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The Suitability of the Ecosystem Services Framework for Guiding Benefit Assessments in Human-Modified Landscapes Exemplified by Regulated Watersheds - Implications for a Sustainable Approach

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Abstract: To support decision-making, benefit assessments have become an obligatory part of natural resource management. In this context, the ecosystem services (ES) framework has been widely adopted for identifying and assessing the values at stake, yet the concept ignores benefits from water and land use functions as important contributions for societal welfare. This paper aims to contribute knowledge for improved benefit assessments in human-modified landscapes, exemplified by watersheds regulated for the production of hydropower. Through a case study approach in two regulated watersheds in Norway, beneficiaries' perceptions of the benefits associated with key watershed activities, i.e., hydropower production, kayaking, angling, and hiking, are presented. Considering the beneficiaries' perspectives, we discuss the relative ability of economic, quantitative, and qualitative assessment methods to present benefits. The study shows that benefit assessments must be carried out on different scales of governance, as benefits are context and scale dependent. We argue for an approach which considers a balance of benefits obtained from ecosystem services, and from water and land use functions within ecological limits. The suitability of the ES framework for guiding benefit assessments in a human-modified landscape and its complementarity with the sustainability concept for informing local-level decision-making are discussed.

Keywords: ecosystem services; benefit assessments; beneficiaries; regulated watercourses; sustainability dimensions; hydropower

1. Introduction

The recent decade's increasing emphasis on the need for benefit assessments as part of policy decisions has been driven by activities involving multiple pressures, multiple ecological issues, and competing social priorities [1]. To support decision-making, benefit assessments have become an obligatory part of natural resource management. They are included as a step before the selection of measures in several planning frameworks, such as the Water Framework Directive [2], and benefit assessments have for long been essential in environmental impact assessments (EIAs). However, the contribution by ecosystem functions in benefit assessments were previously poorly acknowledged, implying the risk of unsustainable outcomes of measures and interventions. Recognizing this shortcoming, a strategy for a global ecosystem assessment was developed in 1998 by WRI (World Resources Institute), UNEP (United Nations Environmental Programme), the World Bank, and UNDP (United Nations Development Programme). The strategy refers to ecosystem functions and a framework of associated ecosystem service contributions to human wellbeing [3]. The conceptualization and definition of ecosystem services (ES) focuses on the benefits that humans obtain from the ecosystem and ecosystem functions, as well as the conditions and processes through

which ecosystems sustain and enrich human life. The ES concept is referred to in the global initiative entitled the Economics of Ecosystems and Biodiversity (TEEB), that focuses on "making nature's values visible" [4], and in the Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services (IPBES) administered by UNEP [5,6]. Further driving the use of ES for guiding benefit assessments is the development of a standardized typology for ES in the EU through the Common International Classification of Ecosystem Services (CICES) [7,8]. These initiatives have fostered a vast number of publications, and the ES framework has been widely adopted for identifying and weighting the social and ecological values which are at stake in management schemes. Debates, however, have been extensive, about the implicit commodification of nature as an economic entity [9,10], the neglect of cultural services [11,12], and the difficulties of operationalizing the framework in policy situations [13–17]. Scholars and practitioners argue that despite the ES framework's intention of being inclusive, the benefits associated with aesthetic or inspirational goods have largely been overlooked due to the methodological challenges associated with assessing such intangible benefits [12,18].The practical application of ES continues to be hindered by its highly theoretical nature [8,17,19,20]. Authors have also emphasized the need for a common vision on how to conceptualize ES within sustainability as an overarching normative goal [8,21,22].

This paper contributes to the ecosystem services and sustainability discourse by studying the ES concept in a human-modified landscape. We understand human-modified landscapes as systems which are exemplified here by regulated watersheds, where the received benefits are products of human management or intervention. We address the issue by focusing on beneficiaries in watersheds regulated for hydropower production. Hydropower production is among the activities that modify watersheds, while also generating several benefits for society [23]. Other examples of human-modified landscapes are aquaculture farms, agro-ecosystems and urban ecosystems. Human-modified landscapes provide important benefits for economic and social welfare, such as renewable energy and flood control [24]. These are examples of benefits which have not been addressed by the ES concept; yet, such benefits need to be addressed in the context of sustainability. Identifying benefits derived from both ecosystem services and from human interventions is important for addressing trade-offs, as managed ecosystems typically involve the promotion of some benefits at the expense of other [22,25,26].

This study builds on the approach in Chan et al. [27] and Pandeya et al. [14], who identify benefits by focusing on the beneficiaries' own perceptions of goods and benefits. A beneficiary is thus here defined as a group or an actor who experiences benefits from goods and activities in the context of a regulated watercourse. The focus on beneficiaries enables a contextualized approach by linking informants' perceptions of benefits to a time and place. It provides an understanding of values people hold in specific places [28]. The paper presents beneficiaries' perspectives on benefits and benefit assessments in two watersheds which have been regulated for hydropower production in Norway. The identified goods and benefits are based on the informants' stories about experiences, both current and previous, from their youth. In line with other studies [4,27,29], we address benefits as end-products of services provided in the watershed. We distinguish between services provided from the watershed ecosystem services [29] and those derived from regulating the water watercourse, i.e. a water use function. We define a water use function as the goods and services provided from human intervention in the form of modifying the water flow regime (modified from [30]). Based on a case study approach, we present benefits associated with key watershed activities referring to hydropower production, kayaking, angling, and recreational activities. Considering the beneficiaries' perspectives, the relative ability of economic, quantitative, and qualitative benefit assessment methods in assessing benefits is discussed. The informants' conception of relevance, credibility, and the legitimacy of assessment results are the criteria for discussing the fit of an indicator or benefit assessment method [31].

This paper highlights the fact that, for a legitimate and relevant assessment approach, methods for benefit assessment need to be suited to the scale and context of the assessment. The beneficiaries' perceptions of benefits may differ, depending on whether the scale is local, regional or national. It is argued that local level benefit assessments require a participatory and place-based approach in order

to identify benefits. Furthermore, addressing the benefits on local, regional and national level by different beneficiaries enables a knowledge-based discussion of trade-offs among benefits for different groups on a local versus a national level. Based on our findings, we discuss the complementarity of the ES with the sustainability concept as a means of informing decision-making.

1.2. Hydropower in Norway and the Case Study Areas

The case study areas are the watercourses in Eksingedalen and Teigdalen in the west, and the Sira and Kvina watercourses in the south-west of Norway (Figure 1). The watercourses were regulated more than 50 years ago for hydropower production by means of a license from the Norwegian Water Resources and Energy Directorate (NVE) and are now due for revision of licence conditions. Old hydropower licenses from the 1960s and earlier do not include conditions for minimum flow or other environmental criteria. The revision thus represents an important opportunity for local authorities and other stakeholders to demand improved environmental conditions in the regulated watercourses. The current national guidelines for the revision process are set in a guiding document by the Ministry of Petroleum and Energy (MPE) of May 2012 [32]. Before 2022, over 400 of the river courses in Norway may be have their licence conditions revised [33]. In the context of a revision, trade-offs must be made between the advantages and disadvantages of the proposed new license conditions. The benefits of improved environmental conditions of the watercourse may include e.g. improved fishing, recreation, positive effects for the landscape and biodiversity, while the disadvantages can be reduced power production and a weakened power balance [33]. The MPE guideline states that the requirements for minimum water flow and storage restrictions will be determined for specific cases where the value and potential of the affected areas are high, the effect of mitigation measures on benefits are high, and the effects for production and regulation capacity are not significant. In this situation, the identification and assessment of benefits, referring to benefits from regulation as well as from other economic and socio-cultural activities in the watercourse, are important for the decision-making process. During the revision process, the general public and stakeholders are asked for comments on experienced and documented harm, and on the disadvantages caused by the proposed regulation.

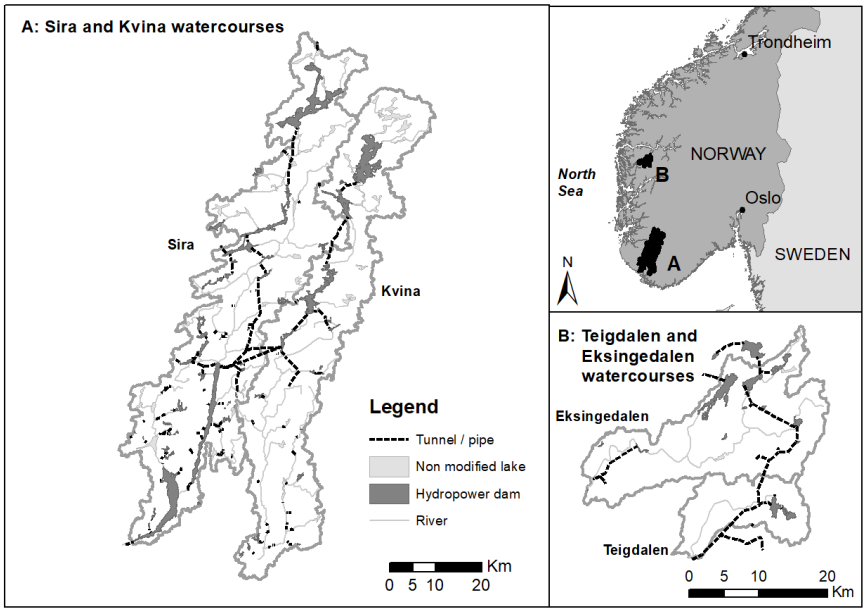

Figure 1. The case study areas in Aust-Agder, Vest-Agder and Rogaland counties, the Sira and Kvina watercourses, and in Hordaland county, the Eksingedalen and Teigdalen watercourses.

The Teigdalen and Eksingedalen watercourses in Hordaland county were regulated in 1966 through the Evanger license. The host municipalities are Vaksdal and Voss. The river basin area is

approximately 254 km² and the annual hydropower production from the Evanger hydropower plant, which is Norway's tenths largest, corresponds to approximately 1267 GWh. The Eksingedalen watercourse does not have minimum environmental flow requirements in the upper parts, and there are no minimum environmental flow requirements in the Teigdalen watercourse. Some voluntary measures for improved environmental conditions, however, have been implemented by the hydropower producer BKK for both these watercourses. Voluntary measures primarily refer to the construction of weirs and big rocks to protect aquatic species' spawning grounds and the removal of water vegetation [34]. Before the regulation, the Eksingedalen watercourse was known for large salmon fish, and salmon fishing in the river was very popular. There has since then been a serious reduction in both the size and number of catches [34,35]. The Teigdalen watercourse is also part of the Vosso Area, which has been described as a world capital for river kayaking [36]. There is active kayaking in several rivers in the Vosso area between April and November during periods of sufficient water flow, usually May and June, in connection with snow melts, and during the rains in autumn. In 2011, a non-governmental community organization Eksingedalen bygdaråd (umbrella organization of local NGOs), the Forum for Nature and Outdoor Life (an umbrella organization for nature and environment NGOs) in Hordaland, and a private enterprise, Stiftelsen Voss Klekkeri, each sent demands for revision of the Evanger license by means of a letter. The letters described environmental damage and argued in favour of revisions of the license conditions. The Evanger license is currently under consideration. The BKK Produksjon AS has submitted applications for upgrading and expanding their projects within the river basins.

The Sira and Kvina watercourses are located in Aust-Agder, Vest-Agder and Rogaland counties (hereafter referred to as the 'Agder area'). The main host municipalities are Sirdal and Kvinesdal. The river basin area is approximately 2700 km² and the annual hydropower production from the Sira-Kvina regulations corresponds to approximately 5% of Norway's total power generation. The watersheds were first regulated for power generation in 1909, but the main concession for the Sira-Kvina regulation was awarded in 1963. Kvina was originally a good salmon river with catches of several tonnes a year, but due to low water supplies and acidification, the salmon have disappeared from the water course [37]. Due to voluntary environmental measures implemented by the Sira-Kvina Hydropower company, the salmon population has returned, but strong regulation and low water flows mean that the fishing conditions are highly dependent on higher water levels after rainy periods (focus group discussion, 2017). Voluntary measures having been implemented by the regulator include a minimum flow regime in certain lengths of the watercourse for salmon migration. In 2010, the Sirdal and Kvinesdal municipalities sent a request to NVE requesting that revisions be applied to the Sira-Kvina hydropower regulations. The demands were based on a local process including various open local meetings initiated from 2005 to discuss the focus of this revision document. The demands included extensive revisions to a document which describes the main negative effects that the development of the Sira and Kvina watercourses has caused for general interests in the area. The Sira-Kvina license was opened for revision in 2015. In January 2019, NVE announced that they would recommend MPE to introduce new and more environmentally friendly licensing conditions for the regulation of the watercourses [38]. The recommendation refers to the dialogue process and a voluntary agreement document developed by the Sira-Kvina Hydropower company, as well as to the host municipalities and two other municipalities which would be impacted by the regulation. NVE's recommendation for the revised license conditions also noted that the associated hydropower plants are important for power supplies both regionally and nationally.

2. Materials and Methods

The starting point for the study was to contribute knowledge in order to improve benefit assessments in regulated watersheds for hydropower production, by exploring beneficiaries' understanding of benefits and their perception of appropriate benefit assessment methods. The study exemplifies benefit assessments in human-modified landscapes, where benefits are experienced from both ecosystem services and land- and water-use functions [30].

Different research activities, methods and data were combined in an overall case study approach. Case studies are well suited to explore complex environmental phenomena and to draw broader lessons from a specific case [39]. As generalizing concepts and lessons from a single case can be imprecise, more than one case was chosen, as was an analysis of multiple data sources to triangulate, and thus to support and complement, insights and aspects which emerged from the cases.

2.1. Research Design and Data Collection

To study the approaches for benefit assessments, fieldwork was conducted in two dedicated study areas during the period of 2015–18: Eksingedalen and Teigdalen in Hordaland county and in the Sira and Kvina areas in Aust-Agder, Vest-Agder and Rogaland counties (hereafter referred as Agder) in Norway (Figure 1). The watercourses were selected because they are regulated for hydropower production with license conditions that are subject for revision. The fieldwork addressed the assessment of benefits, with an emphasis on the activities and experiences which were taking place in the rivers and within the river landscapes.

A dialogue approach towards the actors in the river basins was a key component throughout the research. The objectives of the dialogues and interactions were to collect qualitative research data and to enable the involvement of the relevant actors in the process. A wide range of stakeholders were engaged in the case studies, including representatives from national public agencies, natural resource management authorities, municipalities in the watersheds, hydropower companies and local and regional NGOs. Primary data were collected through one-on-one, semi-structured interviews, in workshops, and as part of focus group discussions. Additionally, the study used sources from a wider spatial range, i.e., beyond the case areas, referring to desktop data from different EIAs and existing benefit assessments of freshwater and other natural environments. An online survey among key groups of actors was undertaken to obtain data on the important characteristics of the indicators and methods relevant for assessing benefits in regulated watercourses.

2.2. Research phases

Data collection followed a process-based approach, initiated by the mapping of important beneficiaries in the watersheds, the situations and stories associated with the experienced benefits, and the connection of these to specific river stretches and their biophysical characteristics. Based on an understanding of the situation concerning the activities in the watercourses, beneficiaries' perceptions of benefit assessments and the methods and indicators used in benefit assessments were explored.

Phase 1: Initial insights and mapping of beneficiaries in the case areas

The study started in 2015–16 by identifying potential the beneficiaries of regulated rivers in Norway, with a focus on the aforementioned case areas. The informants were identified through the snowball method, where some initial key informants, mainly the municipalities and the hydropower company in the watersheds, suggested other informants [41]. Also, social media was central for identifying relevant groups and informants in the case areas. Informants were people working in hydropower companies, in public management, environment and outdoor living organizations and people who owned land alongside the rivers. Altogether, 22 and 16 were interviewed in Hordaland and Agder area, respectively. Interviews were conducted in the informants' local communities. Open-ended questions were asked as a means of encouraging the local beneficiaries to talk about the river, the local conditions and their personal observations and concerns in their own words. Particular river stretches associated with the respondents' stories were identified using a freely-available digital map-based tool, Scribble maps; respondents were asked to make marks directly on the digital map during the interview to indicate precise geographies. Two workshops in Hordaland and Agder were organized in April 2016 with participants from the communities, to present the study and to get feedback on the identified beneficiaries and benefits in the respective watercourses. Also, relevant indictors for benefit assessments were discussed, and about 12 and 20 people attended the workshops

in Hordaland and Agder respectively. Based on this phase, fishing/anglers and kayaking/kayakers were identified as key activities/demographics for further study.

Phase 2: Identification of benefits and biophysical characteristics in the watersheds

In 2017, a structured interview guide focusing on selected watershed activities was used to gain understanding of experience-based preferences for the biophysical characteristics of the watercourse for [42]. This provided information covered variables such as the river's depth, width, length, river bed conditions, water flow and water vegetation, for the respective activities. In total, 20 persons were interviewed about angling, nine about kayaking, and nine about other recreation activities alongside the watercourse such as hiking and biking. The interviews were conducted one-on-one and lasted for one to two hours.

Open online surveys conducted in 2017 targeting anglers and kayakers in Hordaland and Agder included questions about activity levels and the importance of leisure activities [40]. The surveys were shared via the Facebook page of the Hunter and Fisheries Associations (JFF) and the Voss Kayak Club and were responded to by 236 people in total.

Phase 3: Perceptions on benefit assessment methods

To get information on the perceived important attributes of methods and indicators for appropriate benefit assessments, an online survey was conducted in February 2017. The characteristics referred to in the survey were selected based on a literature review [43–45] and on aspects which were mapped during the fieldwork. The survey also provided respondents with the opportunity to give free text inputs. Before sending out the survey, it was tested on a few relevant actors. Two hundred and five actors with a geographic spread throughout Norway and consisting of hydropower producers, public administration and interest organizations/NGOs received an email invitation them to take part in the survey. In total, 83 responded (anonymous responses).

To gain information about perceptions of the appropriateness of different economic, quantitative and qualitative benefit assessment methods, four focus group discussions were organized in 2017. One focus group discussion dedicated to the benefits of river regulation and hydropower production included representatives from the Sirdal and Kvinesdal municipalities in Agder, and representatives from the Sira-Kvina and BKK hydropower companies. Representatives from the two host municipalities in Hordaland were later interviewed about the same issue. Two focus group discussions with anglers were organized; one in Hordaland and one in Agder. Another focus group discussion with kayakers from the Voss municipality in Hordaland was also organized. Each focus group discussion included around 6 people. As an introduction to the discussion, a presentation provided examples of benefit assessment approaches and indicators with reference to economic, quantitative and qualitative approaches. The participants discussed the appropriateness of approaches and indicators, including the relevance of the suggested indicators with reference to local-, regional- and national-level assessments [31]. The aim of an indicator is to express a benefit as experienced by the defined beneficiary group i.e. assessment results are tangible from the perspective of the beneficiary group [10]. Furthermore, the indicator should be sensitive to biophysical changes in the watershed. Benefits can be expressed by indicators expressing value, in terms of monetary units, or by referring to different types of frequency estimates of an activity, preferably in relative terms, and also qualitative indicators, including reference to enforced laws, rules and regulation [24].

Benefit assessments undertaken as part of EIAs in the watersheds were referred to in the discussions, but these were not focal documents, as the EIAs don't include systematic benefit assessments of activities other than hydropower production. Table 1 present an overview of the different benefit assessment approaches and the discussed methods. Follow-up interviews on the phone were undertaken in 2018 with key representatives from all groups.

Table 1. The different benefit assessment approaches discussed in focus group discussions.

Focus group discussions	Benefit assessment approaches discussed	Example basis and reference
Hydropower (Combined Agder and Hordaland)	**Economic methods:** Marked based pricing; damage costs avoided, replacement, and substitute cost methods	Income and ripple effects for employment and economic welfare [44]. Economic welfare creation, and ripple effects as addressed in Environmental Impact Assessments[1]. Hydropower production in a climate mitigating perspective [45].
	Quantitative methods: Descriptive statistics	Employment effects (Environmental Impact Assessments[1]).
	Qualitative methods: Expert, and beneficiary qualitative judgements	No relevant example available. The regulation and benefits for flood control
Kayaking (One in Hordaland)	**Economic methods**: Market based pricing, benefit transfer, willingness to pay	Valuing environmental goods [46]; Economic effects of tourism [47]
	Quantitative methods: Survey on frequency and intensity of activity; general discussion of different approaches	Example survey conducted in the study [40]
	Qualitative methods: general discussion of different approaches	No relevant example available
Fishing (One in Agder, one in Hordaland)	**Economic methods:** Market price method; economic benefit transfer and contingent valuation methods	The market price method was used to calculate the local value of sold fishing permits. Recreation value of fishing was calculated for discussion purposes using benefit transfer and contingent valuation.
	Qualitative methods: Survey on frequency and intensity of activity; general discussion of different approaches	Example survey conducted in the study [40].
	Qualitative methods: general discussion of different approaches	No relevant example available

[1] For some of the discussion points, existing EIAs from the case study areas referring to Knaben Solliåna, Rafoss, Beinhelleren and Horgaset were used as a backdrop; however, it was not an evaluation of the EIA results as such.

3. Results and Discussion

3.1. Perspectives of Key Attributes of Methods and Indicators for Benefit Assessment

The online survey on the attributes of benefit assessment methods and indicators included a total of 83 responses (41% response rate) which were distributed among the following categories: NGOs (25%), hydropower producers (23%), national level authorities, (18%), municipality level (18%), county level authorities (9%), and other (7%). Seventy-three percent of the respondents were men, and 28% women, and the age of respondents varied between 20 and 65, with the majority being over 40.

The respondents rated eight suggested attributes as important or less important characteristics of benefit assessment methods. Overall, the respondents were largely in agreement of which attributes were to be considered important for such methods (Figure 2). That the benefit assessment results can be verified ("verifiability") was considered an important attribute by 98% of the respondents. Furthermore, it is important that the methods for assessing benefits are easy to use (95%), can assess potential value (94%), are flexible with regards to requirement for data (90%), and allow for participation (88%). Somewhat fewer respondents (76%) considered the method's ability to assess the benefit in monetary terms as an important attribute. Several respondents emphasised in free text contributions that it is important to select the appropriate method according to the specific purpose and situation.

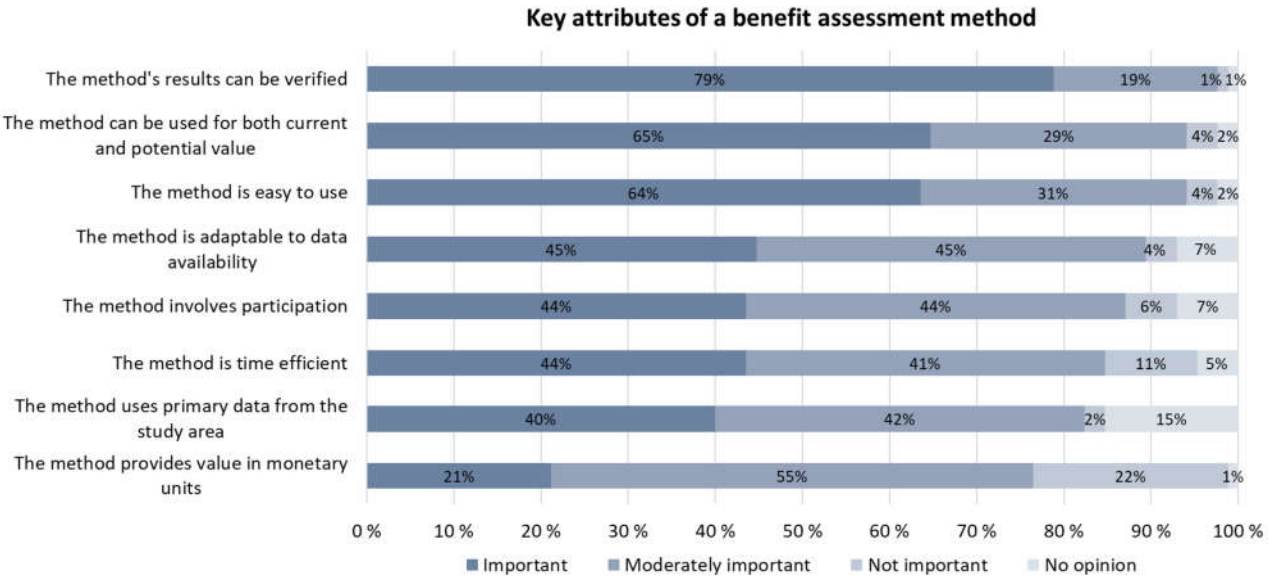

Figure 2. Survey results on attributes of benefit assessment methods.

The respondents also rated nine suggested attributes of indicators as more or less important for use in benefit assessments. Of the respondents, 98 % considered it to be to be important or moderately important that the indicators have "relevance for local interests" (74% + 24 %). Furthermore, 97 % found that "relevance for regional interests" was important (Figure 3). Thus, a majority considered the local and regional level to be more important than the national relevance of indicators. That the indicators are easy to understand was considered important by the majority (97%). Among the other attributes, most were considered important, ranging from 88–92 % by most of the respondents. The exception was the attribute, "provides value in monetary terms", which only 58% considered to be important; in the commentaries, some respondents explained their position on this feature, exemplified by the following quote: "The value of several user interests can be difficult to assess in monetary terms; in such cases, it is necessary to find another value dimension".

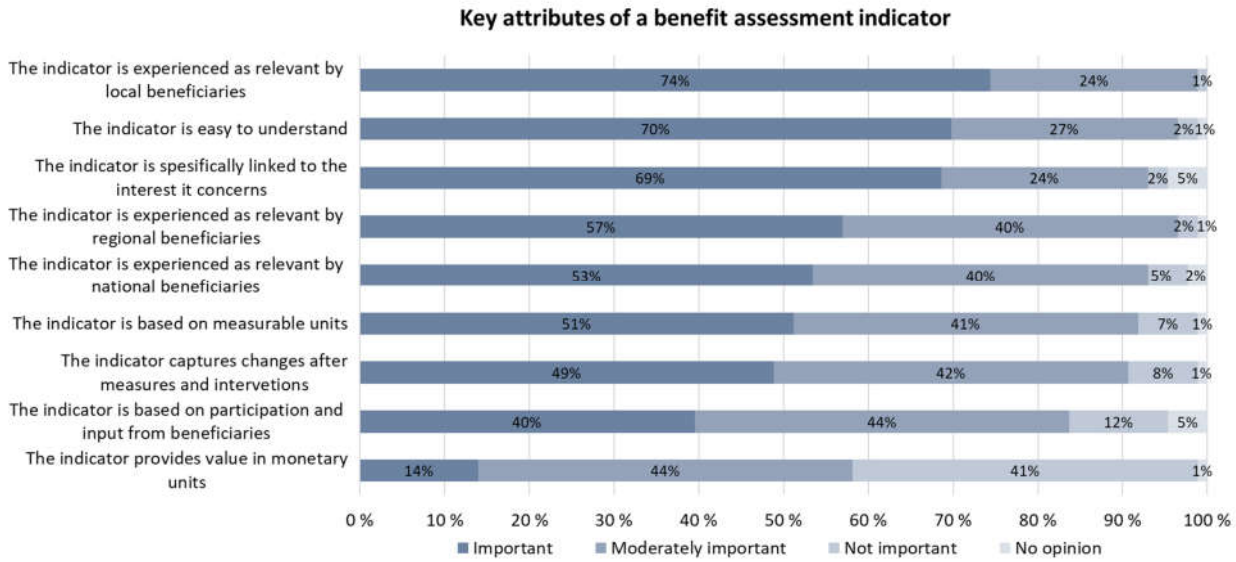

Figure 3. Survey results on attributes of indicators.

3.2. Beneficiaries in Regulated Watersheds and Their Perceived Benefits

As part of the study process with workshops, online surveys, interviews, and focus group discussions with various informants during 2015–18, four categories of beneficiaries with reference to value dimensions in society and the sustainability concept were distinguished: (i) economic beneficiaries from river regulation (water use function) referring to society overall, as represented by the municipality, the county, and the national state, and the hydropower company; (ii) economic beneficiaries from ecosystem services (ES) in the watershed, referring to land owners, municipalities and companies which base their activities on the watercourse; (iii) socio-cultural beneficiaries from ecosystem services (ES) in the watercourse landscape, where benefits experienced do not imply economic production or gain. The fourth category (iv) refers to the intrinsic value of nature, irrespective of human presence, here referred to as the 'natural environment'. Informants arguing for this aspect were typically associated with environmental organizations, but also comprised kayakers, anglers or hikers. The category largely reflects the ES non-use categories, bequest and existence values [4], yet it is different from the ES perspectives which focus on value for humans. Figure 4 shows the four categories and the typical actors within each category and links the categories to the different value dimensions of the sustainability concept [50].

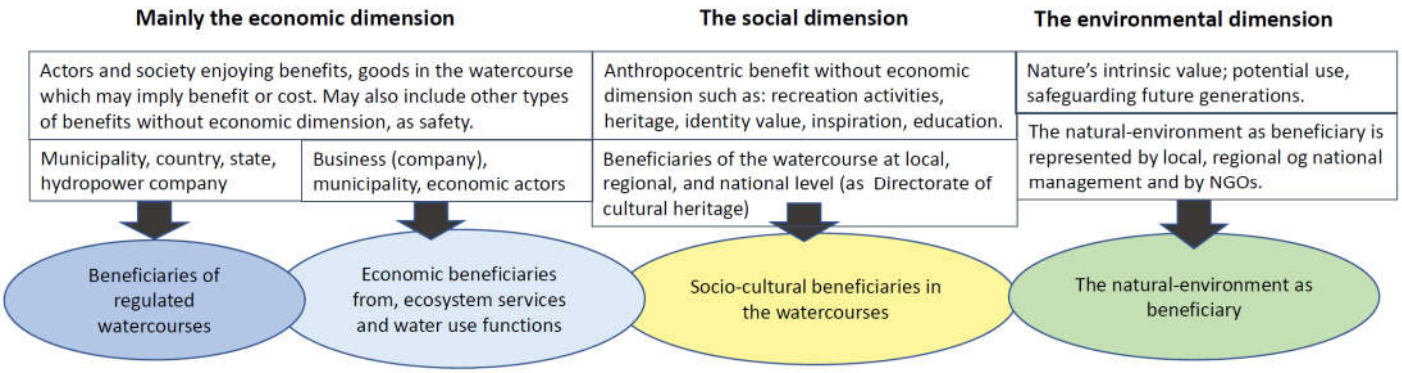

Figure 4. Categories of beneficiaries in a regulated watershed.

Beneficiaries of the regulated watercourses include representatives from the municipality (local level), the county (regional level), and the state (national level). In Norway, the tax system provides income from hydropower installations to the municipality, the county and the state, and for cheaper electricity to the municipality [51,52]. From the perspective of the municipalities, the national level authorities, and the hydropower companies in the study, the major benefits experienced referred to the ripple effect of power production for local wealth creation, some employment effects [46], and flood mitigation [53] (Table 2). From the perspective of national energy authorities, the security and flexibility of power supplies and climate effects were regarded as important benefits and responsibilities at a national level [47].

Informants involved in angling and kayak activities comprised both economic and socio-cultural beneficiaries. The economic beneficiaries were land owners and owners or employees of water sport companies. The socio-cultural beneficiaries enjoyed the watercourse and its landscape for purposes of well-being, social purposes, and/or in pursuit of inspirational experiences associated with a range of activities including kayaking, angling, hiking, biking and swimming; however no economic loss or benefit could be associated with this.

The kayaking occurred in both non-regulated and regulated rivers in the Voss and Vaksdal municipalities in Hordaland county [36,44]. Typically, different rivers represent different kayak opportunities and the informants discussed both local and regional benefits from kayaking. Stories were told about the benefits of spiritual experiences from kayaking, from sport and from social activities among family and friends. Informants also represented "professional kayakers" attending competitions, and some informants had commercial interests in local kayak companies. The

informants stressed the importance of kayaking for local level communities and for social cohesion, as well as for health aspects (Table 2). Local ripple effects from the kayak activity in the municipality referred to local wealth creation, to employment opportunities, and to attracting people to settle in the area. Around 20 families were mentioned as having moved to Voss municipality from abroad for kayaking opportunities. Within the kayaking community, some beneficiaries are economic actors, i.e., business owners or employees, while others are socio-cultural beneficiaries.

The informants identifying themselves primarily as anglers told stories about the local benefits of fishing in the watershed, such as fishing as a social arena for family and friends, sport fishing (catch and release), for educational purposes, for passing on heritage values, for food, as income from selling fishing cards, and from renting out camping facilities to anglers along the river side. The economic value from angling activities in the case study area watercourses, however, was perceived by most informants to be low, as the extent to which fishing could be regulated in the rivers varied. It was explained that with rainfall in the fishing season, possibilities existed for catching fish, and though low, contributions to economic welfare were appreciated. Fishing activities were associated with both economic beneficiaries and socio-cultural beneficiaries (Table 2).

Table 2. Categories of beneficiaries in regulated watersheds and main important types of benefits identified and relevance for local level (LL), regional level (RL), and national level (NL).

Beneficiaries in a regulated watercourse/ watercourse landscape	Main benefits on local level (LL), regional level (RL), national level (NL)	
Beneficiaries of the regulated river (water use function)	Security of power supply	RL, NL
	Flood control	LL, RL, NL
	Wealth creation	LL, RL, NL
	Positive employment effects	LL, RL
	Flexible regulation of power supply	RL, NL
	Climate change mitigation	NL
Economic beneficiaries from ecosystem services, and from other water use function	Businesses' wealth creation	LL, RL
	Economic welfare of landowners	LL
	Socio-economic use of watercourse ecosystem services	LL
	Positive employment effects	LL, RL
	Socio-cultural welfare	LL
Socio-cultural beneficiaries	Active local community	LL
	Contribution to good health	LL
	Safeguarding culture and heritage sites	LL, RL, NL
	Basis for research and education	LL, RL, NL
The natural environment as beneficiary (nature's intrinsic value)	Compliance with binding international environmental conventions	NL
	Compliance with environmental laws and regulations national and local level	LL, RL, NL
	Public environmental concern	LL, RL, NL

3.3. Perceptions on Benefit Assessment Methods

Among the different beneficiaries in the case watersheds, informants appreciated different types of methods for benefit assessments. All informants agreed, however, that methods need to be chosen by considering each specific situation in the watershed. It was argued that neither economic, quantitative, or qualitative methods are equally relevant and appropriate in all situations. This is in line with the results from the online survey on the characteristics of the methods and indicators for benefit assessments (Section 3.1.). Though a number of methods for benefit assessments exist [52], economic methods dominate in EIAs and in benefit assessments generally. There is further a tendency for assessments to refer to the biophysical situation, but little or no reference is made to the potential beneficiaries and their perception of the benefits [54]. In a review of revisions of hydropower licenses by Kohler et al. [55], the authors found that participation, as an integrated approach in assessments, was basically lacking.

The majority of the informants perceived the benefits and goods in the watersheds to be poorly presented in existing EIAs. It was explained by hiker and kayaker informants that the benefits had

been ignored in recent impact assessments. In the sections below, the informants' perceptions of economic, quantitative and qualitative methods for benefit assessments are presented.

3.3.1. Perceptions on Economic Methods for Benefit Assessment

Economic methods for benefit assessments were appreciated primarily by informants involved in commercial activities referring to hydropower companies, the municipalities as owners or hosts of the hydropower plants, owners of small, kayak-related businesses, and some land owners. The informants expressed appreciation of the economic method's ability to show monetary gain and loss in the watershed; it was argued that the economic value dimension makes it possible to show the benefits' contribution to personal or society level welfare [56]. The informants perceived the estimated "total economic value" of an activity in the watershed to present more legitimate results compared to an estimated economic value on a river stretch level. It was argued that a system perspective is required to include economic ripple effects for society for relevant economic results. Challenges of economic assessments on the river stretch level were discussed, such as data scarcity for local level assessments, which is an issue referred to in other studies [14,57]. Table 2 (Section 3.2) presents the economic methods covered in focus group discussions and in interviews.

For the municipalities which own or host hydropower plants, economic valuation was appreciated for estimating expected income. Representatives from the municipalities explained that information on income from hydropower production or from other economic activities is important for supporting trade-off related decision-making, and for estimating municipality budgets. Economic methods were valued to some degree by the municipalities for estimating the benefit of flood control. Regarding the credibility of economic estimates, the municipalities expressed some concerns. It was argued that consultants in impact assessments presented monetary figures as being absolute, while there were often large uncertainties. Some frustration was also expressed with reference to the application of the methods, such as the selection of a given method, or the use of various methods sometimes differed among impact assessments, affecting the informants' perception of the legitimacy of the results.

Informants being involved in kayak activities varied in their appreciation of economic methods. No impact assessments estimating benefits from white water sports as part of formal license procedures for hydropower production were identified. Those emphasizing the usefulness of economic methods tended to be involved in commercial kayak activities, and they argued that the economic value dimension influences decision-makers more than the socio-cultural and the environmental value dimensions. They supported this argument by referring to a situation in 2017 in which a study on the total economic value of white-water sports initiated by Voss Nature organization presented to the Voss municipality board altered decision makers' opinions about regulating the Raundal River [48,58].

The angler communities in the two case study areas were primarily interested in the use of economic methods to express the potential income on the individual and societal level. The situations in other rivers were referred to, where anglers pay large sums of money for fishing cards and equipment, thereby benefitting both land owners and local society. Economic assessment of angling in the regulated rivers, it was argued, would result in low estimations of the value of local fishing, a result the informants perceived as illegitimate because regulated rivers no longer serve as suited reference sites. The informants representing hikers, bikers and others seeking the watercourse landscape for a feeling of wellbeing did not see the relevance of economic methods for benefit assessment relative to their type of experiences.

3.3.2. Perceptions on Quantitative Methods for Benefit Assessment

Quantitative benefit assessment methods, methods that present benefits without referring to economic value, were appreciated for specific situations by all informant groups. Quantitative methods were highlighted as being particularly relevant in situations where (i) no economic gain or loss could be identified, (ii) in cases of data and/or population scarcity, and (iii) when the assessment focused on small scales, e.g., river stretch level. The quantitative approach suggested by the

informants involved different ways of using frequency or "intensity" of an activity to estimate significance or value in society. Examples were the number of registered fishing days, parking statistics, road toll statistics, the registration of presence, posts in newspapers and on social media, crowdsourcing, and peoples' habits. The use of quantitative methods and the frequency concept for assessing value is supported by others as an appropriate approach for benefit assessments, in particularly, to inform the socio-cultural value dimension [17,59]. It is argued that keeping indicators in their natural units further avoids problems of monetisation and discounting [60].

The beneficiaries of the water course regulations expressed appreciation of quantitative, non-monetary approaches for supporting economic results, for directly presenting benefits, e.g. the ripple effect for employment, and for presenting benefits without having to use complex economic methods. This referred to the benefits associated with e.g. flood control and security of supply. The "kayak informants" appreciated quantitative methods for presenting the variety of the different types of, and the frequency of, different kayak activities for youth, families and social gatherings, and for presenting the number of people settling in the area associated with this activity. The hiker informants referred to quantitative methods for presenting local people's low-key type appreciation of the watercourse landscape for various types of recreation activities. In this context, it was referred to a local initiative in Vaksdal municipality, where actors placed a mailbox on the top of a mountain for hikers to register. This initiative was enacted to counteract the description in an EIA that the area was not used much for hiking. All informants, however, emphasised the need to integrate a participatory approach to ensure that the quantitative focus would be suited to the specific context, and to present numbers in the appropriate relative context.

3.3.3. Perceptions on Qualitative Methods for Benefit Assessment

Qualitative methods were appreciated by the informants for presenting the context, for enabling a participatory approach, and for presenting meaning of the benefit. Qualitative methods were emphasized for presenting the relationship between activities and specific areas along the watercourse, areas associated with history and with local experiences. This was exemplified by areas suited for such as swimming, or social gathering because of particular landscape features, or place-associated functions in the watercourse. Place-associated functions referred to such as a natural eddy (a swirling current of water), a "natural bubble bath", or place along the river where the fish were known to bite. The qualitative methods suggested as valid approaches in focus group discussions and interviews included, interpretation of documents, such as laws, municipality plans, nature books, history books, deliberations, focus group discussions, interviews about experiences and stories in the watershed. Current Norwegian management practice refers to laws and regulations such as, protected watersheds and National Salmon Watercourses for indicating high value of an area [32]. While all or most informants appreciated qualitative methods for presenting certain aspects, proponents of qualitative methods tended to represent beneficiaries requiring little equipment for practicing activities, such as hiking, running, and inspirational types of activities. These informants felt that both economic and quantitative non-economic methods were ill-suited for presenting values. One respondent in the online survey commented that qualitative methods were important for mapping activities and experiences in the watercourse by, what was referred to as the "silent majority". This "silent majority" it was argued, "representing such as hikers, people using nature for inspiration, recreation, are rarely organized, yet they represent an important user group". Some informants primarily being kayakers, anglers or hikers, reflected on and emphasized the intrinsic value of nature and biodiversity. These informants referred to such as art, and also law, for visualizing societies perspective or emphasis on nature-intrinsic value in society. In contrast, informants from national level agencies mentioned economic methods as willingness to pay [61] as relevant in this context.

Qualitative methods are particularly suited for providing meaning of place. In line with the results in this study, several other studies stress the need to consider that values are context and place specific, based on cultural characteristics, political and economic settings [12,31]. We argue that the place-based perspective by capturing beneficiaries' ideas of meaning of place is more important on a

local than on a regional and national level, as the local level reflects the area where relationships between the beneficiaries and the environment occurs, and thus where benefits and values can better be recognized and understood [31,62]. As emphasized by Potschin and Haines-Young [31], "socially robust knowledge must guide the assessment process if the goals of relevance, legitimacy and credibility are to be achieved" (p. 1063). Application of qualitative methods by means of participatory data and knowledge co-generation techniques at the local level and in data scarce areas are suited for providing more robust benefit assessment results [36,57]. Using qualitative methods for assessing benefits, however, needs to be performed in a systematic manner and accounted for validated results [63].

3.4. Guiding Benefit Assessments in Regulated Watercourses- the Ecosystem Service Framework and the Sustainability Concept

The informants included beneficiaries from water use functions i.e. the regulated water courses, from ecosystem services (ES) – the economic and socio-cultural beneficiaries, and informants representing the perspective that nature has intrinsic value. In line with other scholars, Kenter [17]; Dunford et al. [64], we argue that strict usage of the ES framework for guiding benefit assessments does not provide adequate support for decision-makers. In human-modified landscapes, as in the case areas, frameworks for benefit assessments need to refer to both benefits derived from ecosystem services [3] and from water and land use functions [30]. Goods and benefits are context dependent and vary depending on the scale of the assessment. This situation requires an approach not well covered in the ES concept, which has a predominantly regional and continental perspective [17,65,66]. There is a need to approach benefits on different scales of governance, as indeed trade-offs in decision-making occurs across local, regional and national scales. Current guidelines for benefit assessment imply that local level benefits are often overlooked in EIAs resulting from a lack of participation and local involvement (this study), while the basis for national level priorities are often not expressed. The benefits identified in this study are associated with economic, socio-cultural and environmental welfare. For shedding light on a decision-situation regarding possible measures or interventions, understanding the position of current beneficiaries, and possible effects of interventions on economic, social, or environmental outcomes is essential (See e.g. Søderbaum [60] for a discussion of positional analysis).

The sustainability and the ES concepts can both contribute with important tools for improved management of human-modified landscapes. The sustainability concept referring to limits to growth serves as a normative frame for considering a balance of benefits obtained from ecosystem services, and from water and land use functions, a perspective lacking in the ES concept [21,68]. Documented availability of ES can be a tool for evaluating intra-generational justice for different groups in society [22,69]. Considering flexible ES terms and categories, the ES is a tool for increasing society's awareness of our dependence on ecosystems for well-being. Several authors reflect on their adaptation of the ES terminology, to inspire beneficiary's reflections on values and benefits as the ES terms don't fit people's everyday language [15,20]. An approach that involves discussions on trade-offs between ecosystem services and water use functions may facilitate for a discussion of what is the best balance of benefits obtained from ecosystem services, and from water and land use functions within ecological limits.

Recently, studies present the low level of practical implementation of the ES concept in actual policy implementation [15,16,22,64]. The exclusion of water and land use functions in ES frameworks, may partly explain why, despite the fact the fact that ES concept is increasingly referred to in policy and in guidelines, is not much used by practitioners [15,16]. In fact, Verburg et al. [15] and Grizzetti et al. [16] present findings that practitioners find it difficult exactly because such sectoral perspectives are excluded in the ES framework. We argue that, rather than excluding land and water use functions, these functions can be assessed in parallel with ES benefits under the sustainability umbrella. Documented ES and land and water use functions evaluated in the context of ecological limits at different scales can serve as useful support for decision-making.

4. Conclusions

This paper presents perceptions of the benefits by different actors on local, regional and national levels regarding watercourses regulated for hydropower production. The benefits identified are derived from water use functions and ecosystem services; hence, it is argued that the ecosystem service framework alone is poorly suited to guide benefit assessments in human-modified landscapes. Focusing on the identification of benefits associated with economic, social and environmental welfare—which are dependent on both ES and water and land use functions—will provide appropriate support for decision-makers. Furthermore, to support decision-making, benefits need to be identified and visualized for the different governance levels, i.e. local, regional and national, as different perspectives, responsibilities, and associations with nature are associated with these levels. The beneficiaries' perspectives on the nature of the benefits, and how they are experienced, comprise central issues for selecting appropriate assessment methods. At the local level, the involvement of local actors is needed for legitimate, relevant and credible benefit assessment results. This study demonstrates that without dialogue with beneficiaries to identify benefits, important values at the local level may be ignored. Combining a participatory approach makes it possible to identify the appropriate benefit assessment methods, with regards to the type of benefits being experienced, data viability, and resources available. The beneficiary approach to assessments, that adopts the perspective of beneficiaries when identifying and assessing benefits, facilitates a placed-based perspective and an understanding of the relationship between the benefits experienced and the watershed functions.

Economic, quantitative non-monetary and qualitative approaches each have different attributes, and as such, different abilities to emphasise the economic, socio-cultural and environmental value dimensions. Economic methods are important for visualizing monetary gain or potential loss of interventions or measures in the watercourse. Quantitative, non-economic methods can present value by means of presenting the intensity of use, or by means of frequency statistics for expressing e.g. good social relations connected with the watershed. Yet, for both economic and quantitative methods, the results (numbers) need to be presented in relative terms. Qualitative methods are important for providing a sense of place, as place is where the relation between the beneficiaries and the environment occurs. This is important for presenting the context and for showing how society values the natural environment (nature protection laws). A combination of economic and qualitative methods will improve assessments and the understanding of benefits. Visualising impacts of interventions on benefits, and the beneficiaries' links with the economic, social and environmental welfare of groups, is needed for trade-off discussions. More documented experiences with assessments of the benefits obtained from ecosystem services and from water and land use functions considering ecological limits at different scales, are needed.

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