention to the specific services involved. Fourth, the net benefit accrues to different businesses or individuals in some cases, but to the common case of a nation or global humanity in other cases. For example, regulating services of a floodplain accrue to local farmers (nutrient provision), downstream communities (less flooding), the navigation (water level) or hydropower sector (increased reservoir life span), which is either national or property of larger international consortia, or the global human population (climate mitigation). Where decision-making involves

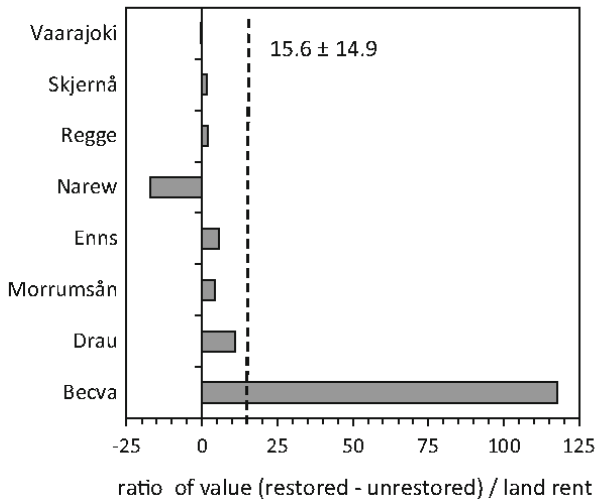

Fig. 7 Ratio of the difference in total economic value between restored and unrestored reaches and their floodplain versus local land rent (*broken line* indicates mean ± standard error, median ratio = 3, from Strelecek et al., 2011)

such different sectors and scales, the appropriate level for decision-making may well be national or supranational (Van Teeffelen et al., 2014). This does not make our conclusion less opportune: river restoration appears economically beneficial to society.

We can ask whether our estimates appear meaningful compared to the literature or local agricultural land prices. Our estimates of total ecosystem service delivery (median 1500, range 1800–5800 € ha^{-1} $year^{-1}$) are comparable to those of Murray et al. (2009, for restored Mississippi floodplain habitats (1000 € ha^{-1} $year^{-1}$), Brander et al. (2013, only regulating services of wetlands in agricultural land ~600 € ha^{-1} $year^{-1}$ compare Fig. 3) or Martin-Lopez et al. (2014, for the whole Cota Donana wetland complex, including irrigated rice production and shrimp fisheries, 9000 € ha^{-1} $year^{-1}$). Our comparison with local land rents suggests that the increase in value due to restoration, observed in six out of the eight cases, was about three times higher than land rent (Fig. 7, using the median ratio). With most provisioning and a limited part of the cultural services grasped in markets, profitability assessment of restoration should still involve a cost-benefit assessment including opportunity costs of the alternatives for the decision maker as well as a conservative rate of interest and return period (Dubgaard et al., 2005). We have not included the cost here. Taken together, this suggests that our economic value estimates of societal benefits of restoration may not be exactly accurate reflections of total economic value, but do appear meaningful and reasonably within range.

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4.4 Article #4

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Research article

Ways forward for aquatic conservation: Applications of environmental psychology to support management objectives

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ABSTRACT

The success or failure of environmental management goals can be partially attributed to the support for such goals from the public. Despite this, environmental management is still dominated by a natural science approach with little input from disciplines that are concerned with the relationship between humans and the natural environment such as environmental psychology. Within the marine and freshwater environments, this is particularly concerning given the cultural and aesthetic significance of these environments to the public, coupled with the services delivered by freshwater and marine ecosystems, and the vulnerability of aquatic ecosystems to human-driven environmental perturbations. This paper documents nine case studies which use environmental psychology methods to support a range of aquatic management goals. Examples include understanding the drivers of public attitudes towards ecologically important but uncharismatic river species, impacts of marine litter on human well-being, efficacy of small-scale governance of tropical marine fisheries and the role of media in shaping attitudes towards. These case studies illustrate how environmental psychology and natural sciences can be used together to apply an interdisciplinary approach to the management of aquatic environments. Such an approach that actively takes into account the range of issues surrounding aquatic environment management is more likely to result in successful outcomes, from both human and environmental perspectives. Furthermore, the results illustrate that better understanding the societal importance of aquatic ecosystems can reduce conflict between social needs and ecological objectives, and help improve the governance of aquatic ecosystems. Thus, this paper concludes that an effective relationship between academics and practitioners requires fully utilising the skills, knowledge and experience from both sectors.

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1. Introduction

The natural sciences record the ecological consequences of human exploitation of aquatic ecosystems both freshwater (e.g. rivers and lakes) and marine (e.g. beaches and seas) (Halpern et al., 2008; Malmqvist and Rundle, 2002). This science informs environmental managers of the effects of resource overuse, such as biodiversity loss (Strayer and Dudgeon, 2010; Worm et al., 2006), degradation of habitat (Dudgeon et al., 2006; Polidoro et al., 2010) and other anthropogenic driven changes to ecosystems (Harley et al., 2006; Ormerod et al., 2010). In parallel to these large-scale environmental impacts, humans receive many benefits from freshwater and marine ecosystems such as food, shelter, renewable energy production, cultural significance and wider well-being benefits (UNEP, 2006; White et al., 2013) illustrating the complex relationship between humans and aquatic systems, with both positive and negative components. Looking to the future, this human–environment relationship must be revised into a sustainable approach to aquatic environment management if marine and freshwater conservation management goals are to be achieved and the current overuse of aquatic ecosystems reduced.

Recognising both the scale of the management challenges in aquatic ecosystems and the considerable social component of the required response, there have been increasing calls to incorporate social science approaches into management efforts (e.g. Fletcher et al., 2012; Sandbrook et al., 2013; Schultz, 2011). To deliver sustainable use of aquatic resources and reduce the degradation of ecosystem health, environmental managers face numerous challenges to engage society and deliver their management objectives. Challenges include: engaging stakeholders in management processes (Leslie and McLeod, 2007), engaging large and public audiences (Vincent, 2011), balancing differing values of aquatic resources (Klein et al., 2008) and understanding the connections between society and aquatic environments (McKinley and Fletcher, 2012). Within the social sciences, environmental psychology investigates the interactions and connections between people and their environment, interrogating the values and motivations behind particular attitudes and behaviours (Bechtel and Churchman, 2002; Gifford, 2007; Saunders, 2003). Environmental psychology provides a rich array of methods to support environmental managers in addressing the societal challenges they face. There are, however, barriers to integrating any social science approach into natural environmental science research and practice. For example, Fox et al. (2006) describe the lack of a shared vocabulary, interdisciplinary funding and collaboration opportunities. Environmental psychology brings with it methods, theories, jargon and philosophies which are unfamiliar in many traditional conservation spheres. These can prevent the application of environmental psychology approaches despite the potential benefits of persisting against these barriers. Recent action such as the World Social Science Report on Changing Global Environments (ISSC and UNESCO, 2013) are proactively addressing these challenges and recommending advances to increase interdisciplinary working which blends natural and social sciences.

The integration of environmental psychology and natural science has already received some successes. The concept of Community Based Conservation (CBD) is based on the premise that long-term conservation success needs to include humans in the wider definition of ecosystems; explicitly including the development needs and expectations of the local community is believed to increase conservation success (Berkes, 2004). Critical analysis of CBD projects reveals that CBD approaches need to be specifically attuned to the needs of each individual community and the wider national perspective within which the conservation project exists (Brooks et al., 2013). This clearly indicates that an in-depth understanding of the attitudes and policy drivers at both the local and national scale is vital. More specific examples of work to include values and attitudes in environmental management show how management choices and ecosystem assessments can be made more effective and accurate with use of local knowledge and by adapting management choices to better fit with local values (for examples see Fischer and van der Waal (2007) in Scotland, and Moller et al. (2004) in Canada and New Zealand).

In this paper, we use case studies to illustrate the benefits that can be achieved through applying environmental psychology approaches to aquatic management. The field of environmental psychology, defined as the study of how humans affect and are affected by the environment, seeks to identify and empirically test strategies to promote a more sustainable use of the natural environment, irrespective of the founding discipline (De Young, 2013). The methods and approaches detailed within this paper may resonate with readers from other disciplines, such as human geography or landscape planning, due to the interdisciplinary backgrounds of our authors. The paper illustrates how environmental psychology approaches can play a role in aquatic management research and contribute to achieving management goals. This paper also evaluates the cases studies and provides recommendations for furthering the natural science – environmental psychology relationship.

2. Methods and results

The geographical scope and spatial scales of the case studies highlight the diverse range of interactions between humans and aquatic environments. Case studies 2.1 to 2.4 are concerned with freshwater environments whilst case studies 2.6 to 2.9 focus on the marine environment. Case study 2.5 provides the transition from freshwater to marine through a catchment-based perspective. The case studies are then ordered from large-scale approaches through to more small scale, site-specific examples. It is useful to investigate a range of spatial scales given the variety of scale relevant in aquatic management. Furthermore, researchers from a variety of disciplines have conducted the case studies; some are written from the perspective of a psychologist looking towards the ecological and natural perspectives, whilst others are written by ecologists applying psychological methods.

Each case study briefly documents the context and methods of the study before discussing the findings. These nine case studies are overviews of larger research studies and further details can be found in the cited References and Acknowledgements section.

2.1. Human–Nature relationship perspectives in river landscape management

Understanding the relationship humans have with nature plays an important role in environmental management (Bauer et al., 2009). It is particularly relevant with regard to the on-going paradigm shift in river management that follows more sustainable and participatory approaches. In this context it can help to investigate the range of different underlying relationships people have with their local river and how these relate to their visions of river use and management (de Groot and de Groot, 2009) to encourage and support mutual understanding between different user groups. In order to investigate these relationships within the context of river landscape management, a list of six typologies of human–nature relationships were developed, based on a literature review (Flint et al., 2013) and explorative interviews. For each typology of human–nature relationships, narratives were written to exemplify how these types were characterized (Table 1).

These narratives were applied in quantitative questionnaire

(n = 505) and qualitative interviews (n = 25) to assess human–nature relationship perspectives and their possible applicability to support participatory management processes in two Alpine river landscapes in Austria (Fig. 2.1).

Perspectives of different stakeholders with backgrounds from the fields of water management, recreational fisheries, nature protection and politics were assessed. The participants had either a recreational or professional relationship to the case study area.

Few participants directly aligned themselves with the master typology (52.4% and 72.2% of participants disagreed with this typology at the River Drau and River Enns respectively). Instead, many interviewees perceived themselves as being users, stewards or participants of nature. This result is comparable to findings of de Groot and de Groot (2009) where river residents "fiercely rejected" the image of "mastery over nature". However, during qualitative interviews, interviewees referred to aspects of the master typology indirectly when describing their relationship to nature and realised that they often hold multiple and even conflicting human–nature relationship perspectives. For example, some interviewees perceived themselves as participant in their private life and at the same time behaving as master in their professional life (Braito *et al.*, in review).

Many participants showed a strong interest in thinking about their human–nature relationships in the context of decisions they made in their private or professional life. Applying the human–nature typology was seen as helpful with regards to the development of a common understanding between different user groups. Further research is needed to develop tools that can more fully explain the range of human nature relationships, which could be used to support participatory processes and the implementation of agreed management objectives.

2.2. What is river quality? Incorporating the perspectives of lay-people in river restoration

Braided rivers are characterised by numerous, mobile channels that split and reconnect around river bars and alluvial islands (Lane, 1957). Braided rivers create a diverse mosaic of dynamic and connected subterranean and aquatic habitats, which support high levels of biodiversity. As a result of anthropogenic activities, the Magra River in northern Italy has become less braided, and consequently less ecologically diverse (Le Lay et al., 2013). In order to counter these alterations and meet the EU Water Framework Directive objectives of good ecological river status, a restoration project for the Magra River was implemented. However, 'good' river quality is subjective; environmental perceptions are known to partly depend on people's knowledge and use of the area (House and Sangster, 1991; Mosley, 1989). Moreover, the success of river restoration projects is particularly dependent upon effectively considering the range of stakeholder and public perspectives on the project's objectives (Raymond et al., 2010).

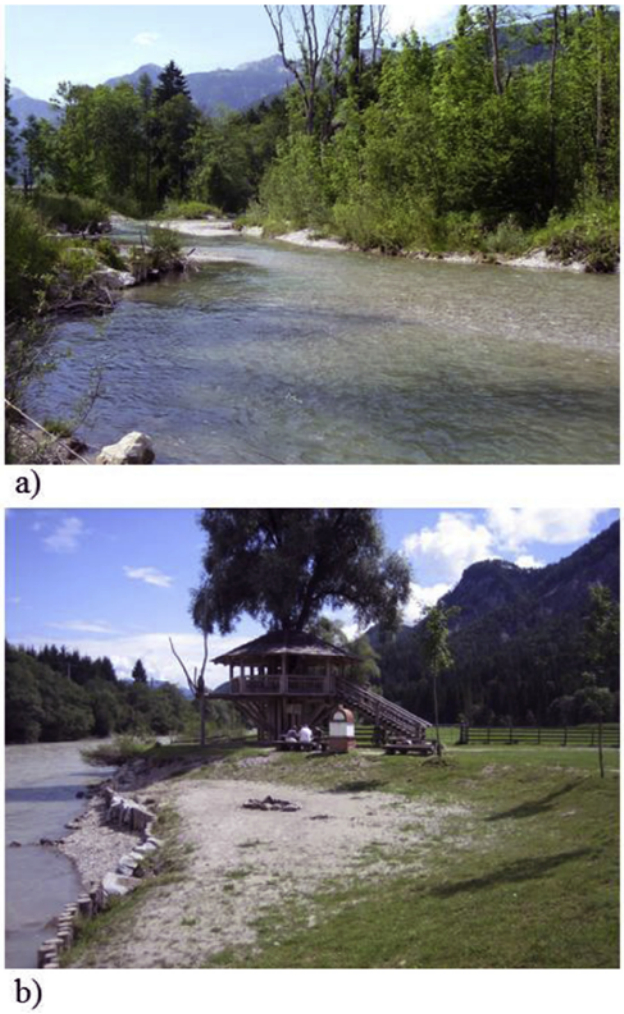

Fig. 1. Case study areas: a) River landscape Enns, Austria, b) River landscape Drau, Austria.

To assess public and stakeholder perceptions of the proposed works on the Magra River, a quantitative photo-questionnaire was developed depicting ten riverscapes with different proportions of water, vegetation and sediments (Fig. 2.2a). Participants were asked to score each photograph, from 1 (low) to 10 (high) in terms of aesthetic value, beneficial uses, and river management needs. Surveys were conducted with 127 people, belonging to five distinct groups: (1) 13–14 year old children attending school more than

Table 1
Typologies of human–nature relationships, used to explain stakeholder relationships towards river management practices. The description illustrates the underlying characteristics explained by each typology.

Typology	Description
Master	I think humans can become independent from nature, by developing technology, and should control and change nature. The production of necessary goods, for instance food, can be improved and natural hazards like floods can be averted.
Apathy	I do not think about nature much in my daily life
User	I believe humans benefit from functioning ecosystems, for instance from clean water, timber or the beauty of landscapes. Hence functioning ecosystems can also create jobs and profits.
Steward	I see a moral obligation to conserve and protect nature, because human development and technology can be a threat to nature.
Partner	I consider humans and nature as equal in value and power. Nature has a value in itself, which cannot be only be measured according to human utilisation.
Participant	I feel as part of nature. I have an emotional or spiritual bond with it. Being or living in nature is fulfilling for me. Our existence and the well-being of nature are intertwined. We cannot separate humans from nature.

10 km from the river, (2) 13–14 year old children attending school less than 1 km from the river, (3) scientists with scientific knowledge of river ecosystem function, (4) local river managers working for the government's watershed authority and (5) residents within the Magra River catchment who use the river for recreational purposes.

The results showed a difference between the responses given by expert groups (scientists and managers) and non-expert groups (children and local residents): the physical characteristics of a braided river (for example the presence of gravel bars) were valued by scientists but were perceived as less valuable by the public. The results indicate that the public had a negative perception of landscapes that included a high proportion of gravel bars (Fig. 2.2b). The survey also demonstrated that local children had a more positive attitude towards braided rivers than children living further away from the river. Consequently, projects aiming to restore braided rivers, which aim to increase to the proportion of gravel bars, may meet a lack of understanding from adult local residents, but engagement with local schools could help the positive associations with braided rivers continue into adulthood.

The results of this study highlight the importance of implementing appropriate engagement activities when planning an environmental management project. Respondent familiarity and knowledge appear to be critical factors in determining perceptions of riverscapes (Le Lay et al., 2012), and therefore must be considered when promoting ecological restoration projects (Cottet et al., 2013).

2.3. *Conserving the ugly: the drivers behind the public's perception of uncharismatic species*

Charismatic species have long been used to spearhead conservation campaigns because of the emotional response they provoke (Lorimer, 2007). However, the species of greatest ecological priority may be unappealing to a lay-audience, particularly invertebrates (Munoz, 2007). Efforts to engage the public with conservation work often focus on providing information in an attempt to promote environmentally conscious behaviour. However, this knowledge deficit approach is an oversimplification as multiple factors, including a person's values of the environment or species in question, also contribute towards environmental attitudes and behavioural intentions (Kollmuss and Agyeman, 2002). This case study examines a particularly unfamiliar invertebrate: the freshwater pearl mussel (*Margaritifera margaritifera*) (FPM), an endangered British mollusc found in upland rivers. By identifying if knowledge or values (or both) are most important in determining lay-person perceptions to this uncharismatic species, it is hoped that conservation efforts can become more targeted.

A nationally representative quantitative online survey was administered to participants in Wales and Scotland to investigate public knowledge and attitudes towards the FPM ($n = 548$). Questions were designed to reveal levels of respondent's species knowledge, perceptions of the importance of conserving specific species and how rivers are valued. Results empirically showed that both values and knowledge play a role in determining the conservation importance attributed to the FPM. Analysis using a stepwise multiple regression model found that significant knowledge variables were the familiarity of the species and whether or not the species was considered native to the UK. Only one values measure, the value associated with local rivers, increased the model's predictive capability (Walker-Springett, 2014).

That the only values measure to affect perceptions of FPM importance was the value of local rivers indicates that conservation agencies should adopt approaches that highlight the local benefits of rivers, in terms of ecology, resources (e.g. potable water) and recreational use. Such an approach is particularly important in view of the risk that negative connotations of climate change and flooding (Spence et al., 2011) might overshadow positive feelings generally associated with rivers (Kaplan, 1977). The knowledge factors showed that uncharismatic species such as the FPM may not be recognised because they are unfamiliar; their

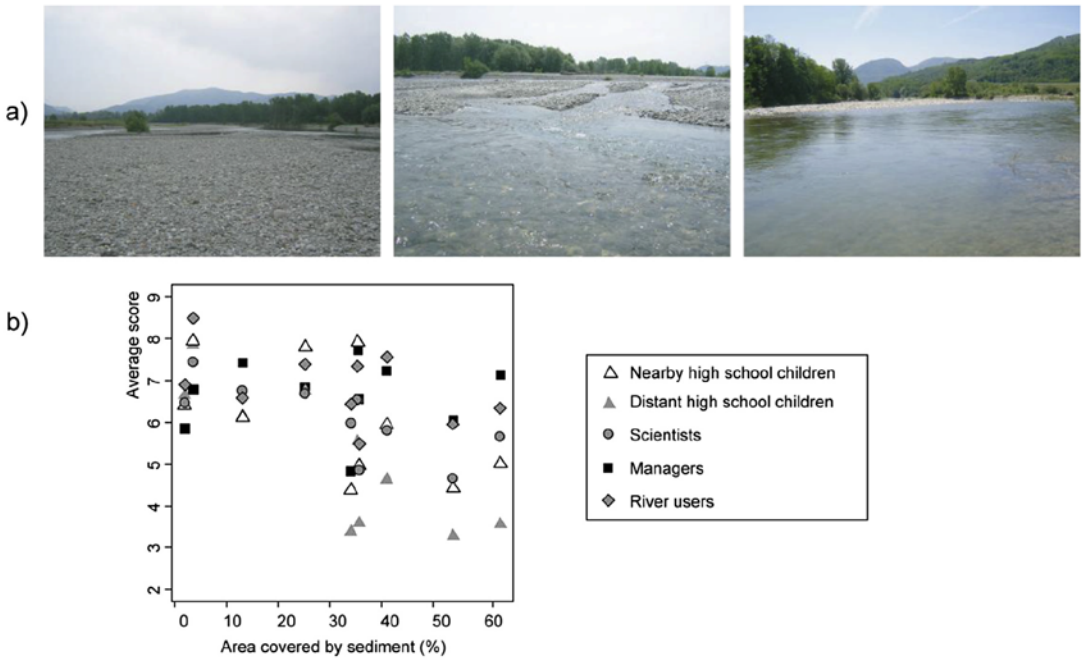

Fig. 2. Public and stakeholder perceptions of Magra River (Italy): a) three of the ten photographs included in the photo-questionnaire; b) aesthetic values given by five respondent groups to ten photographs.

contribution to healthy and productive rivers habitats is not obvious to the lay person. It is recommended that local knowledge of this species should be enhanced, both through information and hands-on experience. Such an approach has already been successful on the River Clun, Shropshire, where local farmers themselves now act as advocates for the conservation of the FPM (M. Kelly, personal communication, May 30, 2011). It is expected that similar approaches could be conducted for other uncharismatic species.

2.4. How pollution became a social problem: newspapers and public perceptions of PCB pollution in the Rhône River (France)

The long standing environmental issue of Polychlorinated Biphenyl (PCB) pollution in the Rhône River, France provides an opportunity to better understand attitudes towards riverine pollution events, and how to engage the public with such environmental issues. PCB pollution in the Rhône River was first recorded in the 1980s (Monod et al., 1988) but by the 1990s, the issue of PCB pollution had been lost from public consciousness (Comby et al., 2014). In 2005, PCB pollution re-emerged as an issue in the Rhône River, being presented in the media as a disaster caused by riverine industrialisation. Five years later, the continued pollution of the Rhône River was no longer receiving large media coverage. This study highlights the potential for newspapers to be used as data sources to analyse the evolution of public attitudes towards a somewhat invisible environmental issue.

A qualitative methodology was derived from geography, environmental sociology, and environmental psychology disciplines, and used media content analysis, ethnographic interviews and participant observation ($n = 10$). A media analysis was conducted on coverage of the PCB pollution of the Rhône River by three regional newspapers between 2005 and 2010 (Fig. 2.3) because "environmental messages delivered via print media and Internet are more likely to spur people's interest" (Jiménez-Castillo and Ortega-Egea, 2015). During this time, we compared *Le Progrès*, covering the upstream stretch of the Rhône River, *Le Dauphiné Libéré*, covering the middle valley area, and *La Provence*, covering the downstream stretch. The timeline of articles related to the PCB pollution shows that the first article was published on the 15th September 2005 in *Le Progrès*; no other newspapers covered this story between 2005 and 2007. *Le Dauphiné Libéré* published their first story regarding the pollution on the 4th March 2007, and *La Provence* on the 21st April 2007. Levels of public awareness of this environmental problem were seen to increase until 2008, which corresponds with the subsequent decrease in media coverage after 2008. Elevated levels of public awareness were also linked to actions by individuals and organisations promoted through the media. The changing patterns of media coverage of PCB pollution also appears to influence the waning and waxing of attention given to this issue by policy makers, seen in the frequency and promotion of legal acts created to address the issue (Comby et al., 2014).

This research illustrates the value of newspapers as a tool to retrospectively evaluate the emergence of public attitudes about environmental issues, and also raises important questions regarding the consequences of delays in media coverage about environmental issues on policy makers and public attitudes, which are both reflected and shaped by newspapers. Furthermore, the study indicates that river managers could use the media as a tool to encourage concern about pollution events, but further work would be needed to assess the duration of public concern, after the media coverage has ended.

2.5. People's values of waterways, from catchment to coast in South East Queensland, Australia

South East Queensland, Australia, has a rapidly growing population and spreading residential and industrial development. Urbanisation around the state capital of Brisbane has changed land use and increased ecological pressures on local waterways. Consequently, reduced biodiversity, and a detrimental impact on water quality has been observed, particularly downstream in the ecologically sensitive Moreton Bay, its marine park and islands. Often, research and management of landscapes that include terrestrial and marine components are treated independently, with an ecological bias. Studies that link human dimensions and values across places, particularly those that focus on the effects of upstream human activities on downstream environments, are rare (Alvarez-Romero et al., 2011; Halpern et al., 2009). Our qualitative research focuses on the values people hold about local waterways, comparing the values held at different spatial locations from the upper catchment to the sea.

Using semi-structured interviews, we examined the perceptions and experiences of key stakeholders using a typology of nature-related values devised by Kellert (1996, 2012, 2003) posits ten value types that describe people's relationship with the natural world and proposes that values held about local places and ecologies can inform evaluation and management outcomes. Across the catchments, waterways were valued as places that bring people together where people derive pleasure, meaning and identity from their aquatic connections. In the upper and mid-catchments, waterways had strong heritage and place-related values arising from the longevity of farming traditions, intimating humanistic values. Aesthetic values were also important in the upper and mid-catchment, as beautiful places to live, farm and explore, while naturalistic values were dominant in the mid and lower catchments and in Moreton Bay, with waterways regarded as significant places to interact with nature whether fishing, diving, sailing or surfing. In the upper, rural catchment, waterways had a greater utilitarian value, signifying their use for water supply and irrigation for farming, while in the more urbanised lower catchment, people express moralistic and ecological values through experiential contact with nature and a desire to care for the waterways.

Implications for conservation relate to recognising that people hold diverse, and often combined, values towards these connected terrestrial, freshwater and marine areas. The strong sense of connection with nature offers new prospects for conservation management, indicating a constituency offering political support, or possible complaint processes may need to be established if specific values are infringed. Where current management is biophysically informed and concentrates on reducing certain forms of environmental damage from human actions, a values-based appreciation focused on people's positive relationships with their waterways offers a way of building public support.

2.6. Connecting values of the marine environment

As described in case study 2.5, engaging society with the sea is essential to achieve marine conservation objectives (Fletcher et al., 2012; Parsons et al., 2014). Efforts to engage society with conservation are often dominated by charismatic species (Simberloff, 1998) rather than more ecologically valuable species such as habitat forming species (Jefferson, 2010). Ecological values reflect those components of an ecosystem that ensure the functions and processes essential for ecological health can continue (Rapport et al., 1998). Knowledge of societal values of the marine environment is limited; however, the prevalence of charismatic species in conservation engagement indicates that these may be the most

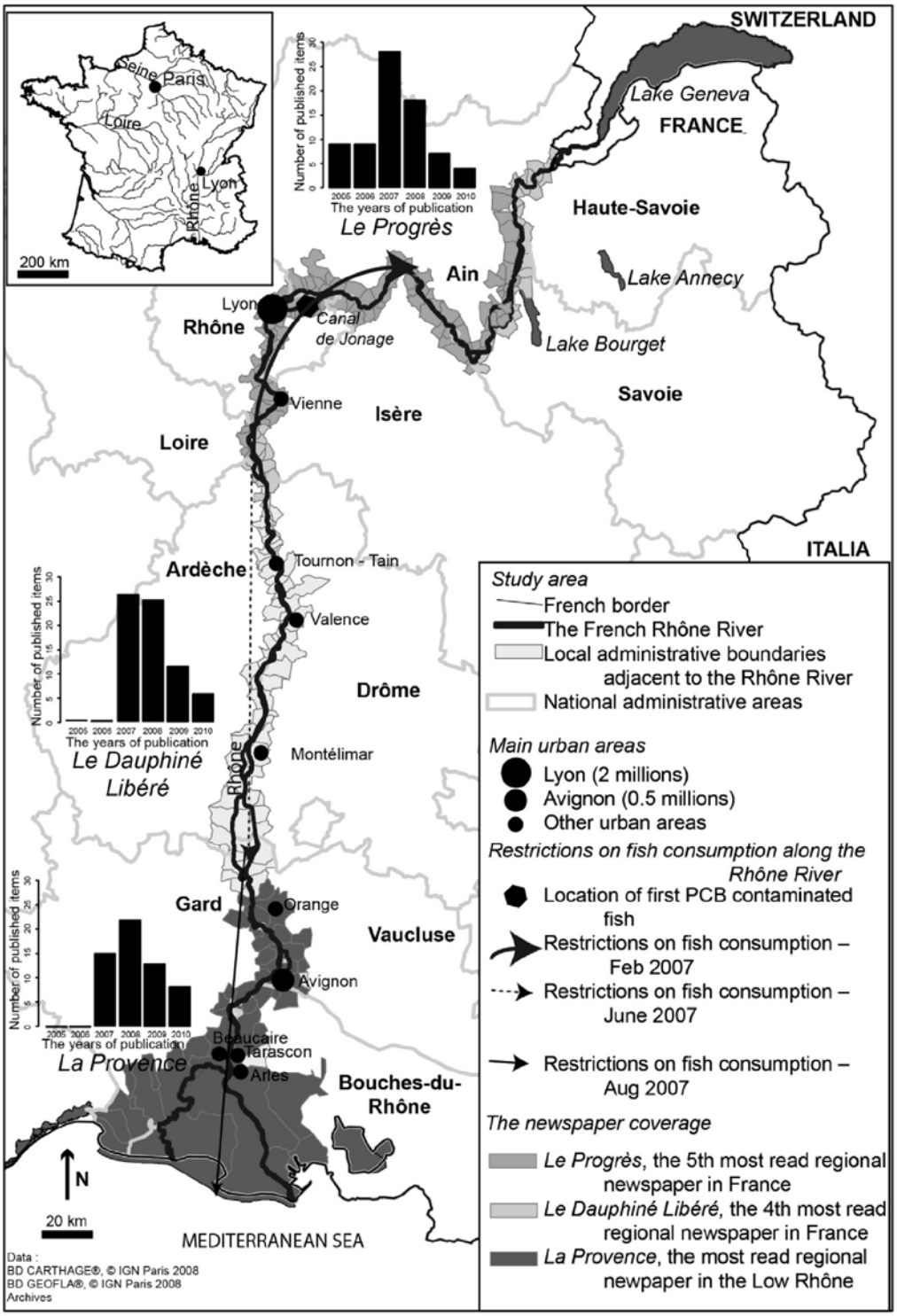

Fig. 3. Development of chemical pollution when seen as a social problem: regional restrictions on fish consumption and marketing compared to the temporal patterns of media coverage about the PCB pollution in the Rhône River (2005–2010).

socially valued ecosystem component. Focussing societal engagement efforts around charismatic species can lead to an oversimplification of conservation issues, a lack of connection between conservation issues and drivers, and policy spending being more strongly influenced by charisma than conservation need (Getzner, 2002). Environmental psychology approaches were applied to investigate the compatibility of social and ecological values of marine environments, and identify opportunities for engaging the

public with less traditionally charismatic species and habitats.

A quantitative study of UK public perceptions of the marine environment (n = 1047) provided a greater understanding of society's interpretations of marine health (Jefferson et al., 2014). This revealed that gender influenced interest in marine species with males expressing stronger utilitarian values, illustrated by their greater interest in edible species and females stronger intrinsic values, with greater interest in colourful species. Additionally, social values, measured using a model based on Maslow's Hierarchy of Needs, influenced perceptions of marine health with some audiences connecting more strongly with ecological components of marine health such as biodiversity, whilst others connected with visual indications such as water clarity (for further details, see Jefferson et al., 2014). The survey results suggest that marine conservation messages based on ecological values can be shaped to resonate with social values. For example, seagrass is an ecologically important species which is of low public interest (7% of respondents interested; Jefferson et al., 2014; Duffy, 2006). However, future engagement which incudes messages relating to the functions of seagrass (e.g., habitat provision, biodiversity support and improvement of water clarity) will enable the construction of stories which can resonate with multiple audiences. Additionally, messages which explain the essential role of seagrass in the life cycle of commercially important species (Heck et al., 2003) would connect with the stronger utilitarian values expressed by males in the survey, whilst stories relating to the intrinsic values of seagrass will connect particularly with female audiences.

The environmental psychology approach of investigating public perceptions and interrogating socio-demographics, such as gender and social values variables, provided a detailed insight into public values of the sea, and into the heterogeneity of public audiences. This can enable efforts to establish stronger connections between society and the sea to have the greatest impact by shaping engagement approaches to specific audiences, and through a broader range of species than more traditional approaches may suggest. The best practice illustrated by this case study is the importance of understanding audience perceptions in order to deliver marine conservation engagement that both resonates with the audience and is underpinned by natural science principles.

2.7. Marine litter: the well-being costs of experiencing a littered shoreline

Marine litter is a universal issue. Defined as any persistent, manufactured or processed solid material that enters the marine environment (Galgani et al., 2010), marine litter contaminates environments from the poles to the equator and from the deep sea to the shoreline (Thompson et al., 2009). Research has shown that litter can have harmful impacts on the environment and wildlife, such as through ingestion, entanglement, and changing entire ecosystems by transporting species to non-native environments (Hall, 2000; Kershaw et al., 2011). However, we know less about the impact of litter on people.

Environmental psychology studies have shown that people dislike litter; whether a beach is clean or littered plays an important role in deciding which beach to visit (Ballance et al., 2000; Tudor and Williams, 2006). Previous research that explores the nature–human relationship has shown that clean coastlines can provide a range of benefits to people; such as people reporting feeling happier, healthier, and mentally restored (Ashbullby et al., 2013; Hipp and Ogunseitan, 2011). A related psychological theory is the Attention Restoration Theory (Kaplan and Kaplan, 1989), which states that mental fatigue and concentration can be enhanced by natural scenes, and facilitate positive experiences with nature. One study, however, has found that these properties, thus benefits, are not as pronounced when the environment is less pristine (Pretty et al., 2005). However, no research had explicitly examined the impact of litter specifically on people's well-being, that is, how individuals think and feel about their lives (Dolan and White, 2008).

Using two quantitative studies, participants in southwest England (n = 79 and 19 respectively) viewed carefully manipulated coastal pictures that were either clean or had marine litter present. Using both quantitative and qualitative approaches, participants' perceived restorativeness and affective responses to the images were examined (as reported in Wyles et al., 2015). Coastal scenes with rubbish were found to have harmful impacts on individuals' well-being; eliciting negative emotional reactions (e.g., reported feeling sad) and, rather than having restorative qualities, respondents felt these littered images were detrimental to their overall well-being (Wyles et al., 2015). By demonstrating the well-being risk associated with marine litter, this case study further stresses the importance of conserving the aquatic environment by addressing the global issue of marine litter, which is harmful to not only the environment, but also to people who visit the coast. Environmental psychological solutions are especially encouraged, focussing on interventions that address the initial act of littering (understanding how and why the rubbish enters the environment in the first place) in addition to retrospective solutions (picking up the rubbish).

2.8. Local perceptions of environmental change in a community-based marine resource management setting

Fiji has a coastline of 1129 km comprising over 330 islands, which represents a huge challenge for the collection of and access to fisheries information (Bell et al., 2011). Overfishing of coral reef areas is ubiquitous across this region, even in some remote traditional fishing areas used mainly for subsistence (Chin et al., 2011; King, 2005). The Government provides limited resources for quantifying impacts on fishing activities (Fiji Islands Government, 2010) and relies on the coastal communities for local governance (Chin et al., 2011; Mühlig-Hofmann et al., 2004). However, the customary community structures needed for successful governance are eroding (e.g. chiefly presence on-site) with consequences for village leadership, clan-based resource ownership, decision-making structures and thus community-based fisheries management (Muehlig-Hofmann, 2007). For such data-scarce management to work (i.e. where little catch data is recorded), understanding resource users' perceptions and behaviour is especially important (Breckwoldt and Seidel, 2012; Novaczek et al., 2005). This study investigated the perceptions and expectations of four communities on Gau, an offshore island which is directly dependent on its fisheries resources. A mixed-method approach using both quantitative and qualitative methods derived from ethnography, human geography and environmental psychology (including questionnaire surveys, life history interviews and participant observation), revealed perceptions on fishing activities, resource status, management and conservation efforts.

A perceived change in resource status and reduced abundance had led to an initial management plan on the island (Muehlig-Hofmann, 2007; Veitayaki, 2002). The management process was initiated by the local fishers and further developed by a team from the University of the South Pacific, in collaboration with Non-Governmental-Organisations. Introduced measures included the establishment of closed areas, and restrictions on fishing licences, species size, gear and destructive fishing methods (e.g. use of plant poison). Most interviewees were satisfied with the present management level and there was a general confidence that the resource status would improve again with the introduction of closed areas.

However, increasing numbers of fishers using modern spearguns and boats with longnets were expected in the future. The interdisciplinary approach of this study has helped to reveal the local perceptions of and expectations towards the introduced management measures, and has provided the local resource users with the opportunity to identify management challenges (for example, the high expectations of the effectiveness of closed areas).

With awareness of these expectations, possible scenarios can be drawn by the resource users for adapting their management and conservation efforts, for example turning a temporary closure area into a permanent one, or planning for the expected rise in spearfishing. This approach has been successfully used by the Fijian Locally Managed Marine Area Programme, to manage marine resources issues at a national scale (Govan et al., 2011). Improved understanding of the links between perceptions, expectations and action, coupled with local ecological knowledge and resource monitoring, can improve the local ownership of the management process, including its assessment, adaptation and implementation.

2.9. Local acceptance of the offshore wind power – does design matter?

Switching our reliance from fossil to renewable energy sources such as offshore wind energy can help to limit further anthropogenic climate change. However, the impact of wind turbines on the landscape is often cited as reason for public unacceptability. To overcome resistance, participatory planning processes are recommended (Devine-Wright and Howes, 2010) in conjunction with landscape planning approaches that aim to create a regional meaning for projects, for example by placing the wind turbines parallel to the coastline to highlight its geographical shape (Arakawa et al., 2002; Schöbel, 2012).

This study attempted to empirically answer the question as to whether offshore wind farms that highlighted unique character of the landscape would be more acceptable by coastal residents than wind farms designed to maximise energy production only. An interdisciplinary, quantitative questionnaire survey was undertaken in four German coastal regions adjacent to the North Sea and Baltic Sea. Interviews were conducted in two regions, each with and without near shore wind farms, with approximately 100 residents per region. The participants answered questions on their attitudes towards offshore wind farms in general and towards six specific designs (Fig. 2.4). Five of the designs were fictitious, based on distinct landscape features of the regions, and the sixth showed the actual technical design of a local offshore wind farm. Images used in the interviews showed each design as a bird's-eye view and as seen from the coast in daylight and at night (see Schöbel, 2011).

Participants rated the region-specific wind farm designs as positive. However, when offered the choice between images of the actual technical and fictitious regional specific designs, on average participants rated their most preferred fictitious image only slightly more positively than the technical image. Differences existed between the regions; over half of Baltic Sea participants (62.4%) rated the technical design as their most preferred option. Although less distinct, the North Sea participants showed two most preferred choices; about one quarter preferred either the actual technical or the "Island" design (Fig. 2.4).

Clear opinions seemed to exist as regards the least preferred designs: of the North Sea participants, 61.7% rejected the design simulating the international shipping route and for 70% of the Baltic Sea participants, the design mirroring the area of the local national park was their least preferred option. The most frequently (23.2%) cited reason against the "shipping route" design was connected to the fear of navigation dangers and not aesthetics. Further work should attempt to expand on the reasons that underpin preference for certain wind farm designs.

These results provide evidence that design does seem to matter in generating public acceptability of offshore wind farms, however concerns about maritime safety appear to override design preferences and need to be addressed in order to foster acceptability. Further work to better understand the factors that underpin preference of wind farm designs could encourage levels of acceptability of offshore wind farms necessary to meet emissions targets.

3. Discussion

The nine case studies illustrate the application of environmental psychology approaches to a diverse range of aquatic management issues and scales. In each case, environmental psychology has provided greater insight into the societal connections with and perceptions of the ecosystem, species or environmental issues in question. In turn, this insight facilitates managers to act with greater agency when engaging multiple stakeholders and perspectives which must be balanced in order to identify and implement effective management options. In this section, emergent themes on audience perception of aquatics environments at various scales are discussed, and an overview of the applications of environmental psychology studies in aquatic management are given. This is followed by a discussion of the contribution of the case studies to the key societal management challenges for aquatic environments raised at the beginning of the paper. Finally, a future perspective is given of how environmental psychology studies can be encouraged and have maximum benefit for aquatic management.

The case studies examined national, regional and local scales in order to identify factors that drive perceptions and attitudes to specific aquatic environments. At the local scale, factors such as place attachment (i.e. how people form bonds with places, see Altman and Low, 1992) were also investigated to decipher the impact of emotional bonds with the environment. The benefits of understanding the societal implications of governance decisions were highlighted, with reference to remote communities that directly depend on natural resources. Moreover, the impact of the environment on human well-being is examined with reference to the UK's coastline. The value of the media in the dissemination of ecological messages is discussed alongside the relative importance of knowledge and values in determining the public assessment of conservation importance.

The human element of the natural environment is increasingly recognised as the least well understood component of any ecosystem, whilst simultaneously, human actions can have the greatest impact on whether sustainable management of the natural environment is realised (Mascia et al., 2003). Many of the case studies illustrate how environmental psychology can be integrated into management plans, alongside a natural science understanding of the issues. It is important to clarify that the authors do not extol the use of environmental psychology methods in isolation, but call for greater connectivity and the adoption of a joined up approach to combine the strengths of both natural and social sciences to inform better management of natural resources. The case studies within this paper give examples of how integrating environmental psychology approaches with natural science principles can help to overcome the key societal management challenges mentioned in the beginning of this paper (Klein et al., 2008; Leslie and McLeod, 2007; McKinley and Fletcher, 2012; Vincent, 2011) and aid in achieving sustainable management outcomes (Table 2). The contributions of the case studies to each challenge are then discussed in the following text.

Fig. 4. An example for the North Sea wind farm designs was the "Island" solution. This design placed the wind turbines in such a way that they represented the old coastal line destroyed by a flood in early medieval times (Schöbel, 2011).

3.1. Engaging stakeholders in management

The application of environmental psychology approaches to support efforts to engage stakeholders in management is shown by four of the case studies. Case studies 2.1 and 2.2 illustrate how an understanding of stakeholder attitudes enables environmental managers to connect with different stakeholders in ways that resonate with the target audience. Case study 2.5 and 2.8 further exemplify this approach buy giving additional examples in Fiji and Australia of the how more effective and sustainable aquatic management can be implemented when stakeholder attitudes are better understood and integrated into management decisions.

3.2. Engaging large and public audiences

Many of the conservation challenges in aquatic environments require the engagement of large audiences to respond to the scale of problems faced in this arena, and five of the case studies in this paper document how this could be achieved. Our case studies show that environmental psychology method can be applied on a large scale to inform the wider public debate about the management of aquatic resources. For example, case study 2.4 documents how conservation issues can be transformed through a media lens and disseminated to the wider audience, allowing environmental managers to engage with the media and communicate widely. Case study 2.5 shows how environmental psychology can engage the public at the scale of the catchment, combining the challenges associated with freshwater and marine environments. Case studies 2.6, 2.7 and 2.9 all give further examples of the use of environmental psychology in engaging large and disparate audiences, in the marine environment. These case studies exemplify the benefits of environmental psychology methods in engaging with large audience who express a range of attitudes and environmental values based on a variety of use of the marine environment, to give insights on the drivers influencing the perspectives held by these public audiences.

3.3. Balancing differing values of aquatic resources

Resource management in the aquatic environment is challenging given the variety of resources and the numbers of stakeholders and publics involved. The environmental psychology approaches used in the five of the case studies show how valuable such approaches can be. Case study 2.8 identifies the issues surrounding local governance of marine resources in order to identify barriers to sustainable resource management. In doing so,

Table 2
The contribution of each case study of this paper to the four key societal management challenges in the aquatic environment.

Case study	Societal management challenges in aquatic environments			
	Engaging stakeholders in management	Engaging large and public audiences	Balancing differing values of aquatic resources	Understanding connections between society and aquatic systems
2.1	x		x	x
2.2	x		x	x
2.3			x	x
2.4		x		x
2.5	x	x	x	x
2.6		x	x	x
2.7		x		x
2.8	x		x	x
2.9		x	x	x

management strategies were then implemented that took account of the community's needs and expectations in addition to ecological pressures. In case study 2.9, public perceptions of wind farm design identified positive features in addition to barriers to acceptability; used in the early stages of wind farm development, this could be a key method to minimise opposition to such development. Finally, case study 2.5 indicates that the value of aquatic resources within the same unit of geographical measurement (i.e. the catchment) can be highly variable, creating new challenges for managing aquatic environments at this spatial scale.

3.4. Understanding connections between society and aquatic systems

A key strength of environmental psychology is to provide a deeper understanding of the human–environment relationship and the drivers behind the interactions and attitudes that affect this relationship (Table 2). All nine case studies contribute to a better understanding of the societal connections with aquatic ecosystems by interrogating and unpacking the values attributed to the aquatic environment. In case studies 2.3 and 2.6, identifying the values attributed to key aquatic species allow environmental managers and experts to see conservation goals from new perspectives and create more robust management decisions. Case study 2.7 identifies barriers to the use of the marine seascape, highlighting how an individual's experiences of and well-being benefit associated with aquatic environments can be influenced by external factors.

Looking towards the future, the authors believe it is vital that the benefits of environmental psychology approaches are broadly distributed, both within academia and to wider audiences including environmental managers. This will necessitate more effective relationships between academics and practitioners in conjunction with increased efforts by academics to disseminate findings more widely than peer-reviewed journals that remain relatively inaccessible to those outside academia. Many of the issues surrounding interdisciplinary research between social scientists and natural scientists documented by Fox et al. (2006) continue to exist between academics and practitioners. However, certain barriers, such as limited opportunities for interdisciplinary collaboration, are beginning to be resolved through funding opportunities such as the Natural Environment Research Council's (NERC) Valuing Nature fellowship, which aims to encourage 'discipline hopping' between social and natural sciences and the wider Valuing Nature programme which draws together natural sciences, social sciences, arts and humanities research and practice. Such opportunities should be widened to encourage academics and practitioners to foster relationships that would speed the process of information sharing and dissemination.

The key message that flows throughout all of the case studies presented here is that environmental psychology is an effective and appropriate discipline to be used in environmental management research and is able to inform environmental management practices across a range of aquatic environments and scenarios. It can provide insight into how people connect with nature and wider management issues, and this insight provides considerable benefit in helping to overcome barriers that are currently faced by environmental managers.

4. Conclusions

Environmental psychology approaches provide tools to facilitate better management and governance of aquatic environments which goes beyond the protection of aquatic species and ecosystems by engaging stakeholder and public audiences. In this sense environmental psychology, as demonstrated by the case studies, support the delivery of management objectives that meet both societal needs and ecological goals. Moreover, environmental psychology enables the provision of science that meets public expectations, that furthers knowledge about topics with societal importance, providing a bridge between science and policy (Lubchenco, 1998).

A continuing challenge is to increase engagement between policy makers and environmental psychologists, which has begun to occur, for example through reports such as NERC's Living With Environmental Change report or the UKERC Energy Transformation project (Parkhill et al., 2013; Upham et al., 2009). Building up relationships between these traditionally distinct disciplines enables the cross-fertilisation of ideas and allows novel methodologies to be trialled and adopted by the wider academic community. In this way, environmental psychology can develop in order to actively contribute to the environmental management challenges that will be faced in the future. The authors hope that the current enthusiasm for integrating social sciences into environmental management will continue.

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4.5 Article #5

Originalarbeit

Österr Wasser- und Abfallw
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Was? Wie? Warum? Jugendliche erforschen Flusslandschaften – Förderung des Systemverständnisses als Basis für gelebte Partizipation im Flussgebietsmanagement

Michaela Poppe · Kerstin Böck · Andreas Zitek · Sigrid Scheikl · Andreas Loach · Susanne Muhar

Zusammenfassung Flusslandschaftsplanung und -management im Sinne einer zukunftsverträglichen Entwicklung einer Flusslandschaft sind dem Prinzip der Nachhaltigkeit verpflichtet. Ziel ist es dabei, eine Entwicklung von Flusslandschaften zu initiieren, die die Anforderungen des Natur- und Gewässerschutzes mit den sozialen und wirtschaftlichen Ansprüchen in Einklang bringt und die betroffenen BürgerInnen in den Entscheidungsprozess einbezieht. Systemverständnis und ökologische Handlungskompetenz sind für Beteiligungsprozesse wesentliche Voraussetzungen.

Im Oktober 2014 startete im Rahmen des Forschungsprogrammes „Sparkling Science" des Bundesministeriums für Wissenschaft, Forschung und Wirtschaft das Projekt „Traisen.w³ – Traisen. Was? Wie? Warum? – Identifizierung und Wahrnehmung von Funktionen in Flusslandschaften und Verstehen einzugsgebietsbezogener Prozesse am Beispiel der Traisen". In diesem Projekt arbeitet ein WissenschaftlerInnen-Team gemeinsam mit SchülerInnen und PädagogInnen zweier Oberstufenklassen des BG/BRG St. Pölten über einen Zeitraum von zwei Jahren zu Forschungsfragen des Flusslandschaftsmanagements am Beispiel der Traisen. Neben der Integration der SchülerInnen in den Forschungsprozess, in Freilandarbeiten und Datenauswertungen und -interpretationen ist vor allem die Entwicklung von Systemverständnis in Bezug auf Prozesse in Flusslandschaften Ziel des Projektes.

Die SchülerInnen wurden mithilfe der Lern-Software „DynaLearn" angeregt, sich konzeptuelles und kausales Wissen anzueignen und damit systemische Prozesse in der Umwelt zu verstehen und in qualitative Modelle umzusetzen. Als weiteres Instrument, die Komplexität von Flusslandschaften anzusprechen, wurde das Konzept der Ökosystemleistungen verwendet. In Wissenstests sowie durch die Auswertung der qualitativen SchülerInnen-Modelle wurden das Wissen und das Systemverständnis der Schülerinnen vor und nach den gemeinsamen Aktivitäten evaluiert.

Die Auswertungen zeigten, dass regionales Wissen über den Heimatfluss und Vorgänge im Einzugsgebiet nicht im Bewusstsein der Jugendlichen verankert sind. Aufgrund der durchgeführten Schul-Workshops konnte ein signifikanter Zuwachs des Wissens und Verständnisses der SchülerInnen festgestellt werden. Die Modelle der SchülerInnen zeigten die komplexen Fragestellungen im Flussgebietsmanagement auf. Alle Modell-Szenarien der Jugendlichen spiegelten nachhaltige Entwicklungen der Flusslandschaft wider und belegten ein maßgeblich gesteigertes Verständnis der SchülerInnen für wichtige kausale Zusammenhänge an der Traisen.

Die Ergebnisse dokumentieren weiters, dass das Konzept der Ökosystemleistungen eine geeignete Methode zur Wissensvermittlung von komplexen Zusammenhängen in Flusslandschaften darstellt. Die Erhebung der Wahrnehmung von Ökosystemleistungen durch BürgerInnen, insbesondere Jugendliche, kann zu einer umfassenden Betrachtung der Flusslandschaft in zukünftigen Planungen im Flusslandschaftsmanagement beitragen. Mittels der in diesem Rahmen identifizierten Wissenslücken und des fehlenden Umweltverständnisses kann der zukünftige Bildungsbedarf hinsichtlich Funktionsfähigkeit und Leistungen von Flusslandschaften abgeschätzt werden. Gerade bei jungen Menschen ist es wichtig, das Interesse für Umweltthemen zu fördern und eine mögliche Beteiligung an Entscheidungen zu forcieren. Gezielte Initiativen sind notwendig, damit junge Menschen zukünftig als BewohnerInnen und NutzerInnen der Flusslandschaften nachhaltige Planungen und Maßnahmen unterstützen, sich aktiv an der Entscheidungsfindung beteiligen und damit Verantwortung für die Gestaltung ihrer Umwelt übernehmen.

Schlüsselwörter Systemverständnis · Flusslandschaft · Einzugsgebietsmanagement · Ökosystemleistungen · Wissensvermittlung · Partizipation

What? How? Why? Students explore river landscapes – promoting a systems-based understanding as the cornerstone of "lived" participation in river management

Abstract River landscape planning and management to promote the positive long-term development of river landscapes must adhere to the principle of sustainability. In this context, the goal is to initiate a development process for river landscapes that successfully reconciles the requirements of nature and water conservation with social and economic aspects, and which actively involves affected citizens in the decision-making process. A systems-based understanding and the opportunity to make ecologically relevant decisions are

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essential prerequisites for participative processes.

In the context of the Austrian Federal Ministry of Science, Research and Economy research program "Sparkling Science," the project "Traisen.w^3 – Traisen. What?How?Why? – Identification and Perception of Functions in River Landscapes and Understanding Catchment-related Processes on the Example of the Traisen River" was launched in October 2014. The project involves a team of scientists working together with teachers and students from two high-school classes from the BG/BRG St. Pölten schools over a two-year period to investigate central research questions on river landscape management using the example of the Traisen River. Beyond integrating the students in the research process, in field work, and in assessing and interpreting results, one of the project's central goals is to promote a systems-based understanding of the processes at work in river landscapes.

With the help of the learning software program "DynaLearn," students were encouraged to acquire both conceptual and problem-solving skills, which in turn allowed them to better understand systematic processes in the environment and implement those processes in qualitative models. The concept of ecosystem services was employed as a further means of approaching the complexity of river landscapes. Using knowledge-based tests and by assessing their qualitative models, the students' systems-based understanding before and after their shared activities was evaluated.

The results show that regional knowledge of their home river and key processes in its catchment area is not anchored in the students' minds. The school workshops confirmed a significant increase in the students' knowledge and grasp of the subject matter, while the models they produced illustrate the complex questions involved in river landscape management. All of the model scenarios the students depicted reflect sustainable developments in the river landscape and evince their considerably improved grasp of important causal relationships on the Traisen.

The results also confirm that the concept of ecosystem services offers a suitable method for conveying complex interrelationships in river landscapes. Raising awareness of ecosystem services among citizens, and especially among young people, can help to ensure that more comprehensive approaches are utilized in future river landscape planning and management efforts. Further, the gaps in knowledge and lack of environmental awareness identified in the course of the project can be used to determine the future need for education on the functions of and ecosystem services provided by river landscapes. When it comes to young people, it is essential that we promote their interest in environmental issues and offer them opportunities to join in decision-making processes. Focused initiatives are called for to ensure that these future inhabitants and users of river landscapes support sustainable planning and measures, actively participate in decision-making, and in so doing take on responsibility for shaping their own environment.

Keywords Systems-based understanding · River landscape · Catchment management · Ecosystem services · Knowledge acquisition · Participation

1 Einleitung

Systemverständnis und Handlungskompetenz in komplexen Systemzusammenhängen sind wesentliche Voraussetzungen für das Treffen von nachhaltigen Entscheidungen in unserer vernetzten Welt (Frischknecht-Tobler et al. 2008). Die 2030-Agenda für eine nachhaltige Entwicklung (UN 2015) beschreibt klare Zusammenhänge zwischen einer nachhaltigen Entwicklung, der Notwendigkeit eines umfassenden Systemverständnisses und neuen gesellschaftlichen Lösungsansätzen (Bückmann 2015).

Demgegenüber stehen die Ergebnisse der PISA-Studie aus 2006 (OECD 2009), die bei 15-jährigen Jugendlichen ein Basiswissen zu Umweltthemen dokumentierten, allerdings klar ein fehlendes Verständnis und geringes Wissen bei den jungen Menschen aufzeigten, wie Umweltprobleme zukünftig gelöst werden könnten. Auch Evaluierungsergebnisse von Wissenstests bei 15- bis 17-jährigen SchülerInnen belegten, dass das Verständnis für komplexe Zusammenhänge gewässerökologischer Themen wenig ausgeprägt ist (Poppe et al. 2013).

Im Oktober 2014 startete im Rahmen des Forschungsprogrammes „Sparkling Science" des Bundesministeriums für Wissenschaft und Forschung das Projekt „Traisen.w^3 – Traisen. Was? Wie? Warum? – Identifizierung und Wahrnehmung von Funktionen in Flusslandschaften und Verstehen einzugsgebietsbezogener Prozesse am Beispiel der Traisen"[1]. In diesem Projekt arbeitet ein WissenschaftlerInnen-Team gemeinsam mit SchülerInnen und PädagogInnen zweier Oberstufenklassen des BG/BRG St. Pölten über einen Zeitraum von zwei Jahren zu Forschungsfragen des Flusslandschaftsmanagements. Inhaltlich baut das Projekt auf Erkenntnissen des Vorgängerprojektes „FlussAu:WOW!" auf (Poppe et al. 2013). Neben der Integration der SchülerInnen in den Forschungsprozess, in Freilandarbeiten und Datenauswertungen und -interpretationen ist vor allem der Aufbau von Systemverständnis in Bezug auf Prozesse in Flusslandschaften Ziel des Projektes. Systemverständnis wird nach Frischknecht-Tobler et al. (2008) als *„Fähigkeit, komplexe Wirklichkeitsbereiche als Systeme zu beschreiben, zu rekonstruieren und zu modellieren sowie Erklärungen zu geben, Prognosen zu treffen und Handlungsmöglichkeiten zu entwerfen und zu beurteilen"* definiert.

Als Werkzeug der Wissensvermittlung und vor allem um das Systemverständnis für Prozesse in Flusslandschaften zu vertiefen, eignet sich das Konzept des qualitativen Modellierens (Bredeweg et al. 2013; Zitek et al. 2009). Im Projekt „Traisen.w^3" wurden die SchülerInnen angeregt, sich mithilfe der Lern-Software „DynaLearn"[2] selbständig konzeptuelles und kausales Wissen anzueignen und damit systemische Prozesse in der Umwelt zu verstehen und in qualitative Modelle umzusetzen. Bereits durchgeführte Evaluierungen dieses Ansatzes mit SchülerInnen einer berufsbildenden höheren Schule haben gezeigt, dass es durch die Arbeit mit der Lern-Software zu einem signifikanten Anstieg von kausal richtigen Beziehungen bei den Antworten zu fachlichen Wissensfragen kam (Zitek et al. 2013; Poppe et al. 2011). Durch diese Möglichkeit der Darstellung von Umweltphänomenen mittels Modellierungsinstrumenten können „Wissenschaftsneulinge" eine Art von Problemlösungsverhalten von ExpertInnen erleben und erlernen (Jonassen 2003).

[1] http://www.traisen.net/

[2] http://www.dynalearn.eu.

Ein weiteres Instrument, die Komplexität von Flusslandschaften anzusprechen, sie „greifbarer“ und damit operationalisierbar zu machen, stellt das Konzept der Ökosystemleistungen (ÖSL) dar. Dieses behandelt die Schnittstelle zwischen Ökosystemen und menschlichem Wohlbefinden und rückt die von Ökosystemen bereitgestellten Güter und Leistungen in den Vordergrund, die zum menschlichen Wohlbefinden beitragen können. Diese können in Versorgungsleistungen (z. B. Verfügbarkeit von Wasser und Rohstoffen), Regulierungsleistungen (z. B. Hochwasserschutz), kulturelle Leistungen (z. B. Erholungsleistung) sowie unterstützende Basisleistungen (ökologische Leistungen, z. B. Erfüllung der Habitatfunktion) eingeteilt werden (MEA 2005). Vor dem Hintergrund sich ständig wandelnder Nutzungsansprüche an unsere Landschaft sind sowohl ökologische als auch kulturelle Funktionen und Leistungen von besonderem Interesse. Gerade letztere spielen für Kinder und Jugendliche, als eine der größten NutzerInnengruppen natürlicher Freiflächen (Millward and Mostyn 1989; Tapsell et al. 2001), eine große Rolle. In der Praxis, zum Beispiel im Rahmen von Kulturlandschaftsbewertungen, finden diese jedoch meist noch wenig Berücksichtigung (Schaich et al. 2010). Um kulturelle ÖSL in Managementkonzepte einfließen zu lassen, wird von Chan et al. (2012) vorgeschlagen, soziokulturelle Methoden in ÖSL-Bewertungen einzubinden. Besonders die Sichtweisen von Kindern und Jugendlichen könnten in diesem Rahmen dazu beitragen, die Nutzbarkeit von Fließgewässern z. B. für Erholungszwecke zu verbessern (Tapsell et al. 2001). Die meisten Untersuchungen bisher beschränken sich jedoch auf Stakeholder-Gruppen mit gewissen Entscheidungskompetenzen an Fließgewässern (Böck et al. 2013) bzw. erwachsene BewohnerInnen eines betroffenen Gebiets (Plieninger et al. 2013). Bis dato gibt es nur vereinzelte am ÖSL-Konzept orientierte, wissenschaftliche Untersuchungen, die sich mit der Wahrnehmung von Jugendlichen in Flusslandschaften befassen (z. B. Chuchmáková 2009; Eder und Arnberger 2010).

Die Erhebung der Wahrnehmung von ÖSL durch BürgerInnen, insbesondere Jugendliche, kann zu einer umfassenden Betrachtung der Flusslandschaft in zukünftigen Planungen im Flusslandschaftsmanagement beitragen. Mittels der in diesem Rahmen identifizierten Wissenslücken kann der zukünftige Bildungsbedarf hinsichtlich Funktionsfähigkeit und Leistungen von Flusslandschaften abgeschätzt werden. Seit der Entstehung des ÖSL-Konzepts gibt es Bemühungen, dieses in Bildungsaktivitäten einzubauen[3]. So wird beispielsweise auf UN-Ebene das ÖSL-Konzept in bestehende Bildungsprogramme (z. B. SWEDESD[4]) eingebunden. Es soll in diesem Zusammenhang dazu beitragen, das Verständnis von Kindern und Jugendlichen für den Nutzen sichtbar zu machen, den Menschen aus intakten Ökosystemen ziehen, und damit die Bedeutung einer nachhaltigen Entwicklung zu unterstreichen. Auch im vorliegenden Projekt „Traisen.w³“ wird das Konzept der ÖSL als Kommunikations- und Bildungswerkzeug in der Zusammenarbeit mit SchülerInnen eingesetzt.

Flusslandschaftsplanung und -management im Sinne einer zukunftsverträglichen Entwicklung einer Flusslandschaft sind dem Prinzip der Nachhaltigkeit verpflichtet. Ziel ist es dabei, eine Entwicklung von Flusslandschaften zu initiieren, die Anforderungen des Natur- und Gewässerschutzes mit den sozialen und wirtschaftlichen Ansprüchen der betroffenen Menschen in Einklang bringt. Umweltwissen und Systemverständnis sind zentrale Grundlagen für eine nachhaltige Entwicklung (UNESCO 2011; Bilharz und Gräsel 2006). Auch im Flussgebietsmanagement, wo komplexe Zusammenhänge u. a. zwischen den Bereichen Wasserwirtschaft, Ökologie, Landschaftsplanung, Siedlungsentwicklung, Land- und Forstwirtschaft, Wirtschaft, Naturschutz und Tourismus bestehen, sind nachhaltige Entscheidungen und Lösungen unabdingbar. Um gemeinsame Entscheidungen zu treffen, Entscheidungsprozesse auf eine breite Basis zu stellen und die Akzeptanz der Entscheidungen zu erhöhen, ist die Information und Partizipation sowohl von EntscheidungsträgerInnen, Akteursgruppen als auch von der breiten Öffentlichkeit notwendig. Die Information und Beteiligung der Bevölkerung an Entscheidungsprozessen ist durch mehrere EU-Richtlinien (u. a. Wasserrahmenrichtlinie: Richtlinie 2000/60/EG, Hochwasserrichtlinie: Richtlinie 2007/60/EG, Richtlinie über die Beteiligung der Öffentlichkeit: Richtlinie 2003/35/EG) gefordert und festgelegt. Daher ist es wichtig, dass sich Jugendliche der Notwendigkeit einer nachhaltigen Entwicklung von Flusslandschaften bewusst sind und als zukünftige BewohnerInnen und NutzerInnen dieser Landschaften nachhaltige Planungen, Maßnahmen und Entscheidungen unterstützen. Umweltbildung und gelebte Partizipation bedingen einander und unterstützen sich gegenseitig.

Der vorliegende Beitrag befasst sich mit der Förderung von Systemverständnis und Umweltwissen zu Prozessen in Flusslandschaften im Rahmen des Projektes „Traisen.w³“. Die Ergebnisse der Wissensevaluierung von Ursache-Wirkungs-Zusammenhängen in Flusslandschaften, des Konzepts der ÖSL und zum regionalen Wissen zur Traisen liegen bereits vor und sind hier zentrales Thema. Ziel ist es, folgende Fragen zu beantworten: 1) Können SchülerInnen durch die Arbeit im Forschungsprojekt mit einer Lern-Software und Arbeiten im Feld verstärkt systemare Zusammenhänge in Umweltfragen herstellen? und 2) Inwiefern ist das ÖSL-Konzept zur Anwendung als Kommunikationsinstrument und zur Verbesserung des Systemverständnisses bei Jugendlichen geeignet?

2 Vorgangsweise und Methodik

2.1 Durchführung der Schüleraktivitäten

Mit dem Kick-off-Workshop im Oktober 2014 startete für die 5. und 7. Klasse des naturwissenschaftlichen Zweiges (5N und 7N) des Gymnasiums St. Pölten die Forschungsmitarbeit im Sparkling-Science-Projekt „Traisen.w³“. Bei der Zusammenarbeit mit den SchülerInnen wurde neben der Wissensvermittlung besonderes Augenmerk auf die Förderung des Verständnisses der SchülerInnen für komplexe Zusammenhänge in Flusslandschaften gelegt. In multimodalen Workshops wurden die SchülerInnnen in die Forschungsthemen eingeführt (Tab. 1).

2.1.1 Modellierungs-Workshops

Die SchülerInnen der 7. Klasse waren bereits im Vorgängerprojekt „FlussAu: WOW!“ (Poppe et al. 2013) tätig und arbeiteten dort mit der Lern-Software

[3] http://www.es-partnership.org/esp/82584/5/0/50.

[4] Swedish International Centre of Education for Sustainable Development.

Tab. 1 Überblick über zeitliche Abfolge und Inhalte der Schul-Aktivitäten inkl. der Wissensevaluierungen im Projekt „Traisen.w^{3}“ im ersten Schuljahr 2014/2015

Aktivitäten	Klasse	Wissensevaluierung	Datum	Thema
Kick-off-Workshop	5N/7N	Prä-Test (T1)	07.11.2014	Vorstellung, Projektvorschau
1. Workshop zu ÖSL	5N		27.01.2015	Flusslandschaften, ÖSL, Flusscharakteristik Traisen
1. Modellierungs-Workshop	7N		29.01.2015	Flusscharakteristik Traisen, „DynaLearn“-Modellieren: Ursache-Wirkungs-Zusammenhänge im Einzugsgebiet Traisen
2. Modellierungs-Workshop	7N	Mid-Test (T2)	10.02.2015	Belastungen/Renaturierungen im Traisen Einzugsgebiet, „DynaLearn“-Modellieren: Entwicklung von Szenarien im Einzugsgebiet Traisen
2. Workshop zu ÖSL	5N	Mid-Test (T2)	13.02.2015	Wissenschaftliche Methode, Google Earth-Kartierung ÖSL
Gemeinsamer Aktionstag	5N/7N	Post-Test (T3)	25.06.2015	Feldarbeiten in Kleingruppen (Bereich St. Pölten und Traisenunterlauf nahe Traismauer), Besichtigung des LIFE+ Projektes Traisen

„DynaLearn“. Darauf aufbauend wurden im ersten Modellierungs-Workshop Expertenmodelle als „Rahmenmodelle“ vorgestellt, die zur Beschreibung typischer Prozesse in Flusslandschaften entwickelt wurden. Basierend auf diesen Modellen konnten regionale Modelle, die für das Traisen-Einzugsgebiet gültig sind, entwickelt werden. Die SchülerInnen erstellten in Kleingruppen von 2 bis 3 Personen qualitative Modelle zum Zustand der Traisen. Sie setzten Ursache-Wirkungs-Zusammenhänge in Flusslandschaften am Beispiel ihres Heimatflusses in kausale Modelle um. Im zweiten Workshop verfassten die SchülerInnen eine textliche Version eines potenziellen Entwicklungsszenarios für das Einzugsgebiet der Traisen. Darauf aufbauend wurde ein entsprechendes Modell konstruiert. Das Modellieren diente vor allem der Unterstützung bei der Ausformulierung der Szenarien. Zur Orientierung wurden den SchülerInnen drei Hauptfragen zur Entwicklung der Szenarien gestellt: (1) Was ist das Hauptproblem an der Traisen, das ihr modellieren wollt? (2) Wie soll sich der Zustand verändern? Und (3) Wo müsste man vermutlich ansetzen?

2.1.2 *Workshops zu ÖSL*

Im Zuge der Workshops mit dem thematischen Schwerpunkt „Ökosystemleistungen“ sollten SchülerInnen der 5. Klasse einen Einblick in die verschiedenen Funktionen und Nutzungsformen von Fließgewässern, insbesondere der Traisen erhalten. Der Fokus wurde dabei auf „unterstützende Basisleistungen“ (z. B. Fluss-Lebensraum) und kulturelle Leistungen (u. a. Bewegung, Naturerlebnis) gelegt. In Kleingruppen erarbeiteten die SchülerInnen verschiedene Themengebiete im Kontext von ÖSL in Flusslandschaften und präsentierten diese dann ihren MitschülerInnen. Im folgenden Workshop erstellten die SchülerInnen digitale Karten in Google Earth, in denen sie ÖSL des Einzugsgebiets der Traisen identifizierten und in der Karte abbildeten.

2.1.3 *Feldarbeiten*

Beim Aktionstag im Juni 2015 kartierten die SchülerInnen beider Klassen gemeinsam an zwei Abschnitten der Traisen ausgewählte Indikatoren für ökologische (z. B. Sedimentbänke, Uferstrukturen) und kulturelle Ökosystemleistungen (u. a. Radwege, Sitzgelegenheiten am Ufer, Infotafeln). Danach konnten sie im Rahmen einer Führung das Projektgebiet des LIFE+ Projekts Traisen und die dort neu entstandene Flusslandschaft besichtigen.

2.2 Durchführung und Auswertungen der Wissensevaluierungen

Zu Beginn des Projekts erfolgte der erste Wissenstest (Prä-Test; T1) während der Kick-off-Veranstaltung in den beiden Klassen 5N und 7N. In der 5N wurde der Mid-Test (T2) nach den beiden Workshops über ÖSL durchgeführt, in der 7N nach zwei Modellierungs-Workshops (siehe Tab. 1). Insgesamt absolvierten 47 SchülerInnen alle drei Tests. Die SchülerInnen beantworteten jeweils die gleichen Fragen zu den Themenblöcken „regionales Wissen“, „Systemverständnis“ und „ÖSL“. Die Antworten folgender Fragen (Block A – regionales Wissen, Block B – Systemverständnis) wurden für diesen Beitrag mit einer Punktebewertung analysiert:

- A1) „Wodurch ist der Zustand der Traisen deiner Meinung nach beeinträchtigt?“ und
- A2) „Kennst du Renaturierungsprojekte im Traisen-Einzugsgebiet? Wenn ja, welche?“
- B1) „Warum wurden/werden Flüsse reguliert? Was verändert sich dadurch (für Menschen, Tiere und Pflanzen)?“ und
- B2) „Warum werden Flüsse renaturiert? Was verändert sich dadurch (für Menschen, Tiere und Pflanzen)?“

Bei den Fragen A1), B1) und B2) konnten maximal 4 Punkte erreicht werden, bei A2) 2 Punkte.

Zusätzlich wurden die Antworten auf die Frage A3) „In welchem ökologischen Zustand befindet sich die Traisen im Bereich St. Pölten deiner Meinung nach?“ nach den Zustandsklassen analysiert sowie die einzelnen Antworten auf die Frage A1) Beeinträchtigungstypen zugeordnet und in einem Balkendiagramm dargestellt.

Die Antworten auf die Frage C1) „Welchen Nutzen haben Flusslandschaften für den Menschen?“ wurden den vier ÖSL-Hauptklassen (unterstützende-ökologische Basisleistungen, kulturelle, regulierende und versorgende ÖSL) entsprechend der Einteilung nach MEA (2005) kategorisiert und ausgewertet.

2.3 Auswertung qualitativer Modelle und Szenarien

Die SchülerInnen-Modelle wurden in Hinblick auf das Erlernen einer kausalen, qualitativen Ausdrucksweise, die das systemare Verständnis fördern soll, evaluiert. Der in „DynaLearn“ umgesetzte qualitative kausale Ansatz, der vom generellen sprachlichen Verständnis ausgeht, wurde dabei durch Ele-

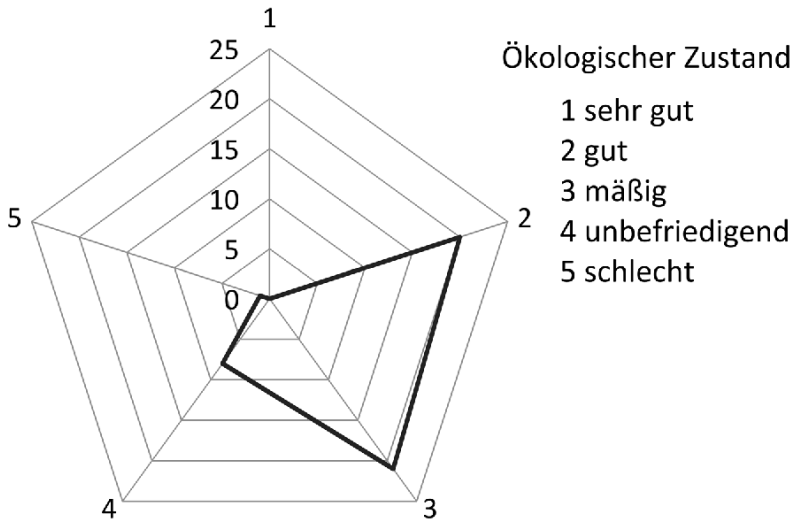

Abb. 1 Einschätzung des ökologischen Zustands der Traisen im Bereich von St. Pölten durch die SchülerInnen im Prä-Test, $N = 51$

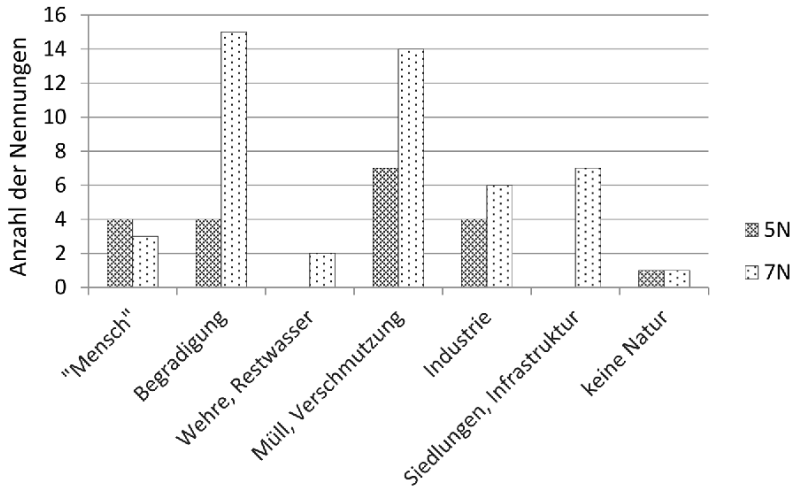

Abb. 2 Antworten der SchülerInnen beim Prä-Test (T1) auf die Testfrage A1) „Wodurch ist der Zustand der Traisen deiner Meinung nach beeinträchtigt?" differenziert nach Belastungstypen

mente der qualitativen Systemdynamik erweitert (Zitek et al. 2013). Die erstellten SchülerInnen-Modelle wurden im Detail auf deren wesentliche Elemente und Zusammenhänge hin analysiert und mit den ExpertInnen-Modellen verglichen. Evaluierungskriterien waren (1) die Verwendung wesentlicher Hauptelemente und deren hierarchische Beziehung und (2) Richtigkeit der Terminologie, der kausalen Beziehungen und der Darstellung von Prozessen in Flusslandschaften.

Die am Ende von den SchülerInnen erstellten Szenarien sollten letztendlich auf einem erweiterten kausalen Verständnis der Situation beruhen und dementsprechend formuliert und aufgebaut sein. Die Idee dabei war, dass lediglich ein gutes kausales Verständnis der Zusammenhänge die Formulierung von sinnvollen und effektiven Maßnahmen zur Verbesserung einer beeinträchtigten Ausgangssituation führen kann.

Es wurden von den SchülerInnen insgesamt 10 Modelle zum Ist-Zustand der Traisen und 10 Szenarien entwickelt; wobei nur 9 Szenarien auswertbar waren, da eines von der Software nicht mehr geöffnet werden konnte.

3 Ergebnisse

3.1 Ergebnisse der Wissensevaluierung

3.1.1 Regionales Wissen zur Traisen

Die Traisen im Bereich St. Pölten weist durch Begradigung und Wasserausleitung einen „unbefriedigenden ökologischen Zustand" (Klasse 4; BMLFUW 2015) auf und wird im 2. Nationalen Gewässerbewirtschaftungsplan als „prioritärer Sanierungsraum" definiert. Kein Jugendlicher stufte die Traisen mit einem „sehr guten" ökologischen Zustand ein. 20 SchülerInnen (39 %) teilten der Traisen im Prä-Test einen guten ökologischen Zustand zu, der keinen Verbesserungsbedarf zur Folge hätte. Beinahe gleich viele SchülerInnen (n = 21; 42 %) ordneten der Traisen die Zustandsklasse 3 (mäßiger ökologischer Zustand, n = 21) zu. Nur 8 SchülerInnen (16 %) nannten im Prä-Test die richtige „unbefriedigende" Einstufung des ökologischen Zustands. Ein Schüler stufte die Traisen schlechter ein (Klasse 5), ein Jugendlicher gab keine Bewertung ab (Abb. 1).

Die Auswertung der Antworten auf Frage A1) betreffend die Beeinträchtigungstypen an der Traisen zeigte einen signifikanten Unterschied zwischen beiden Klassen. Die SchülerInnen der 7N, die bereits im Vorgängerprojekt „FlussAu:WOW!" beteiligt waren, nannten vor allem hydromorphologische Beeinträchtigungen (Begradigung n = 15; Wehre, Restwasser n = 2), Verschmutzung und Müll (n = 14) sowie unterschiedliche intensive Landnutzungstypen (n = 13). Weiters wurden der „Mensch" allgemein als übergeordneter Belastungstyp bzw. „keine Natur" genannt. SchülerInnen der 5N nannten im Mittel signifikant weniger Belastungstypen, wobei die Kategorie „Verschmutzung und Müll" die meisten Nennungen (n = 7) aufwies (Abb. 2).

Die SchülerInnen hatten zu Beginn des Projektes (Prä-Test T1) kaum ein regionales Wissen über die Traisen. Nur 7 SchülerInnen der 51 Befragten (14 %) kannten das LIFE+ Traisen-Projekt im Unterlauf. Kein einziger Jugendlicher konnte ein anderes Renaturierungsprojekt im Einzugsgebiet der Traisen im Prä-Test nennen. Im Median wurde für beide Fragen A1) „Wodurch ist der Zustand der Traisen deiner Mei-

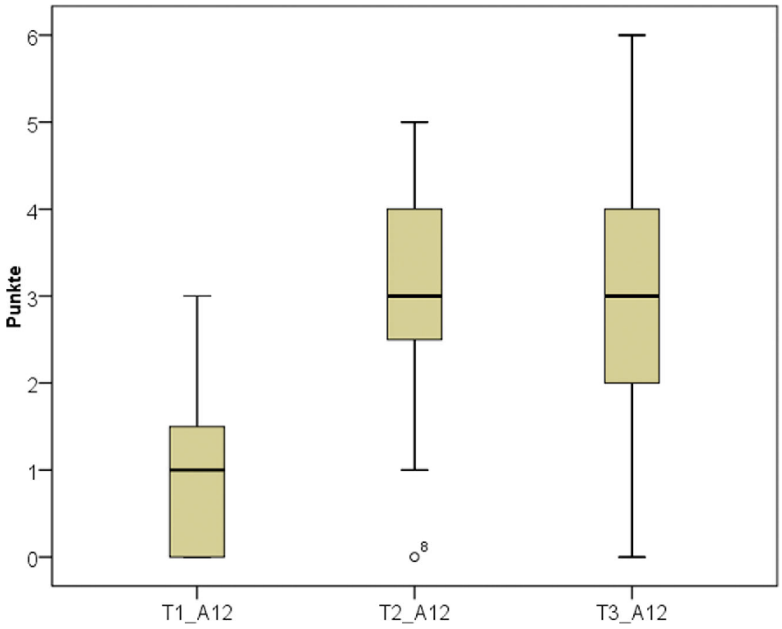

Abb. 3 Ergebnisse der Testfragen in Block A „regionales Wissen" (A12) im Prä-Test (T1), Mid-Test (T2) und Post-Test (T3), $N = 47$; max. Punkteanzahl = 6; Fragen: A1) „Wodurch ist der Zustand der Traisen deiner Meinung nach beeinträchtigt?" und A2) „Kennst du Renaturierungsprojekte im Traisen-Einzugsgebiet? Wenn ja, welche?"

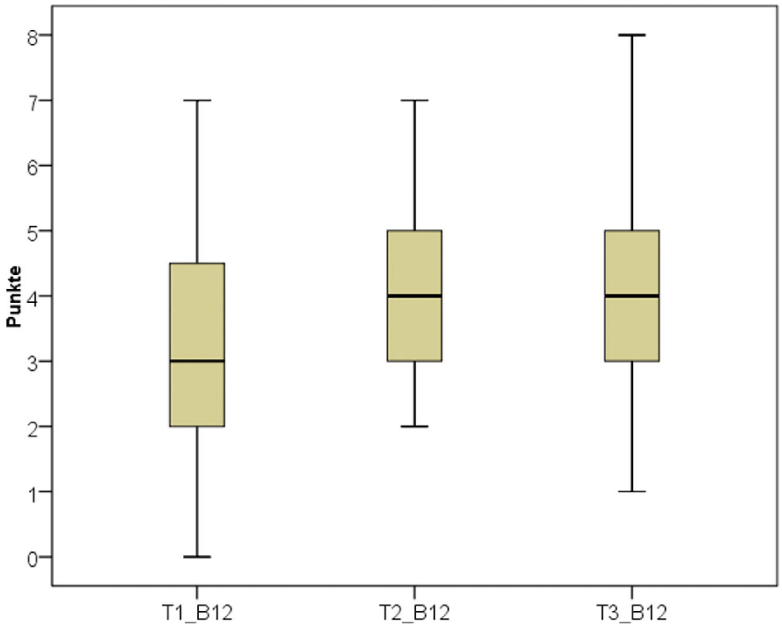

Abb. 4 Ergebnisse der Testfragen zum Block „Systemverständnis" (B12) im Prä-Test (T1), Mid-Test (T2) und Post-Test (T3), $N = 47$; max. Punkteanzahl = 8; Fragen: B1) „Warum wurden/werden Flüsse reguliert? Was verändert sich dadurch (für Menschen, Tiere und Pflanzen)?" und B2) „Warum werden Flüsse renaturiert? Was verändert sich dadurch (für Menschen, Tiere und Pflanzen)?"

nung nach beeinträchtigt?" und A2) „Kennst du Renaturierungsprojekte im Traisen-Einzugsgebiet? Wenn ja, welche?" nur 1 Punkt von maximal 6 möglichen Punkten erreicht. Beim Mid-Test (T2) konnte ein signifikanter Wissenszuwachs festgestellt werden (Wilcoxon-Vorzeichen-Rang-Test, $\alpha = 0.05$, $p = 0.001$), der beim Post-Test (T3) nur mehr in Einzelfällen gesteigert wurde (Abb. 3). Hier war kein signifikanter Unterschied zwischen den Ergebnissen der 5. und der 7. Klasse feststellbar.

3.1.2 Systemverständnis

Die Ursache-Wirkungs-Zusammenhänge von Regulierung und Renaturierung von Fließgewässern (Block B – Systemverständnis) waren den Jugendlichen zu Beginn des Projektes weniger bekannt. Im Median erreichten sie beim Prä-Test (T1) nur 3 von 8 möglichen Punkten (vgl. Abb. 4).

Beim Mid-Test (T2) konnte ein signifikanter Wissenszuwachs festgestellt werden (Wilcoxon-Vorzeichen-Rang-Test, $\alpha = 0.05$, $p = 0.001$). Beim Post-Test (T3) erreichten einzelne SchülerInnen die maximale Punktezahl von 8, in der Gesamtheit konnte aber kein weiterer Wissenszuwachs dokumentiert werden (Abb. 4). Die SchülerInnen der 7. Klasse erreichten bei allen drei Tests signifikant höhere Punktezahlen als jene der 5. Klasse.

3.1.3 Ökosystemleistungen

Auf die Frage C1) „Welchen Nutzen haben Flusslandschaften für den Menschen?" nannten die Jugendlichen im Prä-Test (T1) vor allem versorgende ÖSL ($n = 43$; z. B. Landwirtschaft oder Stromproduktion) und kulturelle Ökosystemleistungen ($n = 42$) wie verschiedene Freizeitaktivitäten, die am Fluss durchgeführt werden können (Abb. 5). Im Durchschnitt nannte jeder Jugendliche zwei ÖSL. Durch die Schulworkshops (Mid-Test, T2) wurde vor allem das Bewusstsein für kulturelle ÖSL ($n = 87$) bei den SchülerInnen erweitert. Nach den Feldarbeiten am Fluss und im Augebiet der Traisen wurden neuerlich vermehrt kulturelle ÖSL angeführt ($n = 97$). Die Jugendlichen nannten weniger versorgende ÖSL ($n = 30$), während regulierende ÖSL ($n = 14$), wie Klimaregulierung oder Hochwasserschutz, verstärkt angeführt wurden. Die Angabe von unterstützenden ökologischen Basisleistungen wie

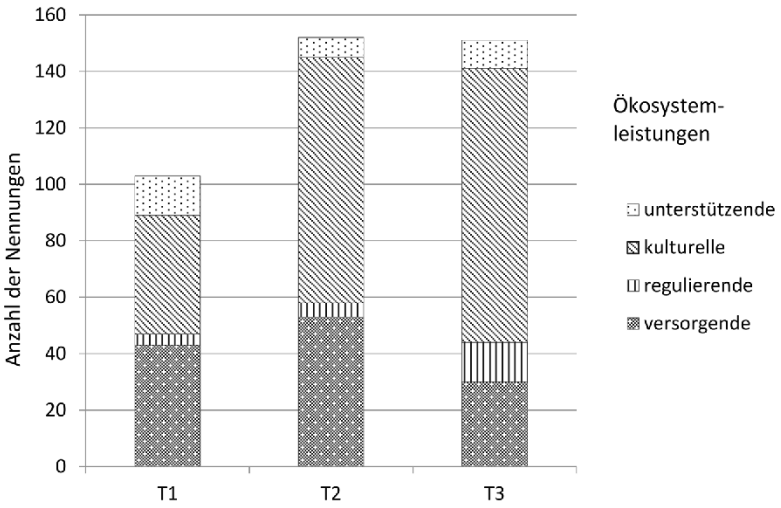

Abb. 5 Nennungen von unterschiedlichen ÖSL auf die Testfrage C1) „Welchen Nutzen haben Flusslandschaften für den Menschen?" im Prä-Test (T1), Mid-Test (T2) und Post-Test (T3)

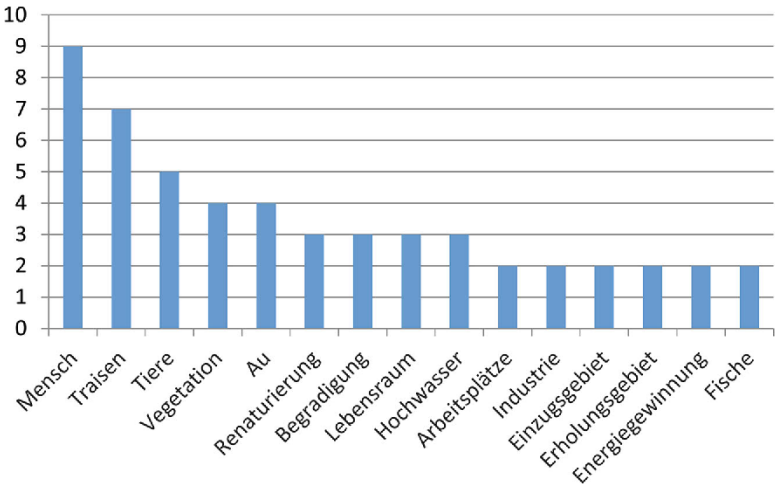

Abb. 6 Häufigkeiten der Hauptelemente in den zehn SchülerInnen-Modellen zum Zustand der Traisen

Lebensraum, blieb bei allen drei Befragungen etwa auf gleichem Niveau. Sowohl beim Mid-Test als auch beim Post-Test nannten die SchülerInnen im Durchschnitt 3 ÖSL auf die Frage C1).

Die Auswertung aller Fragen zeigte einen signifikanten Zuwachs des Wissens und Verständnisses der SchülerInnen zwischen dem ersten und zweiten Test aufgrund der durchgeführten Schul-Workshops. Nach den Feldarbeiten konnte im Post-Test (T3) kein weiterer signifikanter Wissenszuwachs festgestellt werden.

3.2 Ergebnisse der Modellbildung und Entwicklung der Szenarien

Die zehn SchülerInnen-Modelle der 7N zum Zustand der Traisen beschreiben die komplexen Zusammenhänge zwischen menschlichen Aktivitäten am Fluss und in der Au sowie die Veränderungen des Lebensraumes der Au und des Gewässers durch menschliche Einflüsse (z. B. Begradigung) anhand unterschiedlicher abiotischer Parameter (Fließgeschwindigkeiten, Flusslänge, Gefälle, Sedimenttransport) und deren Auswirkung auf Landtiere, Vegetation und Fische. Die Häufigkeiten der einzelnen Hauptelemente sind in Abb. 6 dargestellt. In neun der zehn Modelle wurde der Mensch als Ursache für Veränderungen in der Traisen-Flusslandschaft modelliert.

Flussbegradigungen, Brücken- und Kraftwerksbauten bzw. Bau von Fabriken und Siedlungen sowie die intensive Landwirtschaft wurden als anthropogene Eingriffe in Flusslandschaften als Haupteinflussgröße simuliert. Renaturierungen und Umweltprogramme wurden als Gegenmaßnahmen in die Modelle eingebaut. Als mögliche Motive für Handlungen, die den ökologischen Zustand bzw. die Ökosystemleistungen von Flusslandschaften potenziell negativ beeinflussen, wurden das Streben des Menschen nach Wohlstand, Lebensqualität, Erholung und sichere Arbeitsplätzen genannt. Als mögliche Auswirkungen wurden die Zunahme der Häufigkeit von Hochwässern, die Abnahme des Fischbestandes und der natürlichen Vegetation sowie Wasserverschmutzung genannt. In einigen Modellen wurden auch die durch Hochwässer verbundenen Schäden und Kosten einbezogen. Alle Modelle beinhalteten zum Großteil richtige kausale Beziehungen, wenngleich immer wieder falsche Termini verwendet wurden.

In neun Modellen wurden von den SchülerInnen-Gruppen explizit Startbedingungen gesetzt, die in der Simulation zu unterschiedlichen negativen Auswirkungen menschlicher Handlungen auf die Modellelemente einer Flusslandschaft führten. Nur in zwei Modellen wurden positive Auswirkungen auf das Ökosystem der Traisen durch die Zunahme von Umweltprogrammen bzw. durch Renaturierungen simuliert. In sieben SchülerInnen-Modellen wurden negative Auswirkungen auf die Ökosystem-Elemente, z. B. durch Bevölkerungswachstum, Zunahme von Flussbegradigungen, intensiver Landwirtschaft und steigender Umweltzerstörung, simuliert.

In Abb. 7 ist ein SchülerInnen-Modell der 7N abgebildet. In Abhängigkeit von der Bevölkerungsentwicklung (Start der Simulation – grauer Pfeil) steigt u. a. der Strom- bzw. der Raumbedarf, was mit negativen Auswirkungen auf die hydromorphologischen Bedingungen in der Traisen verbunden ist, und auch deutliche Auswirkungen auf Fische und Vegetation hat. Die Entwicklungstendenzen sind in Abb. 7 durch blaue Pfeile erkennbar. Gleichzeitig steigen

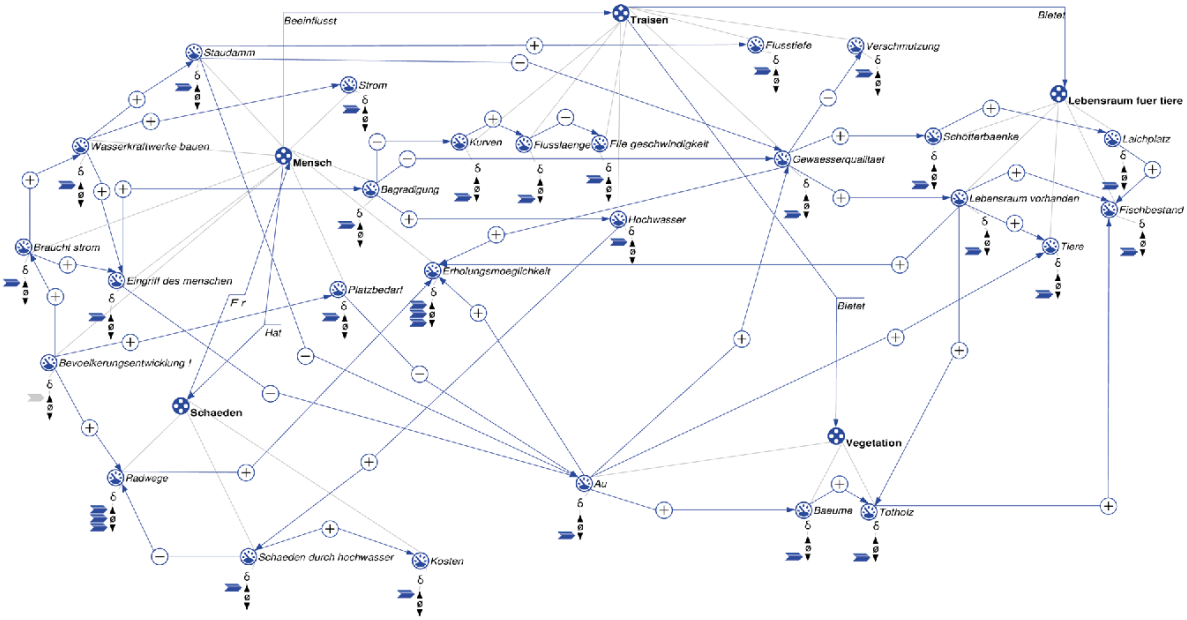

Abb. 7 SchülerInnen-Modell zur Traisen–Modellstruktur mit Simulationsergebnissen (*grauer Pfeil*: Start der Simulation, *blaue Pfeile* zeigen Entwicklungstendenzen)

Tab. 2 Szenarien der potenziellen Entwicklung der Traisen, ausgehend von anthropogenen Beeinträchtigungen mittels unterschiedlicher Maßnahmentypen

Modell Nr.	Ist-Zustand	Maßnahmentyp 1	Maßnahmentyp 2
1	Begradigung	Renaturierung	
2	Restwasser	Entfernung der Wehranlagen	Renaturierung
3	Rückgang des Fischbestands	Renaturierung	Entfernung der Wehranlagen
4	Nutzungsdruck	Bauprojekte am Flussufer verhindern	Ackernutzung in Au untersagen
5	Restwasser	Höhere Restwasservorschreibungen	Renaturierung
6	Schlechtes Ökosystem	Renaturierung	
7	Verschmutzung	Baubeschränkungen	Umweltbildung
8	Rückgang von Fischarten	Fischansiedlung	Renaturierung
9	Schlechter ökologischer Zustand	Entfernung der Wehranlagen	Renaturierung

die Hochwässer und die damit verbundenen Schäden und Kosten. Erholungsmöglichkeiten werden durch Radwege am Fluss dargestellt. In Bezug auf diese ÖSL liefert die Simulation kein eindeutiges Resultat (drei blaue Pfeile). Das kommt dadurch zustande, dass zwar durch das Vorhandensein von Radwegen die Erholungsnutzung steigt, zusätzlich wurde durch die generelle Veränderung der Flusslandschaft durch den Menschen auch eine verschlechterte Gewässerqualität angenommen, welche die Freizeitnutzung durch Radwege kontrastiert.

Die SchülerInnen-Modelle spiegelten oft die generelle Schwierigkeit wider, in Flussgebieten ein Gleichgewicht zwischen der Nutzung der Flusslandschaft durch den Menschen, den Anspruch auf intakte hydromorphologische Prozesse und die Notwendigkeit des Lebensraumes für verschiedenste Lebewesen zu finden. Viele zeigten klar das Spannungsfeld zwischen Wirtschaftswachstum, und damit intensiver Nutzung der Flusslandschaft Traisen, und den beeinträchtigten Umweltbedingungen auf.

In einer Weiterentwicklung der Modelle wurden im zweiten Modellierungs-Workshop Szenarien für das Einzugsgebiet der Traisen entwickelt. Die verschiedenen Beeinträchtigungen des Ist-Zustandes sowie die entsprechenden Maßnahmen zur Verbesserung, die von den SchülerInnen in den einzelnen Szenarien genannt wurden, sind in Tab. 2 dargestellt. In zwei Modellen wurde der „schlechte ökologische Zustand“ bzw. das „schlechte Ökosystem“ der Traisen als Ausgangssituation gewählt. Drei SchülerInnen-Modelle simulierten zwei hydromorphologische Beeinträchtigungstypen – „Restwasser“ bzw. „Begradigung“ – an der Traisen. Mit dem „Rückgang der Fischarten“ bzw. „des Fischbestandes“ arbeiteten zwei SchülerInnen-Gruppen. Zwei Modelle gingen über den Flusslauf hinaus und fokussierten auf die Beeinträchtigungstypen „Verschmutzung“ bzw. „Nutzungsdruck“ in den Aubereichen bzw. in den angrenzenden Flächen der Traisen.

Der häufigste genannte Maßnahmentyp zur Verbesserung des ökologischen und hydromorphologischen Zustandes war „Renaturierung“ ($n = 7$), gefolgt von der „Entfernung von Wehr-

anlagen“ (n = 3) bzw. „Einschränkung der Nutzungen“ (n = 3), vor allem im Ufer- und Aubereich. In einem Modell trug die Maßnahme „Umweltbildung“ indirekt zur Verbesserung der Wasserverschmutzung und des ökologischen Zustandes der Traisen bei. In den Szenarien der SchülerInnen für das gesamte Einzugsgebiet der Traisen gingen alle SchülerInnen-Gruppen vom schlechten ökologischen Ist-Zustand der Traisen aus und verbesserten den Zustand durch wirksame Maßnahmen. In sieben Szenarien wurden sogar Maßnahmenkombinationen modelliert.

Anhand der dargestellten Szenarien konnte ein deutlich zum Ausdruck gebrachtes Verständnis der wichtigsten kausalen Zusammenhänge zwischen Belastung, Zielzustand und Maßnahme bei den SchülerInnen nachgewiesen werden.

4 Bedeutung der Ergebnisse für ein nachhaltiges Flusslandschaftsmanagement

4.1 Umweltwissen und Systemverständnis als Basis

4.1.1 Wissensvermittlung

Wissensvermittlung von gewässerökologischen Themen ist wichtig, da bei den Jugendlichen kaum Bewusstsein über regionale Vorgänge oder Prozesse in Flusslandschaften vorhanden ist.

Die Auswertung der Wissenstests zeigte, dass regionales Wissen über den Heimatfluss und Vorgänge im Einzugsgebiet nicht im Bewusstsein der Jugendlichen verankert ist. 39 % der SchülerInnen bewerteten den ökologischen Zustand der Traisen im Prä-Test mit „gut“, wobei der Fluss gerade in St. Pölten, wo sie zur Schule gehen, stark anthropogen verändert, in einem Trapezprofil begradigt und durch Wasserausleitung beeinträchtigt ist. Hier schnitten sowohl die jüngeren als auch die älteren SchülerInnen im Mittel gleich schlecht ab. Auch europaweite Umfragen (EC 2009) zeigen, dass die Bevölkerung über Belastungen der Flusslandschaften und den Zustand der Fließgewässer kaum informiert ist.

Im Projekt „FlussAu:WOW!“ konnten wir dokumentieren, dass bei SchülerInnen „falsche“ Bilder von Belastungstypen an Flüssen vorhanden sind (Poppe et al. 2013). Dies wurde auch im gegenständlichen Projekt bestätigt, da Gewässergüte und Verschmutzungen als Hauptbelastungen im Traisen Flusssystem gesehen wurden. Viele SchülerInnen nannten die sichtbare Verschmutzung des Flusses und der Au mit Müll als Hauptbelastungstyp, während sie reduzierte Wasserführung, Regulierung oder Staubereiche nicht als anthropogene Eingriffe wahrnahmen. Zu Beginn des gegenständlichen Projekts konnten wir klar ein fehlendes Problembewusstsein der Jugendlichen zum ökologischen Zustand der Traisen belegen. Durch die Durchführung der Schulworkshops konnte dieses maßgeblich verbessert, erweitert und geschärft werden.

Um Interesse und Begeisterung der Jugendlichen hervorzurufen, muss das Thema interessieren und für die jeweilige Person, die an einem Lernprozess beteiligt ist, von Bedeutung sein (Hüther und Hauser 2012). Mit Themen wie z. B. Umweltqualität, die das eigene regionale Umfeld der SchülerInnen betreffen, bzw. mittels eigens formulierter Fragestellungen, können Jugendliche wesentlich leichter motiviert werden, aktiv und gestaltend am Unterricht teilzunehmen (Hödl 2015).

4.1.2 Systemverständnis

Systemverständnis ist wichtig um Ursache-Wirkungs-Zusammenhänge zu erkennen und nachhaltige Entscheidungen im Flussgebietsmanagement zu treffen.

Hinsichtlich des Erlernens, aber auch Verknüpfens wissenschaftlicher Konzepte und Zusammenhänge wird die Verwendung von technischen Hilfsmitteln, wie Computer-Software, zur Erstellung von repräsentativen Modellen als sehr sinnvoll und motivierend betrachtet (Jonassen und Strobl 2006). Insbesondere in der Wissenschaftserziehung hat der Prozess des Modellbildens und -testens eine große Bedeutung (Schwarz und White 2005). Qualitative kausale Modellierung wird hierbei immer öfter als wertvolles Werkzeug zur Wissenschaftserziehung betrachtet, da Lernen grundsätzlich viel mit der Entwicklung von konzeptionellem Verständnis zu tun hat (Bredeweg und Forbus 2003). Dieses bildet die Basis für das Verständnis der zugrunde liegenden Systemstrukturen und die spätere quantitative Analyse (Bredeweg und Forbus 2003; Jonassen 2003). *„Qualitative konzeptuelle Modellierung auf der Basis von feldbasierter ökologischer Forschung kann Lernenden effektiv helfen, Aspekte komplexer Ökosystemfunktionen besser zu verstehen. So werden sonst abstrakte Konzepte über Interaktionen, Feedback, Subsysteme, Einflüsse und Auswirkungen zugänglicher gemacht“* (Dresner und Elsner 2009).

Im Projekt „Traisen.w³“ konnten SchülerInnen damit Zusammenhänge herstellen und ihr Bewusstsein für Flusslandschaften stärken – ein Zugang der auch im nachhaltigen Flussgebietsmanagement immer mehr Anwendung findet (Hare 2011; Halbe et al. 2013). Sowohl die SchülerInnen der 5. Klasse, die verstärkt mit dem ÖSL-Konzept arbeiteten, als auch jene der 7. Klasse, die mit der Lern-Software „DynaLearn“ modellierten, zeigten nach den Schul-Workshops einen signifikanten Verständniszuwachs. Die SchülerInnen der 7. Klasse zeigten bereits zu Beginn des Projektes im Prä-Test bessere Ergebnisse und einzelne SchülerInnen dieser Klasse konnten nach allen Schulaktivitäten die maximale Punktezahl erreichen. Das ist aufgrund der bereits erfolgten Involvierung dieser SchülerInnen im Projekt „FlussAu:WOW!“, ihrer aufgrund des Alters größeren Erfahrung und ev. durch die Fokussierung auf die Modellierungsarbeit zu begründen. Das Modellieren, das mit der Externalisierung des eigenen persönlichen Wissensstandes beginnt und neues Wissen in konstruktiver Art und Weise in diese Modellvorstellung inkorporiert, stellt eine Aktivität dar, mit der gezielt die Komplexität und Wissenschaftlichkeit der Vorstellungen der Lernenden erweitert werden können (Erweiterung der „conceptual models“ oder „mental models“; Greca und Moreira 2000; White und Frederikson 1990; Doyle und Ford 1998). Dadurch werden die SchülerInnen letztendlich im Umgang mit komplexen und umfangreichen Informationen unterstützt und die Entwicklung einer wissenschaftlichen Denkweise über Umweltphänomene wird gefördert (Jonassen und Strobel 2006).

Die „Dynalearn“ Modelle der SchülerInnen zeigen die schwierigen komplexen Fragestellungen im Flussgebietsmanagement auf. In den zehn Szenarien zur Traisen wurde von den Jugendlichen eine Verbesserung der Umweltbedingungen als auch eine Nutzung der Flusslandschaft für Freizeit und Erholung modelliert. Steigender Strombedarf und Nutzungsdruck in Flusslandschaften wurde zwar als

konkurrierende Einflussgrößen festgelegt, Renaturierungen, Entfernung von Wehranlagen und effektivere Gesetzgebung zum Flächenschutz in Augebieten wurden hingegen als Startimpuls für Szenarien gesetzt.

Grundsätzlich bietet das gemeinsame Erstellen analoger oder digitaler „Concept maps" im Rahmen eines gemeinsamen „multimodalen Modellierens" einen motivierenden Einstieg in neue Themenbereiche und unterstützt dabei das gemeinsame Entwickeln und Texten (Liu et al. 2013), wie dies im Rahmen des Modellierungsworkshops anhand der am Ende der Übung verfassten verbalen Szenarien deutlich wurde. Damit konnte auch die Entwicklung der Kompetenzen in Hinsicht auf die „Scientific literacy" (naturwissenschaftliche Grundbildung nach Bybee 1997) deutlich gefördert werden.

Gleichzeitig wurden das Verständnis über kausale Zusammenhänge sowie das grundsätzliche Systemverständnis signifikant gefördert. Die spielerische Entwicklung von Szenarien unter Einbeziehung der menschlichen Bedürfnisse und Handlungen führte zu einem besseren Verständnis über mögliche Handlungsalternativen in einem gegebenen sozialen Umfeld. Alle am Ende des Workshops erstellten Modell-Szenarien der SchülerInnen spiegelten nachhaltige Entwicklungen der Flusslandschaft wider.

Wichtig für die Wissensvermittlung und das Lernen erscheinen multimodale Unterrichtsformen (Zitek et al. 2013; Poppe et al. 2013), die unterschiedlichste Aktivitäten (u. a. Verwendung analoger und digitaler Systemzugänge, z. B. mit der „DynaLearn"-Lern-Software, Diskussionen, Vorträge, Feedback-Runden, Schreiben von Blog-Beiträgen, Befragungen, Feldarbeiten, selbstständig durchgeführte Gruppenarbeiten, Erstellung eines Kurzfilms) in der Zusammenarbeit mit den SchülerInnen integrieren. Interessanterweise konnte bei der Punkteauswertung der Wissenstests kein signifikant erweitertes Systemverständnis durch die Feldarbeiten der SchülerInnen dokumentiert werden. Bei der Analyse der einzelnen Antworten wurden aber nach den Feldarbeiten neue Begriffe verwendet. Beim Themenblock der ÖSL wurden durch die Arbeit im Augebiet der Traisen neue Funktionen von Flusslandschaften wie Hochwasserretention oder Klimaregulation von den SchülerInnen wahrgenommen und in den Testantworten angeführt, während andere, ursprünglich genannte ÖSL weggelassen wurden.

Gemeinsam mit den SchülerInnen des BG/BRG St. Pölten wurde während der Workshops und der Feldarbeiten ein Kurzfilm erstellt[5]. Hier ist der Spaß an der Feldarbeit deutlich ersichtlich, was auch im Feedback der SchülerInnen an das Projektteam gemeinsam mit den vielfältigen, abwechslungsreichen Schulaktivitäten klar als positive Aspekte des Projektes angesprochen wurde.

4.1.3 Social-learning-Aktivitäten

Social learning ist ein wichtiger Aspekt im nachhaltigen Flussgebietsmanagement (Pahl-Wostl et al. 2008; Koontz 2014) und wird durch interaktives, kollaboratives Modellieren und Gruppenaktivitäten gefördert (Hare 2011; Halbe et al. 2013). Zusätzlich zu dem Ziel des gemeinsamen Arbeitens war es wichtig, den SchülerInnen spannende Möglichkeiten des gemeinsamen Lernens zu bieten, bei denen gleichzeitig der Wissensaustausch, aber auch soziale Kompetenzen wie Kommunikationsfähigkeit, Kooperation, Konflikt- und Teamfähigkeit gefördert werden sollten. Dies wurde von einzelnen SchülerInnen im direkten Feedback an das Forschungsteam als bereichernde Art des Lernens genannt. Die durch die Schul-Workshops erworbenen Kompetenzen können z. B. bei zukünftigen Partizipationsprozessen eingesetzt werden.

4.2 Das Konzept der ÖSL als geeignetes Kommunikationsinstrument

Die Ergebnisse dokumentieren, dass das Konzept der ÖSL eine geeignete Methode zur Wissensvermittlung von komplexen Zusammenhängen in Flusslandschaften darstellt. Damit bestätigen sich die Ergebnisse einer Untersuchung an den Flusslandschaften Enns und Drau (Böck et al. 2015), in der InterviewpartnerInnen aus unterschiedlichen Fachbereichen das ÖSL-Konzept als vielversprechendes Instrument für Kommunikationszwecke und Umweltbildung einstuften. Es wurde angenommen, dass das Konzept das Verständnis für die Zusammenhänge zwischen Gesellschaft und Natur verbessern und Neugier und Interesse fördern kann (Böck et al. 2015).

Zu Beginn des Projekts waren vor allem kulturelle und versorgende ÖSL im Bewusstsein der Jugendlichen und wurden auch im Prä-Test genannt. Die Flusslandschaft wurde als Ort für Freizeitaktivitäten (Freunde treffen, spazieren gehen, fischen) gesehen, aber auch als bedeutsam für die Landwirtschaft oder zur Stromproduktion wahrgenommen. Interessanterweise wurde von den SchülerInnen nach den Feldarbeiten eine Vielzahl von kulturellen ÖSL genannt sowie neue regulierende Leistungen. Diese wurden verstärkt durch die Feldarbeit an der Traisen und im Augebiet des LIFE+ Projekts wahrgenommen. Die Bedeutung kultureller Leistungen zeigt sich auch in früheren Untersuchungen zur Wahrnehmung von ÖSL durch unterschiedliche Stakeholder-Gruppen (Chiari 2010; Böck et al. 2013; Hauck et al. 2013). Diese steht jedoch im starken Widerspruch zur Berücksichtigung dieser Leistungen in der Praxis (Daniel et al. 2012; Schaich et al. 2010). Hier wird den Versorgungsleistungen, denen in dieser Studie von den Jugendlichen ebenfalls eine hohe Bedeutung zugemessen wurde, der Vorrang gegeben. Es sollte jedoch nicht vergessen werden, dass besonders kulturelle Leistungen eine entscheidende Rolle beim Management der Interaktionen zwischen Mensch und Umwelt sowie bei der Erreichung öffentlicher Unterstützung für den Schutz von Ökosystemen einnehmen (Daniel et al. 2012).

4.3 Ansätze zur Partizipation: Einbeziehung der Jugend wichtig

Europaweite Umfragen (EC 2012) zeigten, dass gerade die lokale Bevölkerung wenig über die Möglichkeit der Partizipation bei Planungen im Flussgebietsmanagement weiß. Neun von zehn Personen ist der Begriff eines Gewässerbewirtschaftungsplans nicht bekannt. In Österreich gaben 93 % aller Befragten (n = 1003) an, dass sie sich nicht an der Entwicklung der Gewässerbewirtschaftungspläne im Rahmen von Konsultationsprozessen beteiligt haben, wobei davon 45 % bei entsprechender Information teilgenommen hätten (EC 2012).

Einige Studien (CIS 2003; de Stefano 2010; Demetropoulou et al. 2010) zeigten, dass Partizipationsprozesse auf lokaler und regionaler Ebene besonders geeignet sind, um das Umweltwissen, Systemverständnis und das Interesse

[5] http://www.traisen.net/?page_id=452.

der Bevölkerung zu erhöhen. Gerade bei jungen Menschen ist es wichtig, das Interesse für Umweltthemen zu fördern und eine mögliche Beteiligung an Entscheidungen zu forcieren (Nguyen und Bosch 2014). Je mehr Jugendliche frühzeitig in einen Partizipationsprozess eingebunden werden, der ihnen Handlungsoptionen zur Verbesserung der Umweltsituation ermöglicht, desto größer sind die Chancen auf ein bewusstes Umwelthandeln in späteren Jahren (Kromer und Zuber 2003). „Stimme der Jugend[6]“, „strukturierter Dialog[7]“, „Jugend in Aktion[8]“ oder „Youth for the Alps“ (CIPRA 2013) sind österreichische bzw. alpen- oder europaweite Initiativen, die junge Menschen aktiv in Entscheidungsprozesse im politischen und sozialen Umfeld einbinden. Diese Initiativen sollten gezielt auch auf ökologische Themenfelder ausgeweitet werden, damit junge Menschen zukünftig als BewohnerInnen und NutzerInnen der Flusslandschaften nachhaltige Planungen und Maßnahmen unterstützen, sich aktiv an der Entscheidungsfindung beteiligen, und damit Verantwortung für die Gestaltung ihrer Umwelt übernehmen können.

[6] https://stimme-der-jugend.at.

[7] http://www.strukturierter-dialog.at.

[8] http://www.jugendinaktion.at.

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4.6 Article #6

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Human-Nature Relationships and Linkages to Environmental Behaviour

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Abstract

While many theories exist to enlighten the complexity of environmental behaviour, the role of individuals' relationship with nature has not yet been fully clarified. This paper attempts to operationalize human-nature relationships. It expands a scale assessed in an iterative process of mixed-methods in the US and Europe. This scale is then used to assess individuals' relationship with nature and whether such relationships correlate with environmental behaviour. The value scale of Schwartz's Theory of Basic Values is used to validate the results. The results verify that people hold multiple human-nature relationships, confirm strong correlations between human-nature relationships and values, and reveal that individuals' behaviour is connected to the relationship they have with nature.

Keywords: human-nature relationship scale, Schwartz value scale, student survey, Austria, Utah

1 Introduction

This paper shows that considering the relationship humans have with nature enlightens environmental behaviour. In addition to many other aspects of environmental communication and governance, understanding the umbrella concept of human-nature relationships (herein abbreviated as "HNR") helps to recognize "hierarchical views toward nature as well as their effects on behaviours" (Milfont et al. 2013: 10).

Serious environmental problems, such as pollution, scarcity of drinking water, overexploitation of resources, and the loss of biodiversity, are often a consequence of human activities (Vlek and Steg 2007; Klöckner 2013; Steg et al. 2014). Steg et al. (2014: 106) see this as an opportunity because it gives people the chance to manage these problems "[…] by changing the relevant behaviours so as to promote environmental quality". As easy as that may sound, the challenge to change individual behaviours and stimulate a long-lasting transition towards rebalancing the relationship of society and nature is tremendous. Human behaviour is characterized by a multiplicity of variables, circumstances and interactions with other humans (Teixeira 2007). This implies that comprehending environmental behaviour is anything but simple and predicting it might even be impossible.

Three major frameworks tackle the challenge to link the two dimensions of human behaviour and nature at the societal level. Today's most frequently discussed framework is that of ecosystem services (ES) (MEA 2005; TEEB 2010). It bridges the human and the natural system, highlighting the importance of ecosystems and biodiversity for human wellbeing and utility (Raymond et al. 2013). A cause-effect approach is applied by the European Environment Agency in the DPSIR framework (driving forces - pressures - state - impact - responses) that analyses how social and economic developments exert pressure on the environment (Agu 2007). More complexity is introduced by Ostrom's (2009) social-ecological-systems (SES) framework, which conceptualizes human resource uses as embedded in complex, social-ecological systems with tiered subsystems and variables interacting on multiple levels.

However we capture the relationship between humans and nature, each approach has its strengths and limitations. Scholars critically reviewing sustainability concepts (e.g. Benson and Craig 2014; Casado-Asensio and Steurer 2014) argue that something is missing, as sustainability is still not a social norm. People in western societies know that they would be bet-

ter off if they protected their common environment – but they are stuck in a social dilemma (Ostrom 1999; Kamenica 2012). Because of this deadlock the importance of insights into social aspects of transformative processes towards sustainability is increasingly recognized (Sovacool et al. 2015). Gosling and Williams (2010) see peoples' individual relationship with nature as relevant to sustainability efforts and policies. Along these lines, we want to contribute to an intellectual discourse about human-nature relationships and support initiatives that aim to stimulate a long-lasting transition towards rebalancing the relationship of humans and nature.

According to Flint et al. (2013) conceptualizations of relationships humans have with nature are found in philosophical as well as social science literature. These multi-disciplinary discourses revolve around the same notion of human and nature relationship. Yet so far, common understanding or consensus on a common typology has proved elusive (Kellert et al. 1993; Schultz et al. 2004; Fischer and Young 2007; van den Born 2008; Bauer et al. 2009; de Groot and de Groot 2009; Buijs 2009; Teel and Manfredo 2010; Flint et al. 2013). We highlight this conceptual lack of clarity as the first of three knowledge gaps guiding this article. In addition to that, scholarship is ambiguous as to how to assess HNRs empirically (second knowledge gap). We address these knowledge gaps with two research questions: (1) Which different types of HNR concepts can be identified? and (2) What are adequate scales to assess them? Based on an analysis of existing terminologies (Flint et al. 2013), we attempt to expand the already operationalized HaN scale of de Groot and van den Born (2007) and develop a HNR scale that is (a) applicable in different contexts; (b) appropriate for both qualitative and quantitative research; (c) suitable for individual as well as group discussions and measurement; and (d) useful in both empirical and participatory processes.

Furthermore, attention is drawn to a potential link between HNR and behaviour. It is plausible and assumed theoretically that the relationship people have with nature might play a

decisive role in how people behave environmentally, however, the empirical evidence is missing. We address this third knowledge gap with the third research question: What correlations exist between individuals' understanding of their relationship with nature and their environmental behaviour? With our focus on environmental behaviour (Kollmuss and Agyeman 2002; Evans et al. 2013; van der Werff et al. 2013; Steg et al. 2014), we opt for a broader perspective on the natural environment that goes beyond nature and conservation behaviour (Gosling and Williams 2010), and focus on environmental behaviour in the private sphere (see section 2.1).

We do not seek to assess the explanatory role of HNR in determining environmental behaviour; particularly as predicting or even understanding individuals' behaviour holistically is difficult, if not impossible. Rather, we explore potential correlations between HNR and environmental behaviour. To validate our results, we compare these correlations with empirical results guided by Schwartz's Theory, which has been broadly applied to investigate human behaviour (Schwartz 1992; Bardi and Schwartz 2003; Evans et al. 2013; Jonsson and Nilsson 2014).

2 The Complexity of Environmental Behaviour

As Eidelson (1997) extensively discussed, social and behavioural scholars often fail to embed their research in a systemic perspective, neglecting that randomness and determinism coexist in human behaviour and social systems. Therefore, this section starts by elucidating the term "environmental behaviour". Then, based on dominant socio-psychological theories that tackle human behaviour, we build a comprehensive environmental behaviour model to address the three research questions.

2.1 Environmental behaviour

Following the approach of Biel and Thøgersen (2007) as well as Klöckner (2013) in our conceptual framework, we define environmental behaviour neutrally as any behaviour that has a direct or indirect, positive or negative impact on natural environments. Other definitions are more normative in the sense of how one should behave, such as 'environmentally significant behaviour' (Gatersleben et al. 2002; Stern 2005; Biga 2006; Dietz 2014), or 'environmentally responsible behaviour' (Thøgersen 2006).

For the purpose of our empirical investigation we focus on a subset of environmental behaviour, namely environmental behaviour in the private sphere to intentionally minimize the negative impact on the natural environment, which we refer to as "pro-environmental behaviour" (Kollmuss and Agyeman 2002; Evans et al. 2013; van der Werff et al. 2013; Steg et al. 2014). We specifically investigated behaviour related to consumption, mobility, energy and other daily routines for the following reasons: First, private-sphere behaviour has direct environmental consequences (Stern 2000). Second, buying organic products, using public transport, saving energy, or reducing waste are typically considered as 'appropriate' behaviour (Steg et al. 2014: 105). Third, these categories can be associated with tangible, everyday practices (Doyle 2013).

2.2 Socio-psychological theories and models explaining (environmental) behaviour

Socio-psychological disciplines consider variables such as values (Schwartz 1992; Teel and Manfredo 2010; Steg et al. 2014), worldviews (Hedlund-de Witt 2012; Liu and Lin 2014), beliefs (de Groot and Steg 2008; Gadenne et al. 2011), attitudes (Teel and Manfredo 2010; Heyl et al. 2014) or norms (Thøgersen 2006; Onwezen et al. 2013) to enlighten the complexity of environmental behaviour (Hondo and Baba 2010).

Following Ajzens' Theory of Planned Behaviour (TPB) (1991), human behaviour is a consequence of the intention to perform it, whereby the behavioural intention depends on a

person's attitude towards performing the behaviour and subjective norms. Ajzen's linear model includes measuring a person's perceived behavioural control to determine the impact of external conditions on decision making and the extent to which the individual perceives his/her behaviour to be under his/her personal control (Claudy and O'Driscoll 2008). A different approach, the Value-Belief-Norm (VBN) of Stern et al. (1999), starts from the relatively stable Norm-Activation Model (Schwartz 1992) and explains the causal chain of beliefs about the biophysical environment (e.g. environmental worldviews) towards environmental behaviour (Aguilar-Luzón et al. 2012).

The New Environmental Paradigm (NEP) scale links environmental concern with attitudes and beliefs toward more specific environmental issues (Dunlap et al. 2000). The NEP is criticised as sort of "folk" ecological theory (e.g. Stern et al. 1999: 85), as it primarily measures broad beliefs about nature and the consequences of human action. It emphasizes polarization between ecocentric and anthropocentric orientations, missing an opportunity to consider the interplay between different dimensions of the relationship humans have with nature as identified by Flint et al. (2013).

2.3 Values and worldviews

General values are abstract principles that people strive for in their life, and are therefore the foundation of inner psychological processes (Mosler 2004). Schwartz (2012) illustrates that people with collective or self-transcendent values (e.g. universalism and benevolence), are more likely to show altruistic, cooperative or environmental behaviour, than people with self-enhancement values (e.g. power, achievement and hedonism). Schwartz's value scale has been supplemented by biospheric values, in order to measure intrinsic values of nature (Dietz et al. 2005; de Groot and Steg 2008; Howell 2013; van der Werff et al. 2013). Studies using this scale reveal positive correlations between altruistic and biospheric values as both can be identified as self-transcendence values (de Groot et al. 2012).

While one line of socio-psychological discourse perceives humans as guided by an integrated system of values, others describe general worldviews as explanatory variable of behaviour (Hedlund-de Witt 2012). Worldviews are understood as an overarching system that substantially informs how humans interpret, enact, and co-create reality (Poortinga et al. 2004; Hedlund-de Witt et al. 2014). Because of its broadness, the concept of worldviews is often used as an umbrella term referring to the interaction of values, beliefs, and traditions (Hedlund-de Witt et al. 2014). Similar to values, scholars distinguish between general and specific worldviews, such as environmental worldviews. According to Liu and Lin (2014), environmental worldviews describe how individuals see the natural world and how mankind is integrated or separated from it.

Crompton (2010) shows that frames of communication, campaigning, or policies can activate values or worldviews. However, scholars debate whether values or worldviews are more stable or dynamically changing. We see both as part of an integrated and dynamic system, where activating one particular value or worldview affects the other (Karp 1996; Snelgar 2006; Crompton 2010; Steg et al. 2011; Bolderdijk et al. 2013; Hurst et al. 2013).

2.4 An attempt to position HNR in a comprehensive behaviour model

To operationalize our three research questions, we synthesize the aforementioned major socio-psychological theories in a comprehensive behaviour model (see dotted rectangle in Figure 1). Via norms, we connect the Theory of Planned Behaviour (TPB) with the Value-Belief-Norm Model (VBN). Both models suggest linearity and internal, sequential triggering of psychological patterns. However, when people interact with each other as well as with the ecological system and have associated experiences, their values, worldviews, beliefs, feelings, thoughts, and actions towards the environment may change (Mosler 2004).

We add HNR as a complementary, parallel dimension in our model. HNR is an umbrella construct somewhere in between the bundle of abstract worldviews, values, beliefs,

attitudes, and perceived norms of how humans should interact with nature, and ultimately how they should behave. In principle, HNR is a view "[…] people hold about their appropriate relation with nature" (van den Born 2008: 87). Some dialogues about HNR are rooted in traditional religious or philosophical belief systems; others are based on more recent ecological concepts of socio-psychological disciplines. Despite the seemingly clearly defined HNR types in literature, we assumed HNRs to be context specific, dynamic across time and space, and not mutually exclusive (Flint et al. 2013; Raymond et al. 2013). Therefore, we limit our attempt to integrate HNR by considering it as a complementary overarching domain (see Figure 1).

3 A Methodological Approach for Operationalizing HNR

The following section describes the mixed-method approach applied to operationalize HNR and to test potential links with environmental behaviour and the Schwartz's Theory of Basic Values. It was not a linear, but rather an adaptive process, with initial inquiries, interim results, new arising questions, and emerging conclusions, in order to gradually improve the HNR typology and scale (see Figure 2).

3.1 Scale development and empirical research

We developed and refined the HNR typology and a scale to assess it in three subsequent studies (see Figure 2). We started with a comprehensive literature review on existing HNR typologies and scales and tested these typologies and different versions of the scale empirically, combining qualitative and quantitative research methods (study 1 & 2). Each study included additional literature review and reflective discussion to identify the next research steps.

Qualitative interviews served to explore the relevance of the HNR idea and the range of variations in HNR types. Related reactions of the interviewees helped to inform a more sys-

tematic battery of items for an HNR scale. Interviews were conducted with farmers navigating changes in water quality practice and policy in the US and actors involved in sustainability oriented water management in Austria. The focus was on how stakeholders perceive their own or others' HNR, influences on environmental practices, and any potential strengths or limitations the concept might have to improve participatory processes. Interviewees were also asked whether particular frameworks (legal, institutional, organizational) shape their relationship with nature, and if HNR concepts could be of practical relevance for their work. We analysed the transcripts of qualitative interviews in a qualitative content analysis (Mayring 2000) to enhance understanding of the data and corresponding theories (Elo and Kyngäs 2008).

Based on the types and their characteristics defined in literature (Flint et al. 2013 and Table 1) and the adaptation according to the process described above, we ended up with a list of individual statements and a set of seven narratives to portray each type's characteristics. Interviewed stakeholders indicated that narratives provide a more holistic story line, which could be helpful in qualitative, participatory endeavours (see 4.1 and Table 2). Therefore in study 3, which is the basis for the quantitative analyses presented in the article, both the scales and narratives were tested among students from introductory classes from diverse majors at University of Natural Resources and Life Sciences (Vienna, Austria)[1] and Utah State University (Logan, Utah)[2]. We selected the two student groups based on the composition of the research team as well as on the intention to include perspectives across the western world. Although a student sample is not well representing the general population, it allowed us to continuously re-test the scale in a relative homogeneous setting.

[1] BOKU – University of Natural Resources and Life Sciences, Vienna (students from the Bachelor program "Environment and Bio-Resources Management", and "Landscape Architecture and Landscape Planning")
[2] USU – Utah State University (Students in Introduction to Sociology – a general education course)

3.2 The questionnaire

The questionnaire for the third study (focus of this paper) consisted of 5 modules (module 2-5 with a five-point Likert scale). The statistical analysis included statistical relationships using difference of means test, descriptive statistics, and Spearman Rho correlations.

Demographics: We collected basic information about participants' background, such as age, gender, study major, and the setting of their childhood.

Environmental Behaviour: We adopted available items from studies on environmental behaviour in the private sphere (Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management 2014; Statistik Austria 2009; Heyl et al. 2014). Respondents indicated their own behaviour regarding consumption, mobility, energy savings and others such as reducing waste on a scale ranging from "never" to "always". Being aware of possible biases due to the desire to exhibit internal consistency between values, HNR and behaviour, we situated the behaviour module prior to the HNR and value modules.

HNR narratives: Respondents were asked to judge to which extent each of the seven HNR narratives applies to them, using a scale from "does not apply" to "fully applies".

Values: We adopted items from the shortened 'Portrait Values Questionnaire (PVQ)' (Schwartz et al. 2012) as it was found to support assessing respondents' values more indirectly (Fotopoulos et al. 2011). The PVQ consists of short verbal portraits of different people, each describing goals, expectations and wishes of a person that implicitly point to the importance of a single value type (Schmidt et al. 2007; Fotopoulos et al. 2011; Beierlein et al. 2012). Respondents were requested to compare the portrait (item) to them and mark their reflection on the scale from "not like me" to "very much like me". As the PVQ uses the 3rd person to allow asking (indirectly) for a judgment about others we converted the HNR items to the 3rd person as well.

HNR single statements: We again assessed respondents' HNR, but this time by separating the single statements of the narratives and arranging them in mixed order. The aim of this separation was to test whether HNR can be assessed by narratives as well as by single statements. Respondents were again asked to judge to which extent each of the 26 statements applies to them, using a scale from "does not apply" to "fully applies".

4 Results

This section presents outcomes of the HNR scale development and summarizes the main results of the quantitative student surveys (study 3). Results from qualitative interviews (study 1, see Figure 2) underpin the results in our discussion. The sample size presented in this paper was 402 (45% BOKU, 55% USU). The average age of the respondents was 21 (38% male, 62% female).

4.1 HNR typology and scale development

As basis of the investigations we screened numerous journal articles and book chapters and synthesized empirically grounded typologies of HNR, in particular the HaN Scale of de Groot and van den Born (2007) and the philosophical discourses of Zweers (2000). The most frequently used HNR typologies emphasize the following types: 'Master', 'Steward', 'Partner', and 'Participant' (Zweers 2000; de Groot and van den Born 2003; de Groot and van den Born 2007). In the course of our three studies, we expanded the typology as we saw three types missing (Table 2).

First, we included a type that represents the dominant contemporary discourse in resource management – the Ecosystem Services (ES) concept. While initiated by people with conservationist goals, it was directly intended to motivate action by tapping into utilitarian motives and the notion of people using nature or benefitting from a well-functioning nature (Flint et al. 2013; Raymond et al. 2013). The ES literature is contradictory and often linked to

the societal level, while HNRs are mostly conceptualized at the individual level (Flint et al. 2013). Therefore, we integrated elements of the ES concept as a separate HNR type and labelled it as 'User'. We followed Flint et al. (2013: 214) who found that "[…] the predominant articulation of ES fits in the nexus of anthropocentrism, utilitarianism, and notions of nature as separate from humans".

Second, we incorporated the notion of 'Apathy' with regard to nature. Apathy suggests that a relationship with nature may not at all be important or recognized by people. Thompson and Barton (1994), Bauer et al. (2009) and Chan et al. (2012) report the existence of this HNR type.

Finally, we also introduced the 'Nature Distant Guardian', who sympathizes with nature – yet with less direct engagement. We observed in our qualitative interviews that people living in cities sometimes felt less directly connected with nature, whether intentionally or not. Similarly Bauer et al. (2009: 2914) identified the "nature sympathizers" as a type that is environmentally less concerned or less active with regards to nature, but still shows biophilia attitudes towards nature.

Reflecting on the wording turned out to be the most crucial part of developing the HNR scale. During the qualitative interviews, the initial wording of the narratives, in particular those for Master and Participant was perceived as "black-and-white thinking" and too normative. We identified narratives with interconnected, inconsistent or strong normative statements that interviewees struggled with. We subsequently increased consistency and excluded particularly positive and negative connotations.

4.2 HNR types among students

As Figure 3 illustrates, students in Austria (BOKU) and Utah (USU) associated themselves with HNR types of Steward, Partner, Participant, and User and less with types of Apathy, Master and Nature Distant Guardian. No Austrian student and only 6.4% of the US re-

spondents indicated that an apathy relationship with nature 'applies' or 'fully applies' to his/her relationship with nature.

However, Figure 4 shows respondents indicating 5 on the 5 point Likert Scale on each of the HNR types; the respective line indicates the average score on the other types. This is a key finding of our research as it shows (1) that people hold multiple HNRs and (2) that people identify with all HNR types apart from Apathy and Master. Respondents identifying with statements of the Master rarely found themselves in agreement with statements from other HNR types. However, respondents agreeing with Apathy identified to some degree with Partner and Participant oriented statements.

We also tested the trade-offs between assessing HNR by narratives or single statements. The Cronbach's alpha for reliability for most single statements was high (> .6), considering the small number of items per group (de Groot 2012: 6). Reliability scores were somewhat lower for User (.43), Master (.52) and Nature Distant Guardian (.55). However, we found significant enhancements of the alpha scores when the forth item of User (.55) and the third item of Master were excluded (.56). The factor analysis showed that single statements did not always perfectly load into the associated narratives. Whereas master, apathy, nature distant guardian and user seem to be well described, the factor analysis of our sample showed overlaps between the descriptions of guardian, partner and participant.

4.3 Correlations of HNR with environmental behaviour and values

We calculated Spearman Rho correlations between HNR narratives and environmental behaviour and between values and environmental behaviour to assess whether both scales (HNR, values) reveal similar links with environmental behaviour and whether specific relationships towards nature correlate with specific values.

Table 3 lists correlations between items of HNR and environmental behaviour with significance levels of $p < .001$ (***), $p < .01$ (**) or $p < .05$ (*). Three items are control variables

and have to be interpreted inversely. Basically, the HNR types of Apathy, Nature Distant Guardian and Master correlate negatively with pro-environmental behaviour (see section 2.1), whereas User, Steward, Partner and Participant show positive correlations. Students with an apathetic relationship towards nature were least likely to indicate pro-environmental behaviour. We found the highest significant positive correlations with pro-environmental behaviour – particularly regarding food and energy – for the Steward and Participant types.

Correlations between values and pro-environmental behaviour were less strong, yet values of self-direction, universalism and benevolence correlated positively with pro-environmental behaviour. A tendency towards negative correlations was found for values of conformity, tradition, security, power and achievement.

Our data indicate that HNR and values are remarkably compatible (see Table 4). HNR types of Apathy, Nature Distant Guardian and Master correlated positively with significance levels of $p < .001$ (***), $p < .01$ (**) or $p < .05$ (*) with values of security (seeking for safety, harmony, and stability of society), power (enjoying prestige and control or dominance over people and resources), tradition (preserving the world order as it is) and conformity (restrain of actions, agree with laws and norms). In contrast, the HNR types User, Steward, Partner, and Participant correlated positively with values of self-direction (enjoying independent thought and action), universalism (supporting welfare of all people and for nature) and benevolence (seeking to enhance and provide general welfare to others).

5 Discussion

In this section we focus on those results that contribute to the three knowledge gaps identified in the introduction.

5.1 HNR types identified with narratives and single statements among students

We identified similar distributions of HNR types as described in literature. Not many respondents in our quantitative assessment ascribed to the concepts of Apathy and Master (Figure 3). As found previously in qualitative interviews, interviewees did not identify with the Master, but when asked to reflect about society in general, they often indicated they view the Master as a dominant relationship people have with nature. Some interviewees indicated that the rare identification with the Master might be the result of socially desirable response pattern and a certain embarrassment of being categorized as one of these 'negative' types. This, however, is in line with the definition of HNR we presented in section 2.2: HNR is a view "[…] people hold about their appropriate relation with nature" (van den Born 2008: 87). Similarly, interviewees from water management stated that they are longing for the immaterial world, while living in a very material world. Therefore, they did not identify with Apathy and Nature Distant Guardian. Similarly, Bauer et al. (2009: 2918) found the rejection of "nature sympathizers" (similar to our Nature Distant Guardian) and Apathy.

The discrepancy between people's desired relationship with nature and their practiced behaviour was discovered in other studies as well (de Groot and van den Born 2003; de Groot and de Groot 2009; de Groot et al. 2011). Zheng and Yoshino (2003) explain the increasing rejection of the Master in a longitudinal study of Japanese's attitudes to nature over the last 50 years as a consequence of a growing environmental awareness in industrialized societies. Their research in countries with high economic development and a number of environmental accidents shows how a superior relationship towards nature decreased over the past half century. This could be due to the fact that a higher level of economic development comes along with an increased demand for environmental quality (Zheng and Yoshino 2003). Other scholars, however, see the Master well represented in western or industrialized societies (Schroeder 2007; van den Born 2007).

The results further support conclusions of Teel and Manfredo (2010) that HNRs are not mutually exclusive. As Figure 4 shows, HNRs in our sample are interconnected; students hold multiple relationships towards nature respondents. Those who identified with the Master for instance also identified with statements of the User, Steward and Partner. Putting individuals in one specific category is not possible, but also not the aim of exploring HNR.

One of our goals was to test if more holistic narratives can substitute for a long list of single HNR-statements. But the Cronbach's alpha identified some inconsistencies among statements of some HNR types. These critical items need further revision or might be excluded to increase reliability of the scale. However, this points at the risks associated with narratives, such as inconsistent HNR components combined to types that do not reflect the respective context. For an accurate measurement of HNR in quantitative analyses, single statements provide more detailed information, and should therefore be the preferable option. On the other hand, in study situations with pre-existing reflection on HNR, narratives can be useful for participatory research, education, and management processes (e.g., role play games, focus groups).

5.2 The connection between HNR and Environmental Behaviour

Following Kellert et al. (1993) and Tidball (2012) we identified correlations between psychological concepts related to nature and environmental behaviour. The HNR types of Apathy, Nature Distant Guardian and Master were found in this study to correlate negatively with pro-environmental behaviour, whereas Steward, Partner and Participant correlate positively. This shows the linkage between the respondent's affiliation to these types and their environmental behaviour. Correlations with pro-environmental behaviour were rather ambiguous and weak for the User, which we framed to mirror the ES concept with utilitarian notions of a well-functioning nature providing benefits to humans. According to Fairhead et al. (2012) and Raymond et al. (2013) the ES approach could even promote an exploitative

relationship with nature and consequently contradict other HNRs. This concern is particularly relevant, as at the EU level the ES concept is integrated in the management of natural resources (e.g. in the Biodiversity strategy).

The results reveal stronger correlations of the HNR scale with pro-environmental behaviour than with Schwartz's value scale. Still, we found some positive correlations with pro-environmental behaviour for values such as self-direction, universalism and benevolence, and negative correlations for values of conformity, tradition, security, power and achievement. These findings are very much in line with Schwartz (2012) and others (e.g. Karp 1996; Nordlund and Garvill 2002; Steg et al. 2011; Jonsson and Nilsson 2014; Hurst et al. 2013). We do not conclude that the HNR scale is better linked to environmental behaviour, but we perceive HNR as possibly thematically closer to environmental behaviour than values. Values are more general and thus supportive in exploring general human behaviour (de Groot et al. 2012; van der Werff et al. 2013). Schwartz's Theory of Basic Values does not clearly distinguish between altruistic and biospheric value orientations (de Groot and Steg 2008). But, as this study shows, HNR and values are interconnected. Therefore we believe that HNR may contribute to a better understanding of the complexity of environmental behaviour.

As people seem to hold multiple HNRs simultaneously, addressing the relationship humans have with nature might be a supportive approach for governance strategies. This is particularly relevant as we found HNRs correlating with behaviour as well as underlying values. Therefore, the HNR approach might have its strengths, as changing values in the short-term is challenging (Crompton 2010; Chilton et al. 2012; Bolderdijk et al. 2013; Hurst et al. 2013; Price et al. 2014). In addition, interviewees emphasized that including HNR in communication and awareness raising projects may support reflections and discussion on peoples' relationship with nature. According to Liu and Lin (2015) this is crucial for change to happen. Stakeholders of participatory processes in water management see the HNR approach for ex-

ample as a potential auxiliary means to improve mutual understanding and consolidating different interests.

6 Conclusion and Further Research Needs

In this article we addressed conceptual uncertainties related to a typology of human-nature relationships (1st knowledge gap), uncertainties how to assess them (2nd knowledge gap), and finally explored if human-nature relationships are linked with environmental behaviour (3rd knowledge gap). The results for the narratives and single statements show that both approaches are suitable to empirically identify HNR. Furthermore, the series of studies indicate that the HNR scale is applicable in both qualitative and quantitative research.

Promising as the results are, the present study has its limitations. First, the terminology was particular challenging as we were working in both English and German languages. Relatedly, framing a scale that is general enough to support surveys in different contexts limited flexibility in wording. Second, the sample of the quantitative survey was a homogenous student group. While this ensured feasibility, relative homogeneity, and allowed us to continuously re-test the scale, further research needs to test the applicability of the HNR scale and its link with nature conservation behaviour, environmental behaviour in other contexts, and beyond student populations. When using our scale in future surveys we encourage scholars to identify single statements that might need context-specific adaptation. Furthermore, the overlapping of certain HNR types could confirm the assumption that HNR are not mutually exclusive, but could also indicate scope for statistical dimension reduction.

To conclude, the HNR typology highlighted in this paper was derived and tested in an iterative process of literature review and exploratory research. The respondents and interviewees widely negated a dominative relationship towards nature. HNRs are not mutually exclusive and it seems that geographical contexts and student majors or interests have minor effects on the relationship students have with nature. Particularly promising for further re-

search is the clear interconnection between the relationship humans have with nature and their environmental behaviour. As HNRs might be more dynamic than values and more clearly linked with environmental behaviour, we might benefit from future research on how to activate or strengthen HNRs by governance strategies and communication framing. If we understand this, we might be better able to rebalance the relationship of humans with nature.

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8 Tables

Table 1
HNR dimensions (Flint et al. 2013: 210)

DIMENSIONS	CHARACTERISTICS
Positionality dimensions	Anthropocentric/ecocentric
	Humans/nature above
	Humans part of/separate from nature
Character of bond dimensions	Intention of action
	Biophilia/biophobia
	Responsibility/rights
	Role of technology
	Spirituality
	Instrumental/intrinsic
	Connectedness/apathy
Understanding of nature dimensions	Mode of learning
	Fragility/resilience
	Predictability of nature

Table 2
Narratives portraying each HNR type's characteristics

HNR TYPE	HNR NARRATIVE (SCALE)
Master	They think they have the right to alter nature. Technological progress enables them to tame and improve upon nature. They believe they have the right and obligation to protect themselves from natural threats.
Steward	They think their actions may have an impact on nature. They feel responsible to protect nature. They think that mankind can be a threat to nature. They would like technological interventions to be regulated to minimize negative effects on nature.
Partner	Nature is important and enjoyable for them. They try to understand natural processes to reflect on their influence on nature. According to them technological interventions are allowed only in case both humans and nature benefit. In their opinion humans and nature are of equal value.
Participant	They feel as part of nature. The physical and emotional bond between self and nature is important for them. They think that too few humans recognize the power, value and beauty of nature. According to them they do not have the right to use technology to alter nature.
User	They perceive nature as a provider for products and services. In their opinion natural processes enhance economic welfare. They think they have the right to use nature and to enhance natural service provision with technology. They feel responsible to protect nature for today's and future generation's welfare.
Apathy	In their daily life nature does not play a role. They think they are not dependent on nature to survive. In their opinion their behaviour does not have an impact on nature. They think that engagement for nature should not be given too much weight.

Nature Distant Guardian	Pets, houseplants or urban gardening may substitute their direct experience in nature. Exclusive engagement in nature protection through media is enough for them to connect with nature. An environmentally oriented lifestyle may help them to become part of nature without having to leave the city.

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Table 3
Positive (**bold**) and negative (*italic*) correlations between HNR narratives and statements on environmental behaviour (n=402)

	Statements on environmental behaviours	HNR narrative (correlation coefficient)						
		Master	Steward	Partner	Participant	User	Apathy	NDG
Food	I buy organic/environmentally friendly products.	*-.166***	**.339****	**.259****	**.229****	.035	*-.320****	*-.117**
	I buy regional and seasonal food.	-.009	**.224****	**.185****	**.241****	**.166***	-.071	.016
	I eat vegetarian or vegan food.	*-.142***	**.249****	**.180****	**.258****	-.045	*-.185****	-.041
	I try to diminish packaging when buying products.	*-.107**	**.242****	**.269****	**.216****	.013	*-.223****	-.044
Mobility	To reach my holiday destination I take the airplane.	.054	**.147****	.031	-.028	.026	-.002	**.128***
	I take a car for my free time activities.	.072	*-.379****	*-.168***	*-.148***	-.074	**.334****	.082
	I go to university by foot, bike or public transport.	-.073	**.293****	**.164***	.038	**.099***	*-.265****	*-.163***
Energy	I turn the lights off when leaving the room.	-.05	**.227****	**.142***	**.191****	.098	*-.169***	-.081
	I use energy-efficient devices.	.058	**.107***	.078	.084	**.153***	-.08	-.025
Others	I try to convince my friends and acquaintances to change to a green electricity provider.	-.08	**.110***	**.146***	**.200****	-.037	-.079	.09
	I like to buy new clothes.	**.119***	*-.223****	*-.105**	*-.129**	-.004	**.316****	**.172***
	I support a non-governmental organization engaged in nature protection (e.g. World Wildlife Fund).	-.085	.087	**.205****	**.179****	-.017	.028	.087
	I sort my garbage to separate it from recyclable material before discarding it.	*-.106**	**.237****	**.197****	**.131***	**.142***	*-.271****	-.053

*p < .05; **p < .01; ***p < .001;
… inverse defined variables

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Table 4
Positive (**bold**) and negative (*italic*) correlations between HNR narratives and Schwartz values (aggregated mean values) (n=402)

VALUES	HNR NARRATIVES (correlation coefficient)						
	Master	Steward	Partner	Participant	User	Apathy	Nature Distant Guardian
Self-direction	.017	**.176*****	**.105***	**.157****	**.120***	*-.106**	.055
Universalism	-.099	**.420*****	**.349*****	**.292*****	**.129***	*-.253****	-.069
Benevolence	.019	**.104***	**.147****	**.106***	**.101***	-.042	.048
Conformity	**.220*****	*-.230****	*-.131***	-.065	.032	**.347*****	.096
Tradition	.054	*-.197****	*-.109**	*-.101**	-.034	**.240*****	.06
Security	**.193*****	-.068	-.017	-.005	.098	**.188*****	**.227*****
Power	**.228*****	*-.152***	-.098	-.079	.09	**.284*****	**.121***
Achievement	**.113***	.001	-.009	.015	.094	.085	**.186*****
Hedonism	-.034	**.152****	.029	.075	.007	-.066	**.117***
Stimulation	.035	.096	**.104***	**.150****	-.007	.063	**.107***

$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

9 Figures

Figure 1
Comprehensive Model of existing socio-psychological theories with embedded HNR theory (RQ1, RQ2 and RQ3 illustrate the three research questions, VNB…Value-Belief-Norm, TPB…Theory of Planned Behaviour)

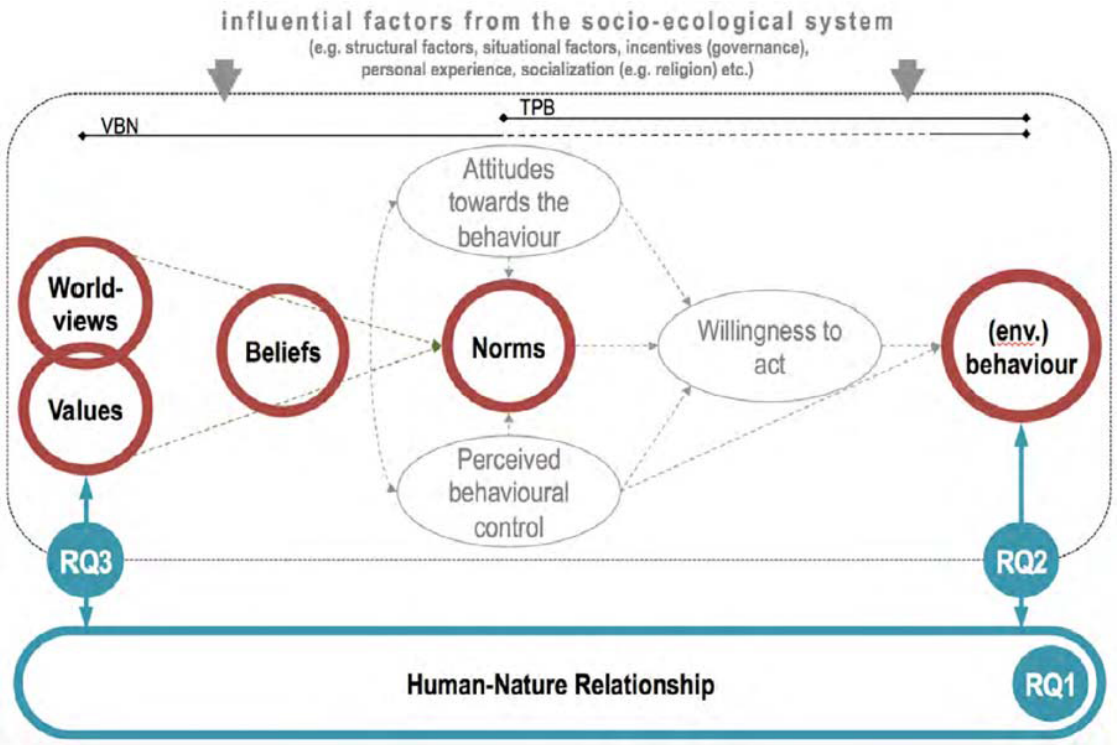


Figure 2
Overview of the HNR scale development process preceding study 3 that is presented in this article (PVQ…Portrait Value Questionnaire (Schwartz et al. 2012))

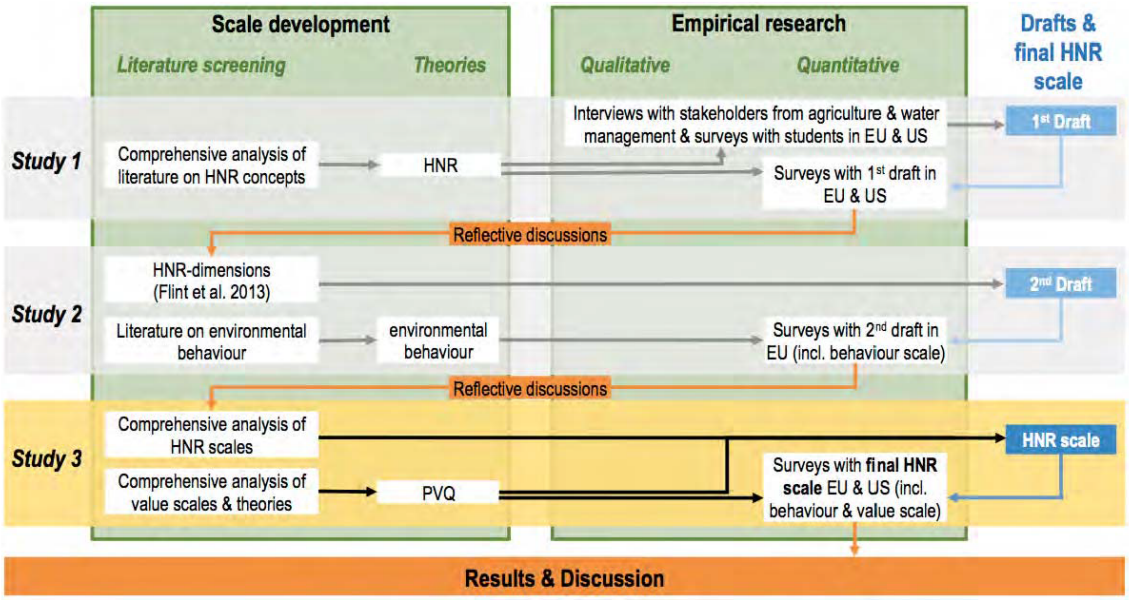


Figure 3
Distribution of HNR types among students (Austria/EU, BOKU: n = 182, Utah/US, USU: n = 220)

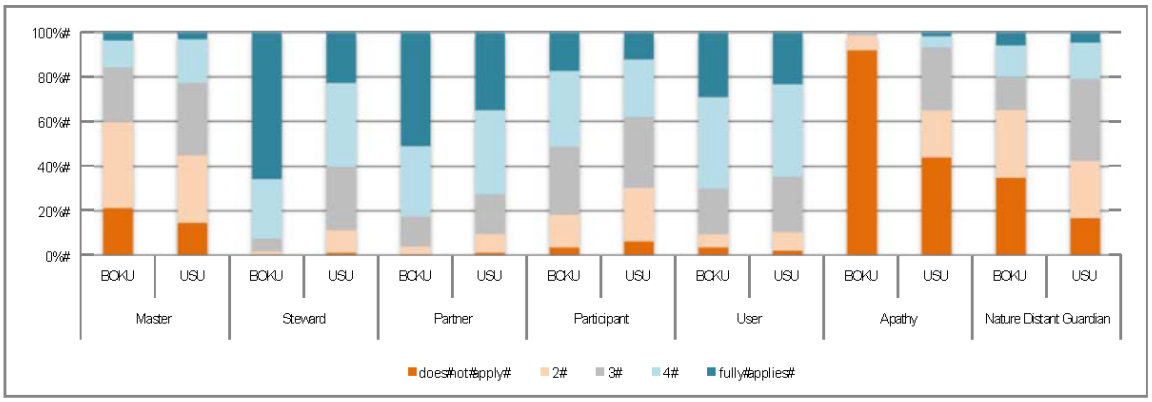
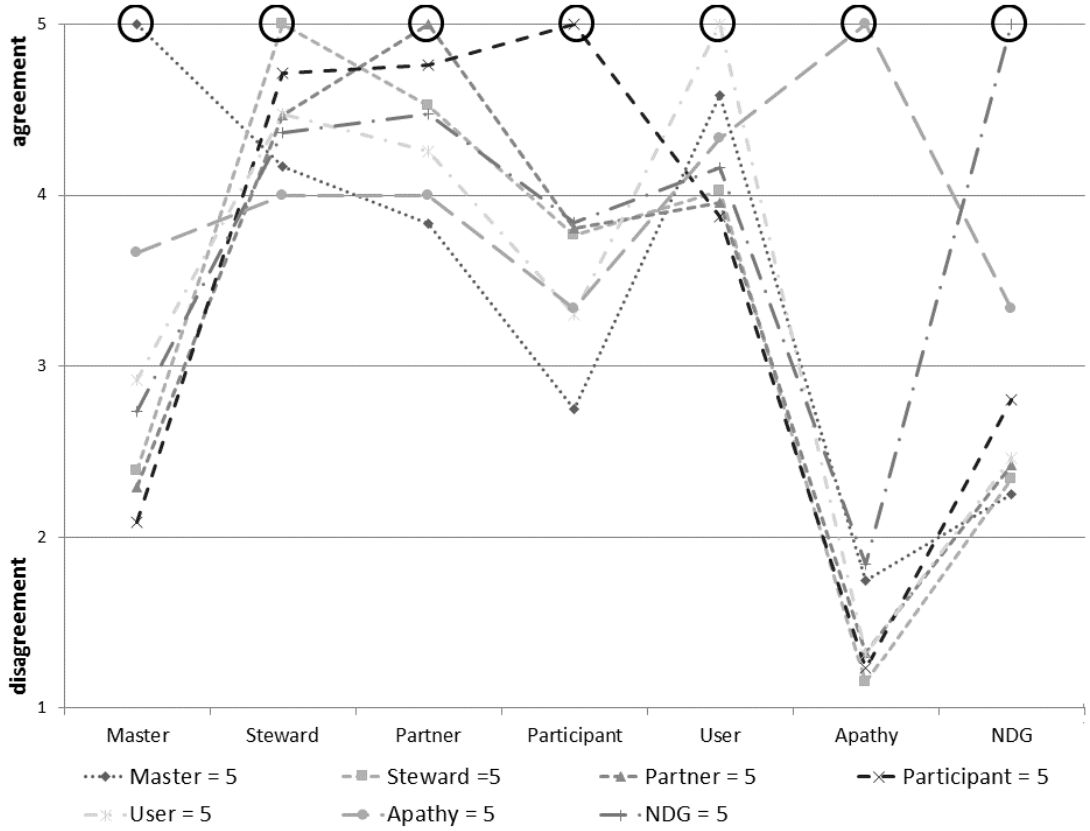


Figure 4
Respondents hold multiple HNRs. Each line belongs to respondents' who strongly identify themselves with a certain type (=5). The circles mark the respective HNR type that the dotted lines represent (arithmetic means, Master n=12; Steward n=167; Partner n=166; Participant n=56; User n=101; Apathy n=3; NDG n=19; Total n=402)



4.7 Article #7

Mastery over Nature as a Paradox: Societally Implemented but Individually Rejected

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In contrast to the reality of global industrialisation, research on individual understandings of the human-nature relationship shows low acceptance of the concept of human Mastery over nature. In qualitative interviews (n=25) we investigated how actors from river landscape management in Austria perceive this paradox. Results indicate the actors who in their professional life act in the sense of Mastery over nature often interpret their role as stewardship. Surveys need to be interpreted cautiously with regard context sensitivity, particularly regarding differences between the private and the professional sphere of a perso Social desirability bias and insufficient wording of narratives can affect results significantly. We suggest to address these issues in research designs and to develop tools for group-based reflection of human nature relationship within planning and governance processes.

Keywords: human-nature relationship; river management; human dominance over nature; social desirability bias;

Mastery over Nature as a Paradox: Societally Implemented but Individually Rejected

Introduction

Mastery over nature as a socio-cultural concept

Empirical research of human-nature-relationships uses a variety of categories, metaphors and narratives to describe the individual understanding of a person's relationship to nature. These categories are all rooted in traditional narratives that evolved parallel to the biological and cultural development of mankind (Eder 1996) and have been extensively reflected in religious and philosophical texts as well as in works of art.

In the context of environmental planning and natural resource management, current research focuses on the development of categorisations based on contemporary interpretations of traditional narratives (Buijs 2009; van den Born et al. 2001; Bauer, Wallner, and Hunziker 2009; de Groot and van den Born 2003; van den Born 2008), on refining methods to assess individual understandings of the human-nature relationship (Braito et al. in print; van den Born 2006), and on linking these understandings to actual behaviour (Buijs et al. 2012). For an overview of concepts and models see the introductory article of this special issue (Muhar et al. forthcoming).

In a review of contemporary categorisations, Flint et al. (2013) identified typical dimensions that are used to describe different types of human nature relationships: (1) the positionality between man and nature (humans above nature, humans as part of nature…), (2) the understanding of nature itself (unpredictable, fragile, predictable, resilient..) and (3) the character of the bond between humans and nature (utilitarian, spiritual,….).

Typical categories in such classifications refer to humans as masters (dominators), stewards, partners, participants, or users of nature. As today nature does not play a significant role in some people's lives, in particular in urban environments, also a category of apathy can be useful to describe the individual understanding of the human-nature relationship and to explain their environmental behaviour (Bauer, Wallner, and Hunziker 2009).

Our paper focuses on one particular concept of the human-nature relationship: Mastery over nature. In scholarly literature, the wordings of the associated narratives are slightly different, yet they mostly describe man as superior to nature, capable and entitled to control nature in the sense of improving nature's productivity in order to provide food and other resources for humans, and to reduce the risk from natural hazards such as floods or pests.

Cultural rooting of the Mastery concept

In the European cultural history, Prometheus is the symbol of Mastery over nature (Small and Jollands 2006). According to the ancient Greek mythology, Prometheus was able to capture and control fire and he passed this ability over to humans in order to reduce their dependence on the goodwill of gods. Thus Prometheus can be regarded as the prototype of an engineer on the interface between the natural and the social system.

Today's global industrialisation is a consequence of developments that were initiated in Europe in the second half of the 18th century. It has often been argued that the Judeo-Christian understanding of the human-nature relationship, in particular in the Protestant interpretation, was a significant foundation for industrialisation. In 1905, German Sociologist Max Weber published his seminal work "The Protestant Ethic and the Spirit of Capitalism", where he argues that the rather rational character of

Protestantism with a strong focus on the virtues of work fostered and justified industrialisation and the systematic exploitation of natural resources (Weber 2002).

Since the early days of the modern environmental discourse, the anthropocentric understanding of the human-nature relationship in Christianity was accused for having prepared the ground for environmental pollution and depletion of natural resources (White 1967; Eder 1996; Drewermann 1981). In fact, the creation mandate in The Bible clearly communicates an understanding of human Mastery over nature:

> „..and God said unto them, be fruitful, and multiply, and replenish the earth, and subdue it: and have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth" (Genesis 1:28).

While in the ancient Greek mythology Prometheus had stolen the fire from the gods in order to make humans independent from divine mercy (and for this act himself had been cruelly punished by the gods), here mastery over nature is presented as a divine mandate.

However, not only Mastery over nature, but also other understandings of the human-nature relationship can as well be justified as rooted in the Christian religion: Contemporary environmental theology interprets the creation mandate rather as a mandate for responsible use of natural resources in the sense of a Stewardship relationship (Irrgang 1992; Nelson 1993), and many prominent environmentalists explicitly refer to their Christian faith when explaining their motivation for engagement. Therefore, over the course of the environmental debate from the mid-1960s until today there has been observed a "greening" of Christianity.

Yet, empirical studies from the fields of practical theology reveal that identification of individual people with the concept of Human dominion over nature is higher within Judeo-Christians compared to Non-Judeo-Christians (Hand and van Liere

1984). However, it varies between followers of different Christian denominations. In an investigation of Australian churchgoers, Pepper and Leonard (2016) found that Catholics were less likely to believe in human dominance over nature compared to Protestants or to other rather Evangelical denominations. Also in a study across 22 European countries, Hagevi (2014) found higher degrees of environmentalism with Catholics and Eastern Orthodox compared to Protestants.

A key determinant in this context seems to be the understanding of the Bible as either the literal word of God or rather as a text that had been written by humans and needs therefore to be interpreted in a symbolic way. In a study in 22 countries across the Americas and in Spain, Schultz, Zelezny, and Dalrymple (2000) found a significant correlation between biblical literalism and anthropocentric environmental concerns. Village (2015) reports a similar correlation between biblical literalism and understanding of human mastery over nature for Protestant churchgoers in the UK.

A second, rather secular line of discourse regarding mastery over nature is connected with the rationalistic ideals of the Age of Enlightenment, beginning in the late 17th century. Of course influenced by the principles of the Christian creation mandate, in this discourse nature has been regarded as something chaotic that needs human intervention to provide structure and order (Gill 2003; Wolloch 2011). Once humans are able to understand and describe the physical principles behind natural phenomena ("The Laws of Nature"), mankind can take over control of natural processes in order to make resources accessible and to increase productivity (Leiss 1974). In 1828, the English engineer Thomas Tredgold defined engineering as the "art of directing the great sources of power in nature for the use and convenience of man" (Mitcham and Schatzberg 2009). This directing, or rather taming of nature is not only reflected in mere physical control, but also in a shaping of natural objects into regular structures, as best

illustrated in the geometric design of Baroque gardens with their straight layout and trimmed trees.

Mastery over nature as global reality

In today's industrialised and globalised society, the concept of Mastery over nature has been largely implemented: Based on scientific and technological progress, human activities are either intentionally or accidentally affecting most components of the natural system at all levels of scale, from changing the composition of the atmosphere at the global level, via the modification of land cover on landscape level, down to manipulation of the genome at the cellular level and even further down at the atomic level, where new chemical elements have been created which had not existed before in nature.

The endeavour of mastering nature is reflected in associated terms such as geoengineering, landscape engineering, genetic engineering or nuclear engineering. Technologies that have the potential to put mankind into a god-like position are sometimes referred to as "Promethean technologies" (Anshelm and Hansson 2014; Hopkins 2002). The impact of one single species on all scale levels is regarded as unprecedented in the history of the earth system, this is why it has been suggested to name this period the "Anthropocene" (Crutzen 2002; Waters et al. 2016).

Rejection in empirical studies

There is a paradox contrast between this societal reality and the acceptance of the Mastery concept on the individual level in the context of research on natural resource management. Many empirical studies from different cultural and geographic contexts reveal that only a small minority of study participants personally identify with this concept, typically less than 20% (de Groot, Drenthen, and de Groot 2011; Braito et al.

in print; de Groot and van den Born 2007; van den Born et al. 2001).

Most of the cited studies are snapshots, each of them implementing a particular research design with specific wording of the narratives, and conducted at a single point in time without repetition after a certain period. Therefore, it is quite difficult to compare them against each other in order to detect temporal trends over the past decades. There is however one interesting long time series of data on the attitudes towards nature as part of the Japanese National Character Survey, where the same set of questions has been asked since 1953 (see Fig.1). This series shows a significant and continuous decline of the acceptance of a statement related to Mastery over nature since the 1970s, in line with the rise of the environmental consciousness (Zheng and Yoshino 2003).

(place Fig.1 about here)

Objectives of the paper

While many authors of the studies cited above explicitly point at the surprisingly low acceptance scores of the Mastery concept, we could not yet find any in-depth investigation of the reasons for this overwhelming rejection. Experiences from our own earlier research and accounts from discussions with colleagues at various conferences indicated that interviewees confronted with questions regarding mastery over nature often reacted in a quite emotional way; they would not only state that they do not identify with this concept, but they would rather explicitly reject it. We had also noticed that even persons who in their professional life do have a role as "Masters of nature" (e.g. engineers in the hydropower industry) would in interview situations personally not identify with this concept. This altogether was the starting point for our investigation. Our main questions were:

- How do people perceive and interpret the discrepancy between their own individual rejection of the Mastery concept and the societal implementation?
- How do persons who in their professional life exert significant influence on ecosystems interpret their role as Master over nature?
- What is the effect of the research method implemented in such studies? How do narratives describing mastery over nature as used in surveys relate to people's individual understanding of the concept?
- How can a discussion of the Mastery paradox be used to reflect behaviour and actions in natural resource management?

Study case and methods

Our study sample was drawn from actors involved in river management in the Austrian federal province of Carinthia, in particular related to flood protection, agriculture, recreation and hydropower use of the river Drau, one of the largest rivers in Austria. We selected this study case out of the following reasons: (1) The effects of river management measures on the bio-physical system are clearly distinguishable for both experts and laypersons, as opposed to other rather invisible interventions such as genetic manipulation or CO_2-emission. (2) Rivers provide many services for society, such as water supply, fishery, recreation, but also pose potential threats, in particular due to floods. Thus river management is inherently challenged to find a balance between allowing for natural dynamics and protecting human assets. (3) In the particular study case of the Drau valley there is a well-established culture of participatory river management planning, where stakeholders from many different domains have been involved over a long time. Therefore, the discussion of the individual understanding of the human-nature relationship could also be used as a reflection of the behaviour in

planning processes. (4) The study region had been included in a previous quantitative survey of the individual understandings of both actors in river landscape management and the general population regarding the human-nature relationship (Walker-Springett et al. 2016).

That study had used six different categories (see Tab.1), and participants were asked in the questionnaire to indicate on a 5-tier Likert scale, to which extent they personally identify with each category.

(place Tab.1. about here)

The results of that survey were in line with most of the studies cited above: There was a strong rejection of the Mastery and the Apathy concept, and a high acceptance of all other categories, with the highest scores for Steward and User (see. Fig.2). Further, individual study participants did not only identify with one single category, but rather with a whole bundle, as also observed by Braito et al. (in print). For this paper we conducted qualitative interviews with 25 actors regularly engaged in river management processes. The interview partners were recruited from different domains such as hydropower energy, flood protection, nature conservation, fishing, agriculture, planning and politics. Reflecting the actual situation in this thematic field in Austria, most of the interview partners (23) were male.

Fig.2 illustrates the results from the above mentioned previous survey (Walker-Springett et al. 2016), detailed for selected stakeholder groups. There was very little differentiation between the various groups, with only a slightly lower acceptance of the Stewardship category by stakeholders from agriculture, water management and hydropower, however, the differences were smaller than expected and hence a good starting point for the interviews.

(place Fig.2. about here)

The interviews were conducted face-to-face, recorded and transcribed. Subsequently we conducted a qualitative content analysis using the software "Atlas.ti". Analysis categories were both derived deductively from literature analysis and preceding expert discussions, and inductively from the material itself.

Results

The duration of the interviews was between 25 and 60 minutes, and in many cases the interview partners not only answered questions by the interviewer but also raised questions and addressed new issues themselves, which resulted in a vivid and stimulating dialogue. In this section we both use literal quotes and also paraphrase and summarise the course of the discussions, which resulted in the following aspects:

Interpretation of Mastery as Stewardship

Some respondents who in their daily life act in the sense of Mastery over nature, e.g. in the field of hydraulic engineering and hydropower construction, interpret their activities rather as stewardship in the sense of caring for nature via their interventions in biophysical systems. An interviewee from a hydropower company for instance stated:

> "Although energy producing companies master nature to a certain extent – if rivers are forced in pipes there is some truth behind this – I do not understand my official duties like that. We lend the water, we take the energy from it that was put into it through the sun. The potential energy is withdrawn and then we give it back again as intact as possible. That is a different approach than mastering and putting the water in pipes."

Also interviewees from the field of agriculture and forestry saw themselves rather as nature users or stewards. This was explained by other actors with a missing understanding of this role.

> "When farmers talk about nature they would probably say that they are part of nature but in their worldview they are men of action. It is their property and not nature."

None of the interview partners referred to the religious or cultural rooting of the Mastery concept.

Context sensitivity

Discrepancy between private and professional sphere: Many respondents pointed at discrepancies between their private understanding of the human-nature relationship and the conditions under which they conduct their professional life, which force them to act rather according to the Mastery concept. An interviewee from the field of nature protection for instance argued:

> "In your job you often have to put your personal opinion in the second place as you will fail otherwise. You have to make compromises so often, that is a strategy for survival. It may be different in the private life but in the professional life you become a pragmatist."

Another interviewee mentioned that arguments based on the Mastery concept are most likely used in official proceedings, while arguments based on Steward, Partner or Participant are not tangible and could even be a reason for not being taken seriously. He argued that people expect "hard facts" based on the Mastery level, while arguments based on emotions and morality would probably not count. These situational factors need to be considered when relating human-nature relationship scores from quantitative scales to actual behaviour.

Situational aspects: The interviewees sensed certain differences with regard to different contexts. An interviewee for instance regarded the contrast as due to the "schizophrenic zeitgeist". While on the one hand people want that nature is protected, this moves into the background when it is about the single person's economic welfare. In the context of river landscapes, interviewees noted that somebody who knows a river just from recreational activities will most likely have a different approach towards the river than someone who is living in an area prone to floods. In the context of natural disasters that are threatening human lives the idea of banning natural threats and domination of nature is more obvious. One interviewee also stated:

> "In case urgent flood control measures need to be taken, ecological aspects are ignored. In this case humans clearly stand in the foreground".

Another interviewee from water management and torrent control noted:

> "Everything changes when nature starts being dangerous. Then nature has to be controlled. Although it is beautiful living next to a stream, if an avalanche goes down or the stream overflows then people say: 'we do not want that much nature'".

Discrepancy between perspectives

Discrepancy between people's vision and reality: The strong tendency towards Steward, Partner and Participant was tried to be explained with a certain longing for correspondence with these types. Interviewees for instance stated that people suffer from the lack of naturalness and wish not to dominate nature:

> "As we have a highly material world there is an idealized longing for the immaterial world. This explains why people like to see themselves there although they are acting in a completely different way."

Discrepancy between self-reflection and reflection through others: When interviewees

were asked to reflect on typical actors in river landscape management that could be allocated to the Master type, they first named water engineering, flood protection, hydropower, agriculture, forestry and (ski) tourism. The term Master was associated with "hard-core technicians". It was suspected that in particular those people who profit from nature without having to interact with nature directly do not develop a feeling for it anymore. However, when reflecting upon themselves those groups most often fiercely rejected the Mastery concept.

Effect of interview situation

Social desirability: Due to current discourses on sustainability, interviewees often feel that an identification with the Mastery concept is regarded as inappropriate. While acting according the Mastery concept is part of our daily lives, people do not want to be described as dominators of nature. While it was seen as proper to say that one lives "in harmony with nature" the term Mastery was perceived as having a negative connotation. An interviewee for instance stated:

> "When you are asked about nature it is rather embarrassing to be categorized as "Master". There is a certain fear of making a bad impression when saying that you are distanced from nature or master over nature."

An interviewee also pointed to a major rethinking in society over the past 25 years:

> "While in the past a majority of the population would have said that nature has to be controlled and the term "ecosystem" caused negative associations, society's awareness for nature raised. Nowadays nature protection has a positive connotation."

Wording of narratives: Small changes in the wording of narratives can cause big differences in the results. In various interview situations, in particular during pre-testing of questionnaire formats and different versions of narratives, interview partners stated

that they would identify only with some aspects of Mastery such as prevention of natural hazards but strongly oppose to others such as genetic modifications. This led to a high number of "neutral" answers. In particular the first versions of the narratives were seen as a bit tendentious and as supporting "black and white" thinking, while the fact that reality is much more complex seemed to be ignored.

Perceived relevance of considering Human-Nature relationship concepts in practice

Perception of the paradox: Interviewees in our study were surprised about the high rejection rate of the Mastery concept in previously conducted quantitative surveys. They would have expected more identification with the Master and the User type. One interviewee actually used the term paradox when explaining that the society as a whole is dominating nature more and more while the single person is seeing her/himself not as "dominator" and not as part of this society.

Most interview partners stated that multiple understandings of the human-nature relationship can be found in negotiations related to nature protection issues.

Limited awareness of people's impact on nature: Interviewees suspected that many people do not have a strong connection to nature and a wrong image of the interlinkages with humans and their environmental behaviour. One interviewee for instance suspected:

> "The single person is not aware of the fact that he lives in a technology centred society. He thinks that he can disconnect from society which is an illusion."

Interviewees stated that it might be the case that people do not see the whole picture and do not associate comparatively small impacts with dominating nature. For instance, there would still exist the opinion among society that small-scale hydropower plants are

good while large-scale hydropower plants are bad. In this context an interviewee noted:

> "People who produce hydropower think that they act environmentally conscious. The knowledge that only the chemical element water is renewable but not the quality of the ecosystem is not very widespread."

Also, it was mentioned that people tend to believe that their whole life is already ecologically compatible if certain aspects are done in a sustainable way (e.g. some square meters in the garden that are cultivated organically) while ignoring those aspects that are potentially harming the environment. Interviewees with a higher degree of self-reflection tended to see themselves more likely as masters. An interviewee from nature protection for instance stated:

> "In my work I always have the problem that this has to do with destroying nature. Even when I am weeding in my garden I am a mini-catastrophe. We are managing our mini-lake in our garden. We want to conserve a toad, this is why we throw out dragonfly larvae and put the tadpoles somewhere else. When I leave nature to its own I do not have any single toad and no tadpole anymore. This is the problem. I am a clear manipulator in my decisions all the time."

Improving mutual understanding: The approach of considering the aspect of human-nature relationships was seen as potentially useful for developing a common language as the basis for development and as a possible tool for alternative planning processes. A scientific view on the issue of human-nature relationships was perceived as a benefit for gaining a deeper insight and allow the scientific realm to consider why certain issues do or do not happen in practice. The concept was seen as a potential auxiliary means to improve mutual understanding and make clear why people act in the way they do. In particular for communication purposes, it was seen as helpful for an internal evaluation of a discussion, weighing different interests and revealing power structures. Reflection of aspect of the human-nature relationship could help to recognize the thought patterns

of others and improve the ability to refer to them. For project leaders it was seen as helpful to know which types he or she has to deal with and which communication strategy would be best to address them.

Raising awareness and motivating people: The human-nature relationship concept was described as interesting approach that could serve as challenge and impulse. It was seen as particularly helpful with respect to raising people's awareness for the way we deal with nature, "which is necessary not only on the surface but on a deeper, scientific basis," as a representative from a planning office worded it.

As people's attitudes influence interests and paths that are taken, dealing with this issue was seen as highly relevant. It could assist in revealing the discrepancy between people's attitudes and current activities and was seen as possible impulse to raise understanding, start ecological movements and "wake up" people. Furthermore, it could be an important tool that allows motivating the single types dependent on their motives and values.

Discussion and implications for future research

Our results shed a new light not only on the specific issue of Mastery over nature, but more generally on the methodology and interpretation of social science research in the field of human nature relationships. At least a significant part of the Mastery paradox can be explained as an artefact caused by the research approaches, therefore our discussion rather focuses on these aspects.

Considering and operationalising the social desirability bias

From our interviews we conclude that many results from survey-based research on human-nature relationship might be influenced by a social desirability bias:

Interviewees apparently not so much state how they actually see themselves but rather how they would like to see themselves or, even more, how they would like to be seen by others. This might be particularly the case with quantitative research methodologies that usually offer fewer opportunities for deliberation and self-reflection compared to more dialogue-oriented qualitative approaches, however, social desirability bias is a crucial issue in many fields of social science research in the context of natural resources management (Nuno and St. John 2015). Rather than trying to avoid and exclude this bias, we suggest to operationalise it in research designs. For quantitative, questionnaire-based approaches it might be useful to specifically address the differences between the perceived actual and the desired status. For qualitative approaches we suggest to actively broach such discrepancies in interview situations in order to detect underlying causes and stimulate self-reflection.

Critical role of the wording of narratives

We found that many interviewees would identify with single aspects of a more comprehensive narrative of the Master concept and fiercely reject others. This is in line with the findings of Braito et al. (in print): In that study participants had been confronted either with long narratives describing different understandings of the human-nature relationship or individual statements taken from the same narratives. The internal consistency between the scores for the individual statements was particularly low for the Master type compared to types such as Steward, Partner or Participant. de Groot and van den Born (2007) reported similar findings from a qualitative study where participants did not always agree with the wordings of pre-defined narratives.

While most of the categories used in current empirical research are well rooted in traditional narratives, it is apparently quite difficult to develop a generic narrative for each type which can be used in all kinds of situational, geographic or cultural contexts.

This is also why one needs to be very careful when analysing and interpreting results from international comparative studies, where questionnaire items had been developed in one language are translated into many other languages (see Chase et al. (2016)). We even had difficulties translating narratives between the closely related languages English and German. One conclusion from this finding might be not to confront interviewees with pre-defined narratives but rather involving them in the wording. Thus the narratives would better fit to the conditions of the respective study case, while still communicating the same principles.

Context sensitivity: noise or source of information

Our results clearly support the view that there is no static understanding of the human-nature relationship that can easily be captured in surveys, as there is always a context-sensitivity that shapes the answers of study participants (see e.g. Yoshida, Flint, and Dolan (forthcoming)). People do not identify with just one single type; depending on the concrete situation, different understandings can be activated and then lead to different ways of environmental behaviour (Muhar et al. forthcoming). As most of our interview partners were professionals in the field of natural resource management, there was a significant distinction between the identity in their professional and in their private spheres.

We suggest not to interpret this context sensitivity as noise, but rather to proactively address it in research projects, e.g. by asking study participants, under which conditions they would act according to which concept of the human-nature relationship.

Insightful proximity between Mastery and Stewardship

While in discussions these two concepts are often portrayed as antagonistic, they seem

to have a lot in common, as both essentially assume human superiority over nature and human capacity to control nature (for a detailed discussion see Berry (2006). The significant difference is that the Mastery concept implies a right, or even duty, to control nature, while the stewardship concept is about responsible use and protecting nature from negative human impacts. However, when Mastery over nature is interpreted as a service to nature in the sense of stewardship, as was the case with some of our interviews, then the boundaries become blurred. In fact, in our study case of river management we ourselves would not always know the right way to find a distinction: Is the restoration of a degraded river by means of an engineering intervention a manifestation of Mastery or stewardship? Rather than proposing to resolve this issue by more precise wordings of the narratives of Master and Steward we rather suggest to use such examples as cases for discussions with the involved actors. While none of our interview partners had specifically referred to the cultural rooting of the Mastery concept, we still believe that this can also be used as a discussion topic.

Developing tools for individual and group-based reflection

We were very much surprised by the positive feedback from our study participants regarding the relevance of the topic. Our study sample consisted of stakeholders engaged in naturel resource management and therefore might not be representative for the general public, nevertheless we can assume that reflecting the understanding of the human-nature relationship can be a useful component of planning or governance processes. Stakeholders from different domains should have the opportunity to reflect their own understanding of the human-nature relationship and become familiar with the perspectives of other participants.

In the past decade research in this field mostly focused on the development of methods for assessing individual understandings of the human-nature relationship in

anonymous situations (questionnaire) or in face-to-face interviews. For future research we suggest to put more focus on the development of tools that can be used for group-based reflection.

Conclusions

The understanding of the human-nature relationship is one out of many socio-cultural concepts of nature, such as "wildlife orientation values", "connectedness to nature" and "place identity". These concepts are often used as explanatory factors for environmental behaviour and engagement in conservation activities, as discussed in other contributions to this special issue, see e.g. Ainsworth (forthcoming). We argue that it is very important not only to survey identifications with socio-cultural concepts of nature according to pre-defined narratives, but rather to explore the drivers that affect the statements of study participants in such surveys. Results that at first sight might appear as paradox can be explained and re-interpreted by looking at the multifaceted and context-dependent array of influencing factors.

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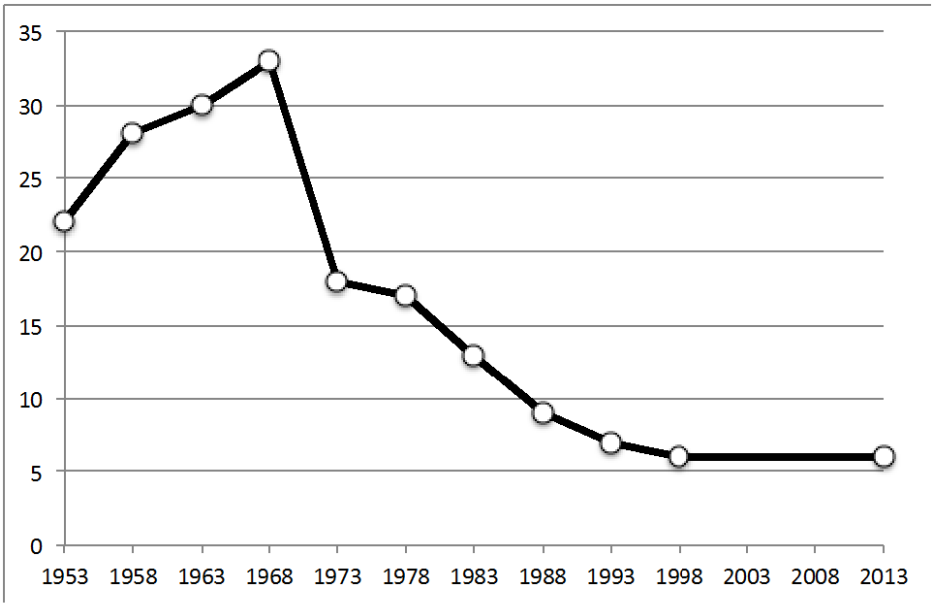

Figure 1.: Acceptance rate (%) of the statement "In order to be happy, man must conquer nature" in the Japanese National Character Survey; data 1953-1998: Zheng and Yoshino (2003); data for 2013: Zheng, personal communication

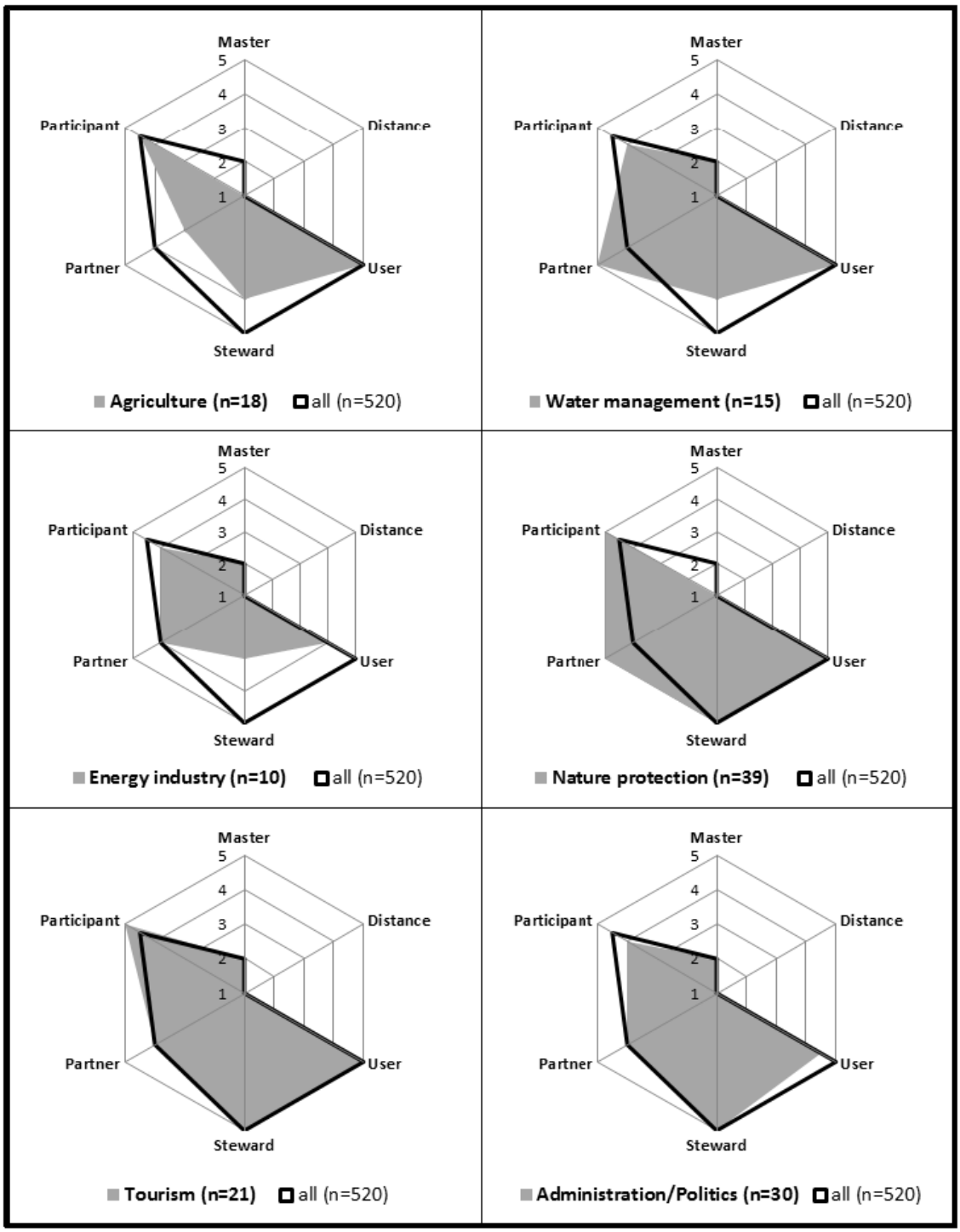

Figure 2: Frequency distribution of identification with different human nature relationship perspectives of selected stakeholder groups in river landscape management in a study of the rivers Enns and Drau (1= rejection, 5= full acceptance); data from Walker-Springett et al. (2016)

Table 1: Narratives portraying the different understandings of the Human-Nature relationship (Walker-Springett et al. 2016)

Master	I think, humans can become independent from nature by developing technology and should control and change nature. The production of necessary goods like for instance food can be improved and natural hazards like floods can be averted.
Apathy	I do not think much of nature in my daily life.
User	I believe humans benefit from functioning ecosystems for instance from clean water, from timber or the beauty of landscapes. Hence functioning ecosystems can also create jobs and profits.
Steward	I see a moral obligation to conserve and protect nature, because human development and technology can be a threat to nature.
Partner	I consider humans and nature as equal in value and power. Nature has a value for itself, which cannot be measured only according to human utilization.
Participant	I feel as a part of nature. I have an emotional or spiritual bond with it. Being or living in nature is fulfilling for me. Our existence and the well-being of nature are intertwined. We cannot separate from nature.

4.8 Article #8

A Model integrating Social-Cultural Concepts of Nature into Frameworks of Interaction between Social and Natural Systems

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A Model integrating Social-Cultural Concepts of Nature into Frameworks of Interaction between Social and Natural Systems

Abstract

Existing frameworks for analysing interactions between social and natural systems, (e.g. Social-Ecological Systems framework, Ecosystem Services concept) do not sufficiently consider and operationalize the dynamic interactions between people's values, attitudes and understandings of the human-nature relationship at both individual and collective levels, as well as linkages to environmental behaviour. We highlight the relevance of individual and collective understandings of the human-nature relationship as influencing factors for environmental behaviour, which may be reflected in natural resource management conflicts, and review the diversity of existing social-cultural concepts, frameworks and associated research methods. Particular emphasis is given to the context-sensitivity of social-cultural concepts in decision-making. These aspects are translated into a conceptual model aiming not to replace but to expand and enhance existing frameworks. Integrating this model into existing frameworks provides a tool for the exploration of how social-cultural concepts of nature interact with existing contexts to influence governance of social-ecological systems.

Keywords

Human-nature relationship, social-ecological system, environmental behaviour, governance

A Model integrating Social-Cultural Concepts of Nature into Frameworks of Interaction between Social and Natural Systems

1. Introduction

Frameworks for analysing relationships and interactions between social and natural systems, also described as Human-Environment Interactions or Coupled Social-Ecological Systems, have become mainstream paradigms for the science, practice, and policy of sustainability (Binder et al. 2013). Prominent examples are the Social-Ecological Systems Framework (Ostrom 2007, 2009) and the Millennium Ecosystem Assessment Framework (Millennium Ecosystem Assessment 2003) that included and popularized the Ecosystem Services concept. A more recent addition is the framework proposed by the Intergovernmental Platform on Biodiversity and Ecosystem Services IPBES, which strives to reach beyond traditional formalized Western science thinking (Díaz et al. 2015).

Figure 1 illustrates the general structure of such frameworks. Differences between individual variants relate to: (1) the understanding of the social-cultural system as being separate from or part of the natural system, (2) the understanding of the linkages between the social-cultural and the natural system (e.g. focus on material flows, economic benefits, symbolic meanings), and (3) the complexity of feedback mechanisms within the social-cultural and the natural system as well as between these two systems. For a detailed analysis of commonalities and differences between various concepts, see Binder et al. (2013).

[Figure 1 near here]

While such frameworks are widely regarded as useful for both research as well as governance processes, they have also been criticized for various reasons: (1) Most existing frameworks do not sufficiently consider the diversity of motivations for modifying, managing,

protecting or restoring ecosystems. These motivations are rooted in different individual and collective understandings of the human-nature relationship, as extensively studied in social sciences, such as environmental psychology, social psychology, sociology, and anthropology (Fabinyi, Evans, and Foale 2014; Mathez-Stiefel, Boillat, and Rist 2007; Greider and Garkovich 1994; Eder 1996; Daniel et al. 2012). (2) Many frameworks under-recognize the effects of social factors, particularly how interactions between individual features (e.g., attitudes and values) interact with collective features (e.g., institutions, norms, customs, symbols) to influence environmental behaviour (Manfredo et al. 2014; Romero and Agrawal 2011). (3) Some frameworks tend to ignore the role of situational aspects, particularly technocratic, economic and managerial discourses (Turnhout et al. 2014) that might lend a privileged voice to some understandings of human-nature relationships while crowding out others (Raymond et al. 2013; Rode, Gómez-Baggethun, and Krause 2015).

There is a growing recognition among scientists that it is essential to consider the interactions of social and ecological aspects across multiple disciplines, systems of knowledge and policy contexts to understand changes in ecosystem services and human well-being (Carpenter et al. 2009; Davies et al. 2015). Empirical evidence shows that disregard of social-cultural concepts of nature can even lead to project failure. In a seminal analysis of World Bank financed development projects of the 1980s, Kottak (1990) found that projects that did not sufficiently consider cultural values of the population were also less likely to be successful in economic terms such as income generation. A more recent literature review of publications on community-based conservation interventions (Waylen et al. 2010) showed that the consideration of local cultural contexts is a key factor for the success of such projects. Resources found in agricultural crops (Barnes et al. 2011) and water systems (Andolina 2012) might be seen as simple commodities by Western standards; however, the spiritual meanings of these resources may differ among indigenous groups and ultimately result in the adoption of different management practices. Different sacred values between primary stakeholders,

managers and the government or the missing reflection of these values in decision making processes can lead to conflicts (Daw et al. 2015). The various bonds between people and their places of residence can stimulate resistance against infrastructure developments (McCreary and Milligan 2014). New technologies will be more readily accepted by indigenous people when there is a cultural match with the respective understanding of nature. For example, acceptance of photovoltaics in certain traditional communities could be facilitated by adopting local terms for describing the sun as the universal source of energy (Dreveskracht 2013). A recent literature review (Rode, Gómez-Baggethun, and Krause 2015) showed that economic incentives for nature conservation can either undermine (crowd out) or reinforce (crowd in) people's intrinsic motivations to engage in biodiversity projects. While the majority of scholarly literature in this field focuses on social-cultural concepts of indigenous people in the context of development projects, similar examples can be found in Western industrialized societies as well, e.g. when controversies about conservation projects are rooted in different understandings of the human-nature relationship among the various actors (Couix and Hazard 2013).

Individual disciplines are now addressing some of these concerns by improving understanding of the interactions between culture and the environment. For example, within the ecological economics scholarship, researchers have developed: (1) frameworks showing connections between environmental spaces, culture and ecosystem management practices (e.g., Church et al. 2014; Fish, Church, and Winter in press); (2) methods for assessing shared and social values for ecosystems within and between individuals and groups (Kenter et al. in press; Raymond et al. 2014), and; (3) measurement models for assessing the effect of these values on behaviour formation and change (Raymond and Kenter in press).

The objectives of our paper are to (1) present and discuss the diversity of existing concepts for addressing the human-nature relationship, (2) highlight the relevance of individual and collective understandings of the human-nature relationship as influencing factors for envi-

ronmental behaviour, and (3) propose a model for the integration into established frameworks of coupled social-ecological systems that particularly addresses the sensitivity regarding individual, social or institutional contexts within which processes and actions are embedded.

Our work is based on a broad scoping of the literature and our own research experiences from a large number of individual projects across the developed and developing world. The literature review focused on relevant review articles for each subtopic but also includes selected single case studies for illustration.

Within this journal's special issue on "Human-nature relationships and their implications for environmental management" our article has also been designed as a reference point regarding fundamental literature, thus avoiding redundancies in other individual contributions.

The idea of providing a model for a better consideration of social-cultural concepts of nature in social-ecological systems frameworks is per se interdisciplinary. However, the literature review had to consider a wide range of disciplines such as social psychology, environmental economics, governance etc., each with their individual terminologies and sometimes inconsistent definitions. Within this paper we use the term "environmental behaviour" in a neutral sense as any kind of behaviour that has a direct or indirect positive or negative impact on natural environments, such as individual consumption, land use practices or engagement in conservation activities (Poortinga, Steg, and Vlek 2004). "Social-cultural concepts of nature" is used here as an umbrella term for a number of concepts describing and operationalising the individual or collective understanding of nature and of the complex relationship between humans and their natural environment (see section 2).

2. Social-Cultural Concepts in the Context of Human-Nature Relationships

Social-cultural concepts of nature are a specific subset of general social-cultural concepts such as worldviews, beliefs, values and attitudes, and therefore also need to be seen in relation

to those (see Figure 2).

[Figure 2 near here]

Most of the key concepts reviewed in recent literature have acted as paradigms, gathering researchers around them without much inter-paradigmatic traffic. Consequently, different scholarships may have the same name for a given concept, but define or apply it in various ways. For example, there are diverse intellectual origins behind the 'sense of place' concept, which has resulted in 'place' being considered as a centre of meaning, a locus of attachment, as well as from phenomenological, discursive and information processing approaches (Williams 2014a, 2014b). In this way, human-nature relationship concepts are not mutually exclusive but tend to organize research in specific ways, starting out from different initial foci, be it nature in general or selected parts of nature such as animals or specific locations, and focusing on different aspects as summarized in Table 1. This pattern implies that the human-nature relationship research field is still dynamic with a growing number of publications originating from many different disciplines and developed for diverse applications.

[Table 1 near here]

Social-cultural concepts of nature become manifest at all levels of human organization: individual people, communities, collective actors such as corporations, NGOs or government agencies, and the general macro level of cultural patterns and public discourse (Manfredo et al. 2014). However, within each level these social-cultural concepts are expressed, reflected and documented in different ways. For example, the state's discourse on human-nature relationships is usually more dominated by rational, often economically determined frames such as the ecosystem services approach, compared to the individual or the

group level, where people's connectedness to nature can also include emotional or spiritual dimensions. The multifarious dynamics between the individual and the collective level can be a determinant for the success of resource management and conservation measures (Kenter et al. 2014).

3. Established Methods for investigating Understandings of Human-Nature Relationships

Methods employed for investigating and discussing human-nature relationships in the context of natural resource management vary according to the purpose of their application and the discipline in which they are grounded. These methods can address either individuals or groups, facilitate different degrees of interaction between participants or with the researchers, and stimulate discussions and reflection of different intensity and duration.

Quantitative approaches to investigate social-cultural concepts of nature at the individual level mostly use standardized survey instruments with predefined sets of dichotomous or continuous response options (Bauer, Wallner, and Hunziker 2009; Braito et al. in press; de Groot and de Groot 2009; Van den Born 2006), often referring to established measurement scales such as the Humans and Nature (HaN) scale (de Groot and van den Born 2007), the Connectedness to Nature (CTN) scale (Mayer and Frantz 2004) or the New Environmental Paradigm (NEP) scale (Dunlap et al. 2000). At the group level, interactive quantitative instruments such as discourse based valuation (Wilson and Howarth 2002) are less common in this research tradition. Studies relying on spatial analysis and on-site behavioural observations are employed to complement surveys and acquire generalizable knowledge about people, objects, events, and processes.

Qualitative approaches such as semi-structured interviews at the individual (Van den Born 2008) or focus groups discussions at the collective level (Buijs et al. 2008; Fischer and Young 2007) allow for inductive reasoning, interaction and reflection, and take into account

the context and cultural background of respondents. This is particularly useful when the research process should prepare grounds for decision-making in natural resource management (Lynam et al. 2007; Davies et al. 2015). Discussion processes conducted over several sessions can exhibit a shift from more distant argumentation toward deeper immersion into the topic (Ahnström et al. 2009), thus also providing space for more personal, emotional or spiritual expression. Such a mode shift can also be achieved by implementing approaches such as role playing (Bourgoin and Castella 2011) or the production of artworks such as sculptures or videos (Gibbs 2014; Kagan 2013; Edwards, Collins, and Goto in press). These approaches help to overcome challenges in communicating issues of human-nature relationships and allow a rich, multi-faceted reflection on the issue.

For the analysis of explicitly stated or implicit human-nature relationship aspects in policy papers, newspaper articles, books and other written sources, well-established methods of document or content analysis can be implemented (Daugstad, Svarstad, and Vistad 2006; Stremlow and Sidler 2002).

4. The Situational Dependence of Linkages between Human-Nature Relationship and Behaviour

A host of cognitive and affective processes shape individual and collective decisions. In this context, human-nature relationship concepts work in tandem with situational factors to induce or constrain behaviour (Flint et al. 2013; Braito et al. in press). If these combined effects of social-cultural concepts and situational factors are ignored, estimates of human behaviour may be rendered invalid or unreliable. There are also various methodological and conceptual challenges to modelling environmental behaviour such as the compatibility among survey items (Ajzen and Fishbein 2005), different levels of specificity in the questions asked to stakeholders (Tarrant and Cordell 1997) and language used in survey instruments (Kaiser, Schultz, and Scheuthle 2007). These uncertainties may affect our ability to understand, antici-

pate and govern human behaviours, which is a centrepiece to support the long-term success of conservation initiatives and sustainability (Mascia et al. 2003; Schultz 2011).

A variety of universal theories and models have been developed in social psychology to better understand the processes that influence behaviour (Bamberg and Möser 2007). Under the assumption of rationality, the Theory of Planned Behaviour (Ajzen 1985) is one example of a social psychological model that provides insight into the predictors of behavioural intentions including general attitudes, perceived behavioural control, and subjective norms, as well as belief structures that antecede these constructs. Another approach to estimating actions that can affect the environment relies on moral normative concerns (rather than self-interest). The Value-Belief-Norm Theory of Environmentalism (Stern et al. 1999) and the Norm-Activation Model (Schwartz 1977) are two examples that have provided conceptual roadmaps for a longstanding body of research to disentangle the complexities of human behaviour.

When trying to understand environmental behaviour, the interactions between human-nature relationship concepts and a range of situational factors must be considered (see Figure 3). These factors are interconnected and collectively comprise the human-nature relationship and resultant behaviours. (Manfredo and Yuan 1992). Below, we shortly describe these factors.

Individual attributes

Individual characteristics such as values, knowledge, and personality remain relatively stable over the course of a person's life (Dietz, Fitzgerald, and Shwom 2005), however, other individual-level attributes such as attitudes and in particular emotions are relatively sensitive to situational contexts (Van Riper and Kyle 2014b). For example, in the case of attitudes towards flood control, personal involvement in recent extreme events will rather activate concepts of control than concepts of partnership with nature (Shaw 2016; Muhar and Böck forthcoming). This is insofar relevant as planning processes for disaster management is often

initiated immediately after extreme events, when actors might still be emotionally affected by the event. These individual attributes have important direct and indirect effects on behavioural intention and self-reported conservation behaviour (for an overview, see Raymond and Kenter in press) and participation in biodiversity conservation programs (Moon, Marshall, and Cocklin 2012).

Group attributes

Group-level characteristics such as shared experiences, power relationships, peer pressure and social control also affect behaviour (Kenter et al. 2014). Culture (e.g., norms, traditions, ideas, material objects, and symbols) and social structures of societies (e.g., race, gender, ethnicity, class) are important considerations for groups that comprise the contexts surrounding individuals and management entities (Brennan, Flint, and Luloff 2009; Flint et al. 2013; Wildavsky 1987). In the context of natural resource management, state-funded programs often target and support community-based action, where the internal dynamics within action groups can be significant determinants for the success of such programs, as e.g. shown by (Kingwell, John, and Robertson 2008) in a review of conservation projects addressing land degradation in Australia.

Governance

The governance regime incorporates the organizational setup of stakeholder involvement in decision-making, the management tactics that support message framing, and the establishment of formal and informal policy instruments that shape natural resource use (Jordan, Wurzel, and Zito 2005). The framing of a governance process towards a certain human-nature relationship concept can either attract or deter certain stakeholder groups (Rode, Gómez-Baggethun, and Krause 2015). These institutional arrangements work in tandem with group and individual level processes as situational factors that encourage and constrain decisions

about human-environment interactions (Ostrom 2000).

Thematic and spatial focus

The thematic focus of a decision process, i.e. the natural resource that may be affected by human activities is a critical consideration. For example, research has suggested that farmers who own both cropland and forests tend to act according to a "stewardship of nature" (Van den Born 2006) orientation in forests, while on cropland their behaviours are guided more by "mastership" orientations (Huber 2012; Yoshida, Flint, and Dolan forthcoming). Another example is the concept of flagship species in biodiversity conservation that is based on the observation that certain species can more easily activate participation in conservation initiatives than others (Jepson and Barua 2015). Also the spatial dimension of the thematic focus can be relevant. Van Riper and Kyle (2014a) identified differences in national park visitors' environmental worldviews and the affected perception of ecosystem service values across different spatial scales. Incidents in the immediate personal vicinity can trigger different behaviour compared to the same issue in areas further away (Kubo and Shoji 2014).

5. Integration into existing Frameworks of Social-Ecological Systems

We suggest that social-cultural concepts of nature should be better considered in existing frameworks analysing social-ecological systems. Figure 3 presents a model that is designed to function as an "add-on module" or extension to such frameworks, rather than proposing to replace them. We intended to set the level of detail so to leave enough leeway for adaptation and integration into individual specific frameworks.

The model operationalizes the relationship between the aspects discussed in the previous sections: Social-cultural concepts of nature are embedded in general social-cultural concepts such as worldviews and values, where there is always an interaction between the individual and the collective level. Effects of human behaviour on the biophysical system and

their relationship to other social-cultural subsystems (economy, technology, religion, political system) are reflected in the formation of different understandings of the human-nature relationship. These concepts can be activated by a number of situational factors such as governance arrangements, which together then influence certain behaviour. Both the social-cultural concepts and the situational factors are of course linked in various ways to other components or subsystems of the social-cultural system such as economy, technology, politics etc.

[Figure 3 near here]

6. Discussion and Conclusions

Challenges and opportunities for implementation in individual frameworks and project designs

The module proposed here can serve as a guide for researchers, to consider how human-nature relationship dimensions fit within broader frameworks of human-environment interactions. The module accommodates a wide range of epistemological approaches and research methodologies, although it will need testing and assessment across cultures and disciplines. Our social-cultural model is also useful for better understanding of how 'culture' is inherently linked to individual and collective aspects of the social-ecological system (as opposed to how culture is presented as an independent unit in the ecosystem services framework).

Empirical research in this field tends to rely upon the integration of qualitative and quantitative methods, thus approaches that recognize the complementarity of qualitative and quantitative data offer the greatest promise. In Table 2 we provide a first overview of the potential contributions of our add-on module to some selected social-ecological frameworks.

[Table 2 near here]

Suggestions for further research

Our add-on module is still at a conceptual level and warrants substantial empirical investigation. We particularly encourage researchers to consider how individual and collective psychological processes interact with each other to drive behaviour formation and change within the individual (Manfredo et al. 2014). Existing behaviour models within environmental psychology rarely account for such multi-level effects, which may explain why much of the variance in conservation behaviour (Gosling and Williams 2010; Raymond, Brown, and Robinson 2011), as well as in other forms of behaviour remains unexplained (Gifford 2014).

Temporal and spatial dimensions of the human-nature relationship and behaviour formation also require more attention (Restall and Conrad 2015). Such research may also include mapping how spatial factors relevant to people's places of interest interact with their understanding of the human-nature relationship, and how these interactions develop over time (Dvorak and Brooks 2013).

Implications for practice

Managers of planning and governance processes in natural resource management at all scales need to be aware of the role that social-cultural concepts of nature play in different contexts. This requires a translation of the scientific terms around human-nature relationships into plain language. Stakeholders in such processes should be encouraged to reflect on their own and others' positions (Raymond et al. 2010). In addition, managers and researchers have to recognize that their positions of power may discourage open communication regarding local beliefs and practices; therefore participatory and collaborative engagements that share power can improve management decisions and foster better conservation outcomes (Reid et al. 2009).

While there is still a need to further develop methods for addressing and operationalizing human-nature relationship in research projects, this is even more relevant for improving the practice of natural resource management. "Human-nature relationship toolkits" prepared by international organizations such as UNEP or UNESCO, various Convention secretariats, and globally acting NGOs to be used by government agencies, practitioners, NGOs, and citizens' groups could therefore be very useful. Such toolkits could also be tailored for certain ecosystem types or cultural contexts, and included in existing manuals for specific management issues, such as e.g. aquatic ecosystem management (Ruettinger et al. 2014). Education for Sustainable Development platforms, such as the UNECE Steering Committee on ESD are several examples of international multi-stakeholder avenues for raising awareness about the role and application of social-cultural concepts of nature, and promoting further development of methods and practices.

Considering the role of social-cultural concepts of nature is particularly useful in the context of UNESCO's work on links between biological and cultural diversity striving to achieve a holistic approach consistent with cultural and spiritual values, worldviews, knowledge systems and livelihoods that contribute to conservation and sustainable and equitable use of biodiversity (Persic and Martin 2008; UNESCO 2010).

Future research could benefit from applying the add-on module in different real-world decision contexts in order to better understand how environmental policies and strategies may influence the relational dynamics among individuals, societies and the environment, and how these relations contribute to individual and collective behaviour and decision-making.

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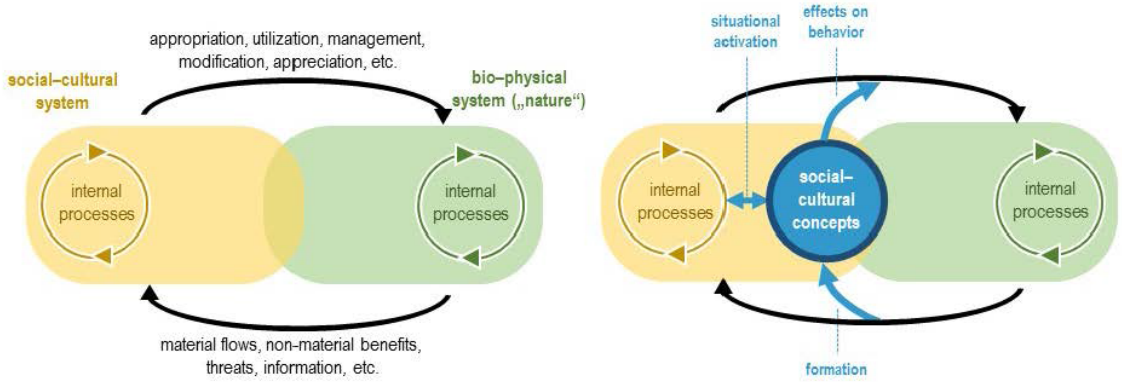

Figure 1: General structure of frameworks to analyse interactions between social and natural systems (left) and proposed add-on module to integrate social-cultural concepts of nature (right)

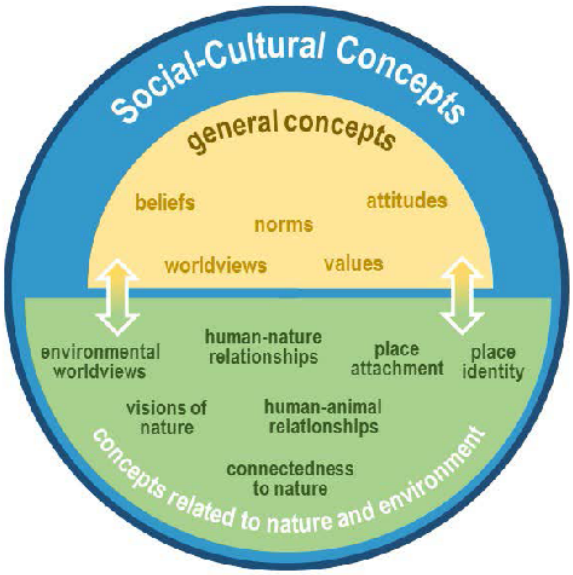

Figure 2: Overview of representative social-cultural concepts in the context of human-nature relationships

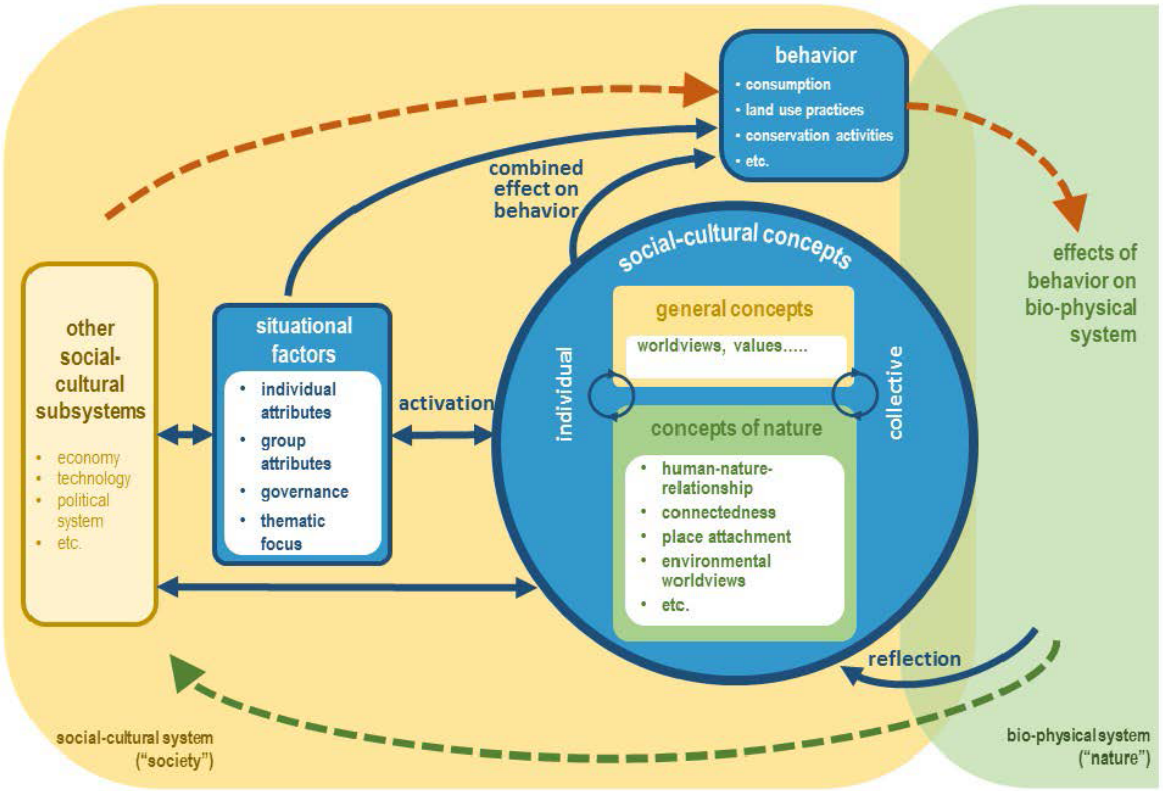

Figure 3: Detailed structure of the add-on module to integrate social-cultural concepts into frameworks of interaction between social and natural systems; dashed lines refer to the structure of existing frameworks (see Figure 1), solid lines indicate the proposed extension.

Table 1: Summary of widely used concepts of the human-nature relationship and their analytical dimensions

Objects of Attention & Concepts	Description	Operationalization of Concept
PLACE		
Place Attachment	Definition: The emotional bonds a person develops with various places. It can be organized along multiple dimensions of person (the actor who is attached), the psychological process (how affect, cognition and behaviour are manifest in attachment) and place (the nature of the area which the person is attached to) (Scannell and Gifford 2010). Evolution of concept: Research consists of methodological and theoretical traditions of the geographical dimensions of "sense of place" (qualitative) and "psychometric" dimensions (quantitative) (Lewicka 2011). The most common distinction is between place attachment (affective bonds and symbolic meaning) and place dependence (instrumental bonds with place).	From a psychometric perspective, a range of dimensions have been measured (see Raymond, Brown, and Weber 2010 for an overview): *Place identity* – the mixture of feelings about specific physical settings and symbolic connections to place *Place dependence*– degree to which the physical setting provides conditions to support an *intended use* *Social bonding* – feelings of belongingness or membership to a group of people, such as friends and family, as well as the emotional connections based on shared history, interests or concerns.
NATURE		
Social Representations of Nature	Definition: The images of nature that are developed in the encounters of people and the natural environment. The images are culturally and historically contingent systems of values, ideas, and practices that are used by social groups to understand the natural environment (Buijs et al. 2012). Evolution of concept: Early work focused on normative elements of images (values and value orientations) and cognitive elements (beliefs and definitions) (Buijs, Elands, and Langers 2009). The current concept also considers expressive elements, such as perceived beauty and fascination (Kloek 2015).	*Values of nature* – the reasons why nature is perceived to be important. Usually divided into anthropocentric, ecocentric and biocentric values (Buijs 2009). *Definitions and boundaries of nature* – what people consider as nature and what types of nature they distinguish (Buijs 2009). *Nature related beliefs* – associations people establish between nature and the attributes they ascribe to it (Buijs 2009). *Psychological experiences* – how people experience nature emotionally or feel about nature (Kloek 2015).

Visions of Nature	Definition: Images derived from environmental philosophy of the human-nature relationship, and guiding principle for the appropriate relationship with nature (Van den Born 2001). Evolution of concept: Three concurrent developments, such as guiding principle for the appropriate relationship with nature, images of nature and values of nature.	*Images of Nature* – what people consider as nature and what types of nature they distinguish *Values of Nature* – the reasons why nature is perceived to be important *Images of the human-nature relationship* – the images of the appropriate relation between humans and nature: • Master over nature • Steward of nature • Partner with nature • Participant in nature Images are measured with the *Humans and Nature scale* (HaN) (Van den Born 2006) (De Groot 2007) (De Groot 2012).
Connectedness to nature	Definition: The extent to which individuals include nature as part of their identity, on three key levels: cognition (how integrated one feels with nature), affect (an individual's sense of care for nature) and behaviour (an individual's commitment to protect the natural environment) (Schultz 2002). Also known as nature relatedness, connectivity with nature, emotional affinity toward nature, or inclusion of nature in self. Evolution of concept: Has evolved to distinguish between Nature-Relatedness (Self) representing an internalized identification with nature; Nature-Relatedness (Perspective) representing an external, nature related worldview, and Nature-Relatedness (Experience), representing a physical familiarity with the natural world.	Measurement scales include: *Connectedness to Nature Scale [CNS]* (Mayer and Frantz 2004)– measuring conscious emotional connection to the natural world. *Implicit Associations Test [IAT]* (Schultz et al. 2004) and Inclusion of Nature in Self [INS] (Schultz 2001) – measuring how much nature is included in an individual's identity. *Nature Relatedness Scale [NRS]* (Nisbet, Zelenski, and Murphy 2008)– measures a broader set of concepts than CNS including physical interaction, comfort level and familiarity with nature. Strong correlations between different measures of connectedness to nature scales have been demonstrated (Tam 2013).

Environmental worldviews	Definition: Nature-based, "primitive" beliefs that reflect an individual's fundamental priorities about human-environment interactions (Oskamp and Schultz 2005). Evolution of concept: Was initially developed to understand the social basis of environmental concern (Dunlap and Van Liere 1978; Van Liere and Dunlap 1980) but more recently to understand environmental behaviour (Stern et al. 1999). A large body of research suggests that underlying belief systems predispose people to act in support or opposition of policy change (Milfont and Duckitt 2004; Nooney et al. 2003). However, the construct has been contested (Amburgey and Thoman 2011).	The New Ecological Paradigm (NEP) (Dunlap et al. 2000) scale indicates potential endorsement of an environmental worldview. It is comprised of statements about living in harmony with (i.e., biocentrism) or having mastery over nature (i.e., anthropocentrism).
ANIMALS		
Wildlife value orientations	Definition: Consist of networks of basic beliefs that organize around values and provide contextual meaning to those values in relation to a particular domain such as wildlife. Value orientations are seen as part of a value–attitude–behaviour hierarchy (Manfredo, Teel, and Henry 2009). Evolution of concept: There is a long-lasting discourse on human-animal relationships (see e.g. Kellert 1985), with subdiscourses focusing on specific groups such as birds (Ainsworth 2014) or domestic animals (Vining 2003). For a comprehensive review see Hosey and Melfi (2014).	Early research measured wildlife value orientations across the dimensions of: wildlife use, wildlife rights, recreation wildlife experience, bequest and existence, hunting/anti-hunting, residential wildlife experience, wildlife education, fishing/anti-fishing (Fulton, Manfredo, and Lipscomb 1996). These orientations have since been clustered into two higher-level dimensions of *domination* (extent to which an individual or group's value are shaped by human mastery over nature) and *mutualism* (extent to which life forms have rights like humans and deserving care and compassion) (Manfredo, Teel, and Henry 2009; Teel and Manfredo 2010).

Table 2: Options for integrating the add-on module into selected existing frameworks of interaction between social and natural systems

Framework	**Ecosystem Services (Millennium Ecosystem Assessment 2003)**	**Social-Ecological Systems (Ostrom 2007, 2009)**	**IPBES (Diaz et al. 2015)**
Key principles	Biophysical systems generate goods and services that are crucial for human well-being. Accurate valu-	The Social Ecological Systems (SES) Framework was developed to understand and improve the management of common-	The IPBES framework can be viewed as a recent extension and expansion of the ecosystem services framework. It is far

	ation of services is assumed to lead to better awareness of the importance of ecosystems, enable exchange payments between resource users, and improve ecosystem stewardship.	pool resources. Accordingly, a system is comprised of resource systems (biophysical component), resource units (goods or services being extracted), governance systems (rules and actions regarding the regulation and management of the system), and users (people who extract and benefit from the resource units).	broader than traditional ecosystem services frameworks, considering multiple forms of knowledge, worldviews and different framings of human-environment interactions.
Potential contributions from integrating the HNR module	Defines well what constitutes a service and how socio-cultural concepts influence the importance of particular services. Considers clearly situational factors that create benefits from ecosystem services for individuals, rather than focusing on abstract societal benefits only. Shows the importance of economic considerations for explaining and influencing environmental behaviour. Appreciates gradually what well-being is and how it can be achieved.	Suggests that not all environmental features need to be considered as "resources". Highlights different ways of perceiving landscapes and valuing biophysical features. Stresses that "users" are not a homogenous group of people, but individuals with different HNR concepts, values and histories. Provides guidance on tools and methods to understand the interplay between individuals, groups of actors and management systems.	Highlights the centrality of worldviews and concepts of nature in shaping a socio-cultural system. This in-turn can influence the conceptual structure of the model. Could assist the IPBES framework in capturing the differences between individual concepts of nature and collective concepts of nature. Can expand on how nature's benefits influence people's quality of life by accounting for the complexities of human behaviour, its antecedents and effects.
Challenges	Defining the purpose of ecosystem services assessment so HNR concepts can be targeted appropriately. Availability of information on individual and group attributes and situational factors Consider the complexity of interactions between individual and collective processes influencing behavior Difficulty of mapping of the spatio-temporal dynamics of human-nature relationships	Incorporate socio-cultural concepts of nature into the structure of first and second tier variables adopted in SES. Dealing with increasing model complexity Translating the complexity and nuance of human-nature connections into practical recommendations for resource governance.	Communicating socio-cultural concepts of human-nature relationships to policy. Relating indigenous perspectives on nature to scientific knowledge

	Reduced clarity of individualized (compared to expert-based) definitions of ecosystem services Accounting for the relevance of ecosystem services to diverse populations. Assessing how access to and experience of ecosystem services affect nature connectedness, values and worldviews	

4.9 Article #9

Chapter 22
Ecosystem services in river landscapes

K. Böck, R. Polt, L. Schülting

24.1 What are Ecosystem Services (ES)?

River landscapes have served as areas for settlements, infrastructure and production for several thousand years. They provide water for drinking, cooling and irrigation, fish as food supply or for recreational fishing, areas for flood protection and they can have cultural and aesthetic value. The increasing intensification of land use and the associated channelization, damming and other radical changes (e.g. through operation of hydropower plants) led to a shift of the functions and related services available in river landscapes. To counteract this trend, one first step is to enhance public awareness of their importance.

One possible way to raise awareness about the importance of unimpaired river landscapes for the provision of services and to consider them more easily within decision-making processes is the ecosystem services (ES) concept. This concept highlights the relationship between different influences on ecosystems and the availability of their functions as they relate to provision of services for humans.

Ecosystem services refer to the interface between ecosystems and human well-being and are described as the many different benefits ecosystems provide to people (MEA 2003). The cascade model originally published by Haines-Young and Potschin (2010) is used as a basis in many studies dealing with the ES concept. It distinguishes between ecological structures, processes and benefits that humans derive from ecosystems (Figure 1). While ecosystem functions describe the capacity to provide goods or services for human society, the extent of ES and consequently the benefit for humans is determined by the actual demand.

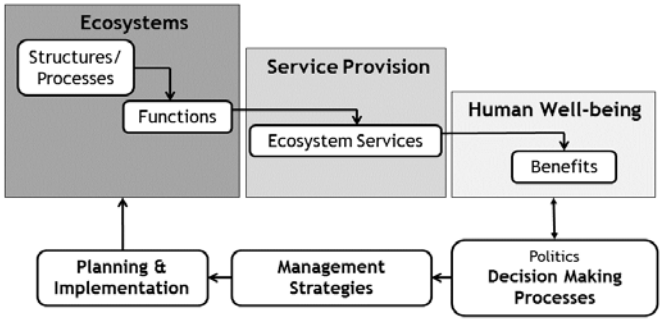

Figure 1: Cascade model showing the link between ES and human well-being (Böck et al. 2015 based on Haines-Young and Potschin 2010, De Groot et al. 2010 and Van Oudenhoven et al. 2012)

Originating in the 1970s, the ES concept became an issue in the international environmental discussions in the 1990s. Since then its influence has continued to rise. An important milestone was Robert Costanza's publication on the value of world's natural capital and ES that calculated the total value of world's ES with \$16-\$54 trillion per year (Costanza et al. 1997). A more recent publication by Costanza et al. (2014) gives an updated estimate for the total global ES in 2011 of \$125 trillion per year. Other important steps were the Millennium Ecosystem Assessment (MEA 2003) that assessed the consequences of ecosystem change for human well-being, the TEEB initiative (TEEB 2010) that highlighted the global economic benefits of biodiversity, and the establishment of the

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES 2015) that acts as an interface between scientists and policy makers. Furthermore, the Convention on Biological Diversity (CBD 2010) has a strong focus on ES and includes this issue as one of its strategic goals. A comprehensive review on the history of the ES concept is given by Gómez-Baggethun et al. (2010).

In the field of landscape planning the ES approach is comparable with the idea of "landscape functionality" that has already been an issue for decades (Kienast 2010; Von Haaren and Albert 2011; Grunewald and Bastian 2013). Although this concept overlaps to a certain extent with the understanding of ES, many open questions remain before the ES concept is fully integrated in landscape research and decision making (Hermann et al. 2014).

Depending on the research question and the context, there are different ways to categorize ES. An overview of these different classifications is given by e.g. Häyhä and Franzese (2014). The most commonly used classification was developed in the frame of the Millennium Ecosystem Assessment (MEA 2003) that divided ES into four categories: supporting, provisioning, regulating and cultural services. Below, some examples are listed for the freshwater context (based on Aylward et al. 2005):

- *Supporting services* – needed as a basis for almost all other services. Ecosystems provide living spaces for plants and animals and support their maintenance. Examples for the freshwater context are:
    - Role in nutrient cycling – maintenance of floodplain fertility
    - Primary production
- *Provisioning services* – material/"tangible" outputs from ecosystems including food, water and other resources, e.g.:
    - Water for consumptive use – drinking, domestic use, agriculture and industrial use
    - Water for non-consumptive use – generating power, transport, navigation
    - Aquatic organisms - food and medicines
- *Regulating services* – services that ecosystems provide based on their regulating capacity, e.g.:
    - Maintenance of water quality – natural filtration and water treatment
    - Buffering of flood flows, erosion control through water/land interactions and flood control infrastructure
- *Cultural services* – nonmaterial benefits people obtain from ecosystems including aesthetic, spiritual and psychological benefits, e.g.:
    - Recreation – river rafting, kayaking, hiking, fishing
    - Tourism – river viewing
    - Existence values – personal satisfaction from free-flowing rivers

Within the scientific debate also another term – the so-called "ecosystem disservices" are discussed. This describes the negative values of ecosystems such as diseases, parasites, predators, or certain insects that are often overlooked in valuation attempts of ES (Dunn 2010). In the context of river landscape management the ecosystem disservice "flooding" is of specific importance. While flooding also provides valuable services, such as supporting fish nurseries in the floodplain or storing water in the floodplain and the aquifer, especially in areas where people settled or built too close to water bodies or in previous floodplains, flood events are considered as "bads" (Nedkov and Burkhard 2012). However, there is often little awareness of the fact that many of these disservices are actually caused by human activities in the first place.

Although the ES concept is highly popular in the scientific realm and is discussed in countless research articles and policy papers, its application in practice lags behind (Portman 2013; Hauck et al. 2013; Albert et al. 2014). One reason for this research-practice gap is seen in the lack of any guidance for policy makers to define, measure and value ES and to integrate them in policy and governance

(Bouma and van Beukering 2015). This points to the need for more direct science-policy interaction between researchers and stakeholders and a better communication to stakeholders and the public (Neßhöver et al. 2013; de Groot et al. 2010). Also, Böck et al. (2015) found that many stakeholders detected a certain redundancy between the ES concept and already existing guidelines and legal frameworks. Adding ES rather seemed like an additional instead of a reduced workload.

Despite these limitations, the ES concept can be very useful and offers many potential areas of application. They include 1) raising awareness about the importance of conserving ecosystems and their biodiversity; 2) understanding their significance in relation to human activities and well-being; 3) providing a new communication framework between policy-makers, scientists and the public on nature and society inter-linkages; 4) promoting the idea that maintaining natural capital through conservation and restoration will help sustain the provision of ES that we depend on (Wallis et al. 2011). It can also be helpful in the course of the evaluation of restoration projects to examine the effect of restoration on biodiversity and consequently the provision of ES (Rey Benayas et al. 2009).

24.2 Evaluation & assessment approaches for water-related ES

The increasing consumption of natural resources and the related loss of biodiversity are often used as an argument for the valuation of ES. Thereby, their visibility and their consideration in political and economic decision-making processes can be improved (Schwaiger et al. 2015). Several quantitative and qualitative, monetary and non-monetary, assessment methods and techniques have been developed to systematically assess the multitude of ES and the importance of biodiversity (Schröter-Schlaack et al. 2014). In addition to these newly developed approaches, already existing methods for data collection and assessment are also used for ES studies. This includes mapping and monitoring activities, (expert) interviews or statistical analyses (Grunewald and Bastian 2013).

Deciding on the most suitable assessment method depends on the research question and the assessment goal. Such a decision may hinge on the fact that the range of ES that can be assessed in monetary terms is rather small in comparison to the larger number of ES that can only be assessed qualitatively.

From the full range of ES, a large part can be assessed qualitatively, a smaller part can be assessed quantitatively and even smaller parts can be assessed in monetary terms. In particular, cultural ES are often given less consideration in quantitative and monetary assessments as their classification and measuring is difficult (Satz et al. 2013).To ensure a representative picture we need to combine monetary with other quantitative and qualitative assessments (ten Brink and Bräuer 2008). Therefore, Häyhä and Franzese (2014) suggest an interdisciplinary and systems perspective for ES assessments to avoid partially informed decisions and a consequent mismanagement of natural resources. Also Kumar and Kumar (2008) and Gómez-Baggethun et al. (2014) point to the need for integrated assessment approaches that also consider the social and ecological aspects of ecosystem service values. This need has already been considered by several recent initiatives such as the MEA, the TEEB initiative or the IPBES framework (Kelemen et al. 2014).

Several researchers point to the need of not only considering the utilitarian value of ecosystems for humans but bearing in mind that ecosystems can also have intrinsic values, irrespective of their utility for human well-being (MEA 2005). Already in the past, several researchers questioned whether a human-centered utilitarian perspective is sufficient to protect the environment or whether it is necessary to consider the needs of the environment apart from its usefulness to humans (Seligman 1989). Giddings et al. (2002) raised the question of how money can compensate a tree for acid rain or an animal for its loss of habitat.

It also needs to be considered that people are not only utility maximizers or satificers but have several other conflicting objectives (reciprocity, relational and ecological identity and similar processes) that

influence decision-making processes (Kumar and Kumar 2008). Gómez-Baggethun et al. (2010) discuss the uncertainties of the side effects of mainstreaming market-based conservation approaches in terms of possible changes in people's motivation for conservation as well as in their human-nature relationship.

It should be noted here, that evaluation and assessment approaches are not limited to applications within the specific context of the ES concept. Even though many recent studies focus on the valuation of the benefits humans derive from ecosystems, the valuation approach itself can be also applied to other aspects of nature, such as whole ecosystems, individual species or habitats. Ecological valuation methods, for instance, usually value ecosystems, rather than ES (Kronenberg and Andersson 2016). The approach of assessing nature is also important in the field of biomonitoring and bioassessment.

24.2.1 Monetary ES assessment approaches

The monetary evaluation of ES is seen particularly critically by various authors (e.g. de Groot et al. 2010; Kosoy and Corbera 2010; Spash 2008). They highlight technical difficulties and ethical implications. Norgaard (2010) for instance argues that "the metaphor of nature as a stock that provides a flow of services" is not sufficient to face today's challenges but can only work as part of a larger solution. Also a large share of interviewed stakeholders in a study of Böck et al. (2015) had a negative view towards a monetary ES assessment and voiced the fear of a commodification of nature.

Despite these limitations, economic arguments are more and more frequently used in nature protection practice. A prominent result of this emerging trend is the international TEEB-initiative (TEEB 2010), which has initiated several follow-up projects at the national level (Schröter-Schlaack et al. 2014). An economic view can improve the visibility of nature's functions and services and stress the related values to critical decision-making bodies, e.g. the World Bank, which currently follow the tenets of neo-liberal economics. It tries to support decision-making processes by revealing, in monetary terms, the benefit of protecting and the consequences of using nature (Schröter-Schlaack et al. 2014). Van Beukering et al. (2015) suggest four main reasons for an economic valuation of ES:

(1) Advocacy – using the economic valuation of ES to promote the economic importance of the environment
(2) Assisting decision- and policy-makers to make better informed decisions
(3) Assessing the compensation required after the damage of an ecosystem
(4) Setting taxes, fees or charges for the use of ES

As we can see from these arguments, monetary valuation is not always undesirable. For this reason, Kallis et al. (2013) propose a normative framework as decision support when to choose monetary valuation that considers four questions/criteria:

(1) Additionality – Will it improve the environmental conditions at stake?
(2) Equality – Will it reduce inequalities and redistribute power?
(3) Complexity blinding – Will it suppress other valuations?
(4) Neo-liberalism – Will it serve processes of enclosure of the commons?

According to the authors, a monetary valuation is reasonable if the answers to the first two questions are "yes" and the answers to questions (3) and (4) are "no".

A large number of various valuation methods is available to estimate the value of different ES. This is because no single economic valuation technique is applicable to all ES, but the methods vary depending on the ES' characteristics and data availability (DEFRA 2007).

A basic distinction is made between market-based and non-market-based valuation methods (Figure 3). The first method derives economic values from market prices, while in the second case ES are valued indirectly via revealed preference methods. The most commonly applied (indirect) market

valuation methods are the hedonic pricing and the travel cost method. The hedonic pricing method compares sales prices of two commodities (usually houses). The commodities need to be identical in most respects, except in regard to a certain environmental characteristic (e.g. traffic noise). The difference of the commodities' sales prices can then be interpreted as a revealed "Willingness to Pay" for the ES, resulting in a price for the ES. The travel cost method observes the travel expenses (e.g. travel costs, time, admittance fees) of people visiting, for instance, a recreation site, which implicitly represent the economic value of the site (Koetse et al. 2015). If there is no market price available, and the application of revealed preference methods is not possible, non-market valuation methods (i.e. stated preference methods) are used. The most important approaches in this context are the contingent valuation and the choice experiment method. In that case, surveys are used to ask people for their preferences for hypothetical changes in the provision of ES. Thereby, the values that people attach to them are estimated (DEFRA 2007).

Two alternative methods are the meta-analysis and the value transfer. Although they are not valuation methods in themselves they are relevant to mention as they are often used to derive ES values.

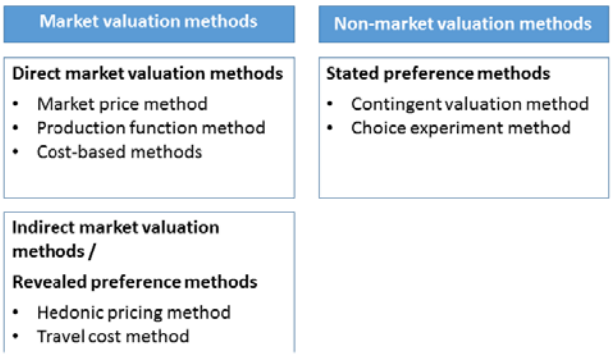

Figure 2: Methods for the valuation of ES based on Koetse et al. (2015)

Building on the work of Turner et al. (2004) and Young (2005), Brouwer et al. (2009, p.35f) summarized commonly used monetary valuation methodologies for water resources and differentiated them regarding the assessed water use. All techniques have certain weaknesses and strengths. The decision on which one to use depends on several factors (based on Brouwer et al. 2009):

- Type of ecosystem good/service to be valued
- Type of values – use values can be estimated by all valuation techniques while non-use values can only be estimated by the stated preference method
- Valuation purpose
- Data availability
- Required accuracy of results
- Available resources & time

24.2.2 Non-monetary assessment approaches

Because only a small part of nature's services can actually be assessed in monetary terms (cf. Figure 2) there is a need for non-monetary assessment approaches that also consider those services that are difficult to quantify. This is particularly the case for cultural services that are difficult to integrate in decision-making due to the challenge of assigning a monetary value to them (Chan et al. 2012). This can lead to a limited awareness of the variety of services that are provided by ecosystems and can be a challenge for mainstreaming ES across different societal actors (Martín-López et al. 2012). Although they are highly valued by different stakeholder groups, they are not reflected by economic indicators and therefore often sacrificed for economic or ecological reasons (Milcu et al. 2013; Chan et al. 2011).

To address these services, sociocultural valuation approaches are increasingly gaining attention (Chan et al. 2012; Chan et al. 2006). These approaches consider services that are related to non-use values, such as local identity or the intrinsic value of ecosystems, and cannot be addressed using economic techniques (Castro Martínez et al. 2013). They can be divided into qualitative and quantitative methods, both involving direct and indirect consultative methods (cf. Figure 4).

Oteros-Rozas et al. (2014), for instance, describe a socio-cultural valuation approach of ES that investigates people's perceptions of the importance of ES in a cultural landscape.

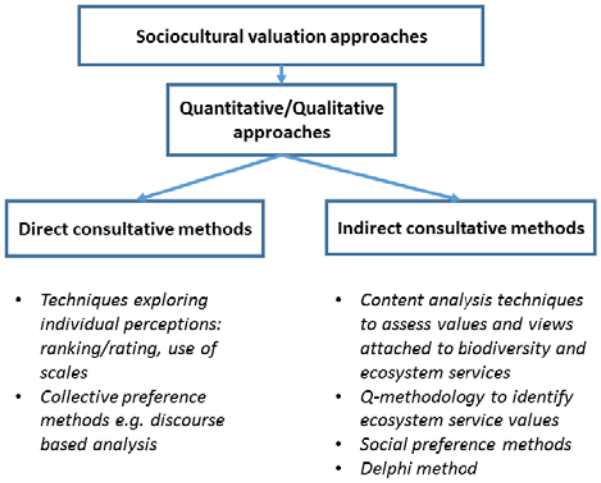

Figure 3: Overview on sociocultural valuation approaches (based on Kelemen et al. 2014 and Castro Martínez et al. 2013)

There are several other creative ideas from different researchers regarding non-monetary assessment approaches. For instance, García-Llorente et al. (2016) suggest that to analyze the social support for biodiversity conservation activities and the related delivery of ES, one calculates the willingness to give up time. Kumar and Kumar (2008) point to the need of considering psychological and sociological aspects in ecosystem service valuation. They argue that there is a need for approaches that combine natural and social science research.

24.3 Mapping and assessment of ES

An alternative to valuation that has become increasingly popular is the spatial representation of ES. This approach is often associated with participatory mapping or photo-based methods (Milcu et al. 2013; Raymond et al. 2009; Eder and Arnberger 2016) and is also frequently combined with monetary and non-monetary valuation methods.

The approach of mapping ES has rapidly increased in the last years. It can be particularly helpful to identify highly valuable areas for conservation, ES' supply and demand in a specific area and trade-offs between different services (Chan et al. 2006, Häyhä and Franzese 2014). Mapping ES can visualize the effect of different management strategies on their supply and can therefore be a starting point for developing strategies for management and conservation (Naidoo et al. 2008). It is also very useful with regard to communication and visualization purposes and can thereby support decision-making processes (Alkemade et al. 2014); especially participatory science processes that involve scientists, policy makers and local practitioners.

Verhagen et al. (2015) identified three main applications of ES maps, namely (1) the identification of "hotspots of change" i.e. areas that need to be protected from changes that affect the service supply, (2) the visualization of trade-offs and synergies between ES and, (3) the active management of landscapes to "optimize ES to locations" i.e. spatial configurations to optimize ES supply.

Different authors have proposed a variety of approaches for mapping ES, including the use of biophysical metrics or monetary valuations (Häyhä and Franzese 2014). Martínez-Harms and Balvanera (2012) classify ES mapping approaches into three main approaches: (1) Valuation of ES through benefit transfer (transferring the monetary value of a similar previous study to the current land cover map), (2) community value methods that integrate survey-based perceptions of place with biophysical data and, (3) different social-ecological assessment approaches that model the relationship between ecological and social variables to map ES supply. Which of the different proposed methods is applied depends on data availability, the scope of the study and time constraints (Verhagen et al. 2015).

Regulating services are the most commonly mapped group of ES. When looking at the individual services, carbon storage, carbon sequestration, food production and recreation are most frequently studied (Martínez-Harms and Balvanera 2012).

Several tools and frameworks are already available to map ES (Castro Martínez et al. 2013):

- The *InVEST-tool* was developed within the frame of the Natural Capital Project (http://www.naturalcapitalproject.org/invest/). Analyses can be conducted at local, regional or global scale. The results are either returned in biophysical or economic terms.
- The web-based *ARIES* (Artificial Intelligence for Ecosystem Services) technology (http://ariesonline.org/) combines a series of applications that assist in mapping ecosystem service provision, use and benefit through utilizing GIS data from global through local scale.
- Remote sensing – land use/land cover can be used as a proxy for quantifying and mapping ES. A review on relevant remote sensing approaches can be found in Ayanu et al. (2012)
- Polyscape – a GIS framework that is designed to explore spatially explicit synergies and trade-offs among ES to support landscape management (Jackson et al. 2013)

24.4 ES indicators

The assessment of ES generally requires the identification and application of a suitable and comprehensive set of indicators. Indicators are variables that provide aggregated information on certain phenomena (Wiggering and Müller 2004), provide a means of measuring service provision (Norton et al. 2015) and serve as communication tools to simplify the complexity of human-environmental systems (Müller and Burkhard 2012). Heink and Kowarik (2010, p. 590) provide the following general definition: "An indicator in ecology and environmental planning is a component or a measure of environmentally relevant phenomena used to depict or evaluate environmental conditions or changes or to set environmental goals". Some examples for indicators describing freshwater ES are the area occupied by riparian forests, the amount of fish produced (catch in tonnes by commercial and recreational fisheries), the ecological status of the water body in question or the number of visitors to specific sites (Maes et al. 2016).

When selecting indicators for an ES valuation, a careful and critical approach is essential. The framing and selection process not only defines what is being assessed (Hauck et al. 2015), but it also has significant influence on how the subsequent assessment can help policy and decision makers to take appropriate steps to counter undesirable ecosystem changes (Feld et al. 2010; Niemeijer and de Groot 2008).

An important factor to consider when choosing ES indicators is practicability and, in this regard, especially data availability. Some authors argue to use indicators that can be described by data that was already collected for other purposes. Others say this approach focuses too much on the currently most visible and easily accessible services (Hauck et al. 2015) and at the same time causes other ES to recede from view and to be neglected in policy decisions (Heink et al. 2015; Maes et al. 2012). Another essential aspect of the indicator selection process is to make a distinction between potential

and actual use of ES, because it results in different requirements for indicators. This circumstance is best explained with an example: When referring to the actual use of fish, one would choose a flow indicator (measured per unit of time) like tonnes of fish caught per year. When referring to the potential use of fish however, e.g. to find out about the reproductive potential of the fish population, a stock indicator (measured at a particular point in time) like the fish population size would be more suitable (Boyd and Banzhaf 2007).

Wiggering and Müller (2004) provide a list of scientific and management-related factors, which are relevant for successful indicator development, including, among others: a clear representation of the phenomenon of interest by the indicator, a clear proof of relevant cause-effect relations, a high degree of comparability in and with indicator sets, a good fulfillment of statistical requirements, high political relevance concerning the decision process, high comprehensibility and public transparency, a satisfying measurability and a high degree of data availability. Keeping all these factors in mind, the indicator selection depends heavily on the specific context of application and the characteristics of the investigated ecosystem (Reyers et al. 2010; Fisher et al. 2009).

24.5 The ES concept – applications in research & practice

The ES concept offers a number of potential applications in research as well as in the practice realm. In the following, the application of the ES concept is shown at the example of different case studies.

24.5.1 Case study: Monetary quantification of ES within the EU Project "REFORM"

An example of a project dealing with the quantification of ES is the EU-funded project REFORM (REstoring rivers FOR effective catchment Management) where, amongst many other issues, 20 pairs of restored and unrestored river reaches were investigated throughout Europe. The main project objective was to provide a framework for successful and cost-effective river restoration and to monitor the biological responses to hydromorphological changes, in order to reach the good ecological status or potential of rivers (REFORM 2015).

To investigate and quantitatively assess the success of the applied river restoration measures, REFORM used different response variables, such as hydromorphological attributes, habitat composition of the river and its floodplain, aquatic and floodplain-related organism groups (fish, invertebrates, floodplain vegetation, …) and stable isotopes. For eight pairs of restored and unrestored reaches, however, the project team additionally applied the ES approach to estimate restoration success (Muhar et al. 2016). Provisioning (agricultural products, wood, infiltrated drinking water), regulating (flooding, nutrient retention, carbon sequestration) and cultural (recreational hunting and fishing, kayaking, biodiversity conservation, appreciation of scenic landscapes) services were quantified and monetized by means of locally available data and literature, by conducting surveys among inhabitants and visitors, and by using a selection of economic methods (e.g. market value, willingness-to-pay survey). Afterwards, the resulting numbers were summed up to provide an estimate of annual economic ecosystem service value, normalized per area (Vermaat et al. 2015).

The authors of this study acknowledge that a monetary quantification of ES may not depict the fullness and diversity of societal appreciation (Westman 1977). Nevertheless they used this approach because it enables the comparison and evaluation of trade-offs and provides tangible information that is understandable for the general public and policy makers (Vermaat et al. 2015).

The results of the analysis show, that river restoration indeed enhances overall societal benefits. The restored reaches and their floodplains provided significantly higher service delivery and higher total value than the paired, unrestored reaches did (Vermaat et al. 2015).

24.5.2 Case study: Application of the ES concept in the context of the renaturalization of the river Emscher

One of the largest river restoration projects in Europe is currently being carried out in North Rhine-Westphalia, Germany with a total budget of 4.5 billion Euros (RWI 2013). The Emscher River is a tributary of the River Rhine. Its river system drains the Ruhr region, and its catchment of around 865 km² is home to some 2.5 million inhabitants. Thus, it plays an important role for economy and recreation in the area (Busch et al. 2001). As with most other rivers in Europe it has experienced major alterations during industrialization since the beginning of the 19th century. The Emscher system was transformed into a system of concrete sewage channels due to straightening, embankment and sewage discharge (Gerner et al. 2015; EG/LV 2015; Sommerhäuser and Gerner 2015; Winking et al. 2014).

A thirty-year project to restore the river system was started in the 1990s. The restoration measures include the construction of four decentralized sewage plants and 400 km of new, separated sewers, as well as restructuring of 350 river km in order to obtain a near-natural state (Sommerhäuser and Gerner 2015).

Even though the project is still ongoing, the benefits from several ecosystem services, such as biodiversity, climate regulation, water quality, flood retention, recreation and regional attractiveness have already been recognized. Since the 1990s, the flood retention area has doubled and a substantial increase of plant and aquatic macroinvertebrate species was measured. The increase of green areas (around 1 km²) improves climate regulation in the urban area. Additionally, the creation of 120 km of bike and walk ways strongly contributes to the enhancement of the region's attractiveness, educational value as well as to the increase of its monetary value (Sommerhäuser and Gerner 2015). Besides the direct effects of the restoration results, the construction measures themselves have to be considered. A study from 2013 revealed vast socio-economic effects from the project's implementation. On average, the project directly creates or saves 1 400 jobs per year, resulting in 41 554 person-years of useful work. According to the study, the numbers are even higher (109 787 person-years and 3 700 jobs/year) when including indirectly-connected production and employment effects. Additionally, the project generates tax incomes for the municipalities (around 50 m. Euros), federal states (around 91 m. Euros) and the German state (around 1.1 bn. Euros) over the whole project period (RWI 2013). The effect of the restoration activities on ES in this case study is specifically investigated within the frame of the "DESSIN" project (IWW Water Centre 2014) that aims to demonstrate a methodology for the valuation of ES.

24.5.3 Case study: The ES approach as a way to address different stakeholders' perspectives in river landscapes

Besides its potential applicability for assessment and communication purposes, the ES approach can be used to address different perspectives towards river landscapes. Based on this consideration, the ES concept was applied in three study cases in Austria as a basis to investigate people's perceptions of the availability and importance of various services provided by near-natural, restored and degraded river landscapes. The focus lay on stakeholders with a certain decision-making competency and recreational river users in the case studies of the Enns and Drau rivers (Böck et al. 2013). In the third case study, the river Traisen, the focus lay on children and young adults (Poppe et al. 2015).

The results of the semi-quantitative questionnaire-based surveys revealed that in all three case study surveys, participants perceived cultural and supporting services the highest. In the Enns and Drau river case studies, survey participants regarded nature experience, recreation and tourism as well as recreational fishery and water sports as specifically relevant (Böck et al. 2013). The surveyed young adults in the Traisen river case study most often associated structural elements, such as water or stones, with cultural functions, e.g. recreation possibilities within the river landscape. Similar to the

first two case studies they regarded cultural, regulating and supporting services – specifically room for free movement, restfulness and reduction of pollutants - as highly important (Poppe et al. 2015).

All three case studies applied a strong focus on non-monetary river landscape uses. This contrasts with the limited consideration of these services in practice in the formulation and application of policy. There, provisioning services tend to be given priority as they can be quantified and evaluated more easily and are therefore better comparable with economic values like jobs and property values.

The results of the investigations shall contribute to gaining a comprehensive view of river landscapes and thereby improving future restoration planning and management. The insights into people's perceptions have the potential to foster awareness for the importance of conserving a wide range of different river ES and assist in estimating future educational needs.

24.6 Policy context – ES concept as decision making tool

The ES concept has the potential to contribute to already available management approaches. Its integration can help to support the evaluation of policy impacts e.g. through the application of combined quantitative and qualitative valuation approaches. Its implementation into existing policy frameworks is discussed by several authors (e.g. Wallis et al. 2011; Vlachopoulou et al. 2014) and has the potential to be an added value in future decision making processes.

24.6.1 Integration of the ES approach into the WFD

Although the ES-concept is not yet explicitly mentioned in the EU-Water Framework Directive, the aspect of ensuring the provision of ES is implicitly linked with the WFD objective of "reaching a good ecological status" (Wallis et al. 2011). The following WFD articles specifically refer to the valuation of ES (based on Wallis et al. 2011):

- Article 5: assessment of the economic significance of water use, current level of cost recovery
- Article 4: decisions on derogations
- Article 9: assessment of the level of cost recovery and incentive pricing
- Article 11: selection of the most cost-effective sets of measures for achieving good ecological status/potential for the programs of measures

The clear linkage between the WFD and its principles and the ecosystem approach is also shown by Vlachopoulou et al. (2014). They argue that it has the potential to act in a complementary way. It could, for instance, be applied for the evaluation of different management scenarios and thereby support decision-making processes. In particular, the more holistic management approaches that are supported by the ES approach, such as the spatial mapping of ES or the comprehensive evaluation of multiple benefits, can potentially assist in achieving the goals of the WFD (Vlachopoulou et al. 2014).

In this context, Koundouri et al. (2015) propose an integrated methodology that regards the ES approach as the core aspect to achieve a more sustainable and efficient water management. It combines the ES framework with traditional economic frameworks and consists of a socio-economic characterization of the river basin area, an assessment of water use costs that are recovered and a suggestion for appropriate measures for sustainable water management.

In order to enhance the WFD implementation, Reyjol et al. (2014) established a list of research needs that also includes the reinforcement of the knowledge on relationships between good ecological status, biodiversity and ES. They recommend enhancing understanding of ecological processes through developing further research on the links between good ecological status, biodiversity and ecosystem functioning. As the ES concept is still not very well known among water policy makers and managers, they point to the need for easily comprehensible guidelines for these actor groups.

24.6.2 Integration of ES into Biodiversity policy – 2020

In 2011 the European Commission adopted the "Biodiversity Strategy to 2020" aiming to "halt the loss of biodiversity and the degradation of ES in the EU by 2020, and restore them in so far as feasible, while stepping up the EU contribution to averting global biodiversity loss" (European Commission 2015). Besides the first target of creating a habitat network by ensuring the implementation of the Birds and Habitat Directive, the second target of the Strategy specifically addresses the protection and restoration of ecosystems and their services, since it is assumed that the restoration of ecosystems goes hand in hand with the protection and provision of ES. More specifically, Action 5 of the Strategy recommends to "assess the state of ecosystems and their services in their national territory by 2014, assess the economic value of such services, and promote the integration of these values into accounting and reporting systems at EU and national level by 2020" (European Commission 2011). For fulfilling these aims the working group "Mapping and Assessment of Ecosystems and their Services" (MAES) was established and delivered an approach for mapping and assessment of ES. In a technical report from 2014 the working group stresses that several conceptual issues regarding ES remain unexplained and that the links between biodiversity, ecosystem functioning & the provision of ES are still not well understood (Maes et al. 2014).

A mid-term review of the Biodiversity Strategy to 2020 states that since the strategy was adopted, some local improvements have been made in terms of ecosystem restoration but at a rate so low that it leads to further ecosystem degradation and loss of ES. Human pressures on freshwater systems and other ecosystems remain unfavorably high, such that high impacts on biodiversity in freshwater systems persist. However, some important enhancements in the knowledge base have been made, and the collected data of assessed and mapped ecosystem and related services will be available for the support of decision makers and private stakeholders in planning processes (European Commission 2015).

24.7 Opportunities of the ES concept in river landscape management

Despite the aforementioned limitations and the fact that the ES concept has not yet "taken off" in river landscape management practice, it has the potential to raise awareness in society in general and for administrative actors and political representatives in particular (Böck et al. 2015). It could help to improve societal and political acceptance of river restoration projects (Vermaat et al. 2015) and serve as a tool to improve environmental communication and education (Böck et al. 2015; Rewitzer et al. 2014). Due to its integrative character, actors in river landscape management also regarded the ES concept as a valuable support for planning and decision-making processes (Böck et al. 2015). For landscape planning processes, Kienast (2010) stresses conceptually strong points of the ES concept, such as the systematic approach of determining services and interdisciplinary, holistic approaches to supporting decisions based on integrating values generated from different perspectives (see Chapter 19).

A major benefit from the application of the ES concept can be gained through its integration into on-going programs, tools, processes and policies. Through the recognition and quantification of ecosystems' benefits for society they are no longer deemed as worthless in decision-making processes (Everard 2009). On the contrary, the worth of ES will be increasingly recognized as society begins to decarbonize our economies to mitigate the impacts of climate change. This will involve lowering or eliminating the use of fossil fuels, whose services were used to substitute for the loss of ES over the past two centuries. Increasing acknowledgement of the vital role that ES play in the functioning of river social-ecological systems will be formalized not only in policy but in practice. This transition will be challenging, if only for its novelty, but earlier incorporation of ES into our economic and political practice will make it easier.

12

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5 Synthesis of research results

In the following chapters, the main research findings of the dissertation are summarized and discussed.

5.1 Stakeholders' perceptions of river-based ecosystem services

In river landscape management a trend towards integrating visions and perspectives of different stakeholder groups in decision making processes can be determined. The basis for that is a common understanding of river landscapes and their manifold functions that prevents from missing aspects that are relevant for single stakeholders (Dunn 2004). The ES concept has the potential to support this common understanding by addressing the complexity of river functions and make them more tangible.

Article #1 describes how different stakeholder groups with a professional or personal interest in river landscapes perceive ES. The focus lies on similarities and differences between different stakeholder groups' perceptions and potentials for conflict. ***Article #5*** specifically addresses youths' perceptions of ES in river landscapes.

A general high estimation of the importance of ecological and cultural services of river landscapes could be determined among the different surveyed stakeholder groups. This high awareness of cultural services corresponds well with the findings of Chiari (2010). Also in this study the importance of intact rivers, e.g. for recreational use, was observed as high by interviewees. However, this strong focus on the non-monetary use of the river landscape is not consistent with the limited consideration of this view in practice where provisioning services are in the foreground (Daniel et al. 2012).

The interviewees primarily saw conflict potential between the energy and agricultural sectors and ecological and cultural river functions. This perception is coherent with the debate on the expansion of hydropower use (according to the Renewable Energy Directive) and probably also biased through it.

The perceptions of ES of different stakeholder groups were largely coinciding. Expert practitioners from various disciplines and non-experts alike listed a broad range of ES. These homogeneous results are most likely due to various participation processes in the past, which produced both a shared basis of knowledge and an acceptance of different perspectives and interests.

The ES concept proved to be helpful to describe the functions and services of river ecosystems that different stakeholder groups are interested in. Moreover, the assessment of ES perceptions can contribute to a more comprehensive view in future river landscape management planning. The knowledge gaps and identified lack of environmental awareness can be used to determine future education needs regarding river landscapes.

Whether the ES concept will be applied in practice, e.g. in future participation processes to analyze different interests regarding river use was estimated differently. This question is also dealt with in the following chapter.

5.2 Stakeholders' views on the ecosystem services concept

While the ES concept is already regarded as "mainstream" in the scientific realm (Braat and de Groot 2012) its' practical application is described as lacking behind by several authors (Portman 2013; Hauck et al. 2013; Albert et al. 2014). This also became evident in the course of the fieldwork phase where many interviewees were not familiar with the concept and reported a limited practical application.

Article #2 addresses this imbalance and analyses stakeholders' awareness of the concept, the observed practicability and concerns regarding the implementation in processes of river landscape management. For this purpose, a qualitative survey was undertaken addressing decision makers, involved parties in river management processes as well as people that are affected by benefits and losses of river landscape functions at the example of two case studies in Austria.

Only half of the interviewees knew the ES concept and it only played a minor role in their actual working environments. The term "ES" as such was observed as less relevant while the issue was seen as being dealt with indirectly e.g. in the frame of status assessments according to the Water Framework Directive. Certain redundancies to other concepts that have been used already earlier e.g. landscape functions or environment and resource costs were reported. Moreover the concern was stated that the concept was too complex to use it as a basis for decision making. Critical arguments regarding the assessment of ES mostly referred to the challenge of classifying and measuring cultural ES. Also, many interviewees had a negative view towards a monetary ES assessment.

Despite the addressed challenges, the ES concept was also seen as a tool that could potentially be relevant for assessment tasks, as a support for communication and education as well as for argumentation purposes. In particular its integrative character was described as helpful. It could be an opportunity for gaining a comprehensive viewpoint and thereby raising awareness about the manifold services of near-natural and restored river landscapes among society as a whole, administrative and political representatives.

Based on these results a better integration of practice experts in the further development of the ES concept, downscaling to local levels and developing alternative assessment methods in order to enhance the concept's practicability is recommended.

5.3 Application of the ES concept in river landscape management

As already indicated in the previous chapters the ES concept can be relevant for different practice applications. ***Article #9*** gives an overview on different applications of the ES concept in the context of river landscape management. This includes different evaluation and assessment approaches and the use of the ES concept as policy and decision making tool.

Article #3 describes the use of this concept for the estimation of the success of river restoration as a possible support for policy evaluation. It was investigated whether the societal appreciation of restored reaches is higher than that of unrestored reaches and whether service provision and valuation are related to any underlying geographic difference.

At the example of eight pairs of restored and unrestored river reaches and floodplains selected provisioning, regulating and cultural services were assessed with different monetary assessment methods. Despite a range of criticism regarding this approach (McCauley 2006; Kosoy and Corbera 2010; Jax et al. 2013), it has the potential to improve comprehensibility among the general public and decision makers. It allows a harmonization of differently expressed values that can be compared more easily and was therefore also used as a basis for the study. The investigated ES were expressed in biophysical units, monetized and summed per reach.

The results show that restored reaches had a significantly higher total ecosystem service value than unrestored reaches. This was primarily due to an increase of cultural services. Relating catchment and floodplain land use to ecosystem service delivery it was found that cultural services are valued higher in areas with higher population density and more intensive agriculture.

Although the economic value estimates may not be exactly accurate reflections of total economic value due to methodical limitations they still appear meaningful compared with similar approaches in literature.

Article #5 describes the application of the ES concept in another context, namely for addressing the complexity of river landscapes in the communication with youths. The aim was to improve students' knowledge and understanding regarding key processes in the catchment of their "home river". The results of the investigation confirm that the ES concept is a suitable method for sharing knowledge regarding complex relationships in river landscapes.

5.4 Stakeholders' understandings of concepts of human-nature relationship

In connection with the previous project parts, consideration is being given to the fact that the perceptions of river landscapes are possibly influenced by different understandings of and attitudes towards nature. In the context of the ongoing paradigm shift in river management that follows more sustainable and participative approaches these understandings have the potential to assist in guiding and reflecting upon participation and engagement processes (de Groot and de Groot 2009).

To analyse different stakeholder groups' views and possible connections with engagement in participation processes, a list of six typologies of human-nature relationships (HNR) was developed based on a literature review (Flint et al. 2013) and explorative interviews. ***Article #4*** describes the application of the related narratives in quantitative as well as qualitative surveys at two river landscapes in Austria.

Findings of the quantitative survey indicate that despite prior assumptions of river managers as either controllers or "masters" of natural processes, a strong rejection against this type could be determined while the highest agreement could be found for the types "user" and "steward" of nature.

Article #7 tries to find reasons for this situation – the global reality of industrialisation on the one hand and a high rejection of the concept of "Mastery over nature" on an individual level on the other hand. In qualitative interviews it was investigated how representatives from different stakeholder groups view this paradox. Possible reasons were seen in (1) the interpretation of activities in the sense of "Mastery over nature" as "Stewardship", (2) discrepancies between stakeholders' private understanding of HNR and the conditions under which they conduct their professional life, (3) situational aspects, (4) a certain discrepancy between people's vision and reality, and (5) a discrepancy between self-reflection and reflection through others. Furthermore, social desirability issues as well as the wording of the narratives were seen as an issue.

Many study participants showed interest in reflecting on their HNR and highlighted this approach's potential of improving mutual understanding. It was also seen as a potential auxiliary means to raise awareness for the way we deal with nature and motivate people. However, due to the concept's complexity the concern was raised that it was not comprehensible enough to use it in practice. For the application of this approach, e.g. in future participatory processes, further research is needed to develop an easily comprehensible tool that cannot only be used for assessing individual understandings of human-nature relationships but also be applied for group based reflections.

5.5 Development of a method to operationalize concepts of human-nature relationship

Discourses on the conceptualizations of human-nature relationships (HNR) can be found in social science and philosophical literature (Flint et al. 2013). Although these discourses revolve around the same notion of HNR, no shared understanding on a common typology has been developed yet. Also, there is no established way on how to assess HNR empirically. Based on these knowledge gaps ***Article #6*** addresses the questions how different types of HNR concepts can be identified and which scales are suitable for that. As there is no empirical evidence on the potential link between HNR and behaviour it furthermore explores potential correlations between individuals' understanding of their relationship with nature and their environmental behaviour. To validate the results the link to

Schwartz's Theory of Basic Values (Schwartz 1992) is established that has been successfully applied in numerous studies to explore environmental behaviour.

Based on a comprehensive literature review and testing the applicability of already existing HNR scales, these scales were expanded and revised in the course of three subsequent studies (also including the study described in ***Article #4***). A combination of qualitative and quantitative research methods as well as reflective discussions served to develop the final scale that was applied in a quantitative survey involving students from the US and Europe. The questionnaire used in this survey did not only include the developed HNR narratives but also items to assess environmental behaviour and items from the "Portrait Value Questionnaire" (Schwartz et al. 2012).

The results support the findings of ***Article #4*** and revealed that people hold multiple HNRs. Furthermore, also in this survey the notion of "Apathy" and "Master" was rejected while the study participants rather identified themselves with the HNR types of Steward, Partner, Participant and User. Strong correlations between HNR and values as well as a connection between HNR and environmental behaviour could be identified.

The results also confirm findings in literature that HNRs are not mutually exclusive and context dependent (Flint et al. 2013). As people seem to hold multiple HNRs simultaneously, addressing the relationship humans have with nature might be a supportive approach for (participatory) governance processes. In this context it might also assist reflections and discussions on peoples' relationship with nature as emphasized by several interviewees.

Furthermore, the findings suggest that considering the relationships humans have with nature assists in understanding the complexity of human behaviour.

Based on these findings ***Article #8*** goes one step further and analyses different frameworks for investigating relationships and interactions between social and natural systems. It highlights the relevance of individual and collective understandings of the HNR as influencing factors for environmental behaviour as existing frameworks often consider this aspect only insufficiently. Based on that, the article proposes a model for a better consideration of social-cultural concepts of nature in social-ecological systems frameworks. This model is meant to act as add-on-module to existing frameworks and can serve as a guide for researchers to consider how dimensions of HNR fit within broader frameworks of human-environment interactions. In the practice context it could help to improve the practice of natural resource management via "human-nature relationship toolkits" to be used by government agencies, practitioners, NGOs and citizens' groups. They could support in making managers of planning and governance processes in natural resource management aware of the role that social-cultural concepts of nature play in different contexts and could help them to reflect on their own and others' positions.

6 Conclusion

Out of the research articles following conclusions can be drawn:

Concepts of human-nature relationships on the societal level: Integrating the ecosystem services concept in river landscape management

- Stakeholders across all levels (strategic, implementation, user) in river landscape management show little awareness regarding the ES concept.
- Although the results revealed a limited integration of the ES concept in river management practice, interviewees perceived the concept as worth to be applied. It was particularly seen as suitable to aid planning and decision making and as communication and education tool.
- The ES concept proved to be useful to describe the functions and services of river ecosystems that different stakeholder groups are interested in and to illustrate the societal benefits of river restoration. Moreover it could assist in assessing and improving the understanding of complex processes in river landscapes among youths.
- Several concerns stated by the interviewees point to the need to further develop the ES concept through a better integration of practice experts, downscaling to local levels and further developing alternative assessment methods.

Concepts of human-nature relationships on the individual level: Development and application of a related scale

- The results confirm findings in literature that HNRs are not mutually exclusive and context dependent. Furthermore a clear correlation between the relationship humans have with nature and their environmental behaviour was identified. This finding suggests that considering the relationships humans have with nature assists in understanding the complexity of human behaviour.
- A structured tool for group based reflections on HNR could be helpful for fostering engagement and guiding sustainability oriented processes. Many stakeholders showed a strong interest in discussing people's relationship with nature in relation to their professional or private activities.
- A starting point could be the described "add-on module" for existing frameworks for analysing interactions between social and natural systems. For the practice of natural resource management the scientific terms need to be translated into plain language and the developed "Human-Nature relationship toolkits" need to be tailored for certain ecosystem types or cultural contexts.
- Future research should focus on the question on how to activate or strengthen HNRs by governance strategies and communication framing to better rebalance the relationship humans have with nature.

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