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Towards Intangible Freshwater Cultural Ecosystem Services: Informing Sustainable Water Resources Management

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Abstract: Rivers provide a range of Cultural Ecosystem Services (CES) such as aesthetic values, sense of place and inspiration, which remain insufficiently studied due to challenges associated with the assessment of their subjective and intangible attributes. However, the understanding of CES remains important as they are strongly linked to human wellbeing. This study utilizes a questionnaire-based survey to capture views from two villages along the mainstream of the Beas River in India, to identify the CES it provides, to assess how local communities appreciate their importance and how they relate to river flows. In total, 62 respondents were interviewed. Findings show that the Beas River provides several CES but among these, spiritual/religious ceremonies and rituals, aesthetic values and inspiration benefits were indicated as absolutely essential to the local communities. Results also demonstrate that people's perception of the quality of CES is sometimes linked to river flows. It can be concluded that the Beas River is crucial in the functioning and livelihoods of local communities as it lies within the core of their cultural, religious and spiritual practices. This study reinforces the need to consider the full suite of ecosystem service categories in sustainable water resources development, planning and decision making.

Keywords: cultural ecosystem services; freshwater; human wellbeing; rivers; water resources management

Citation: Ncube, S.; Beevers, L.; Momblanch, A. Towards Intangible Freshwater Cultural Ecosystem Services: Informing Sustainable Water Resources Management. *Water* **2021**, *13*, 535. https://doi.org/10.3390/w13040535

Academic Editor: Luis Garrote
Received: 13 January
Accepted: 17 February
Published: 19 February 2021

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1. Introduction

The Ecosystem Services (ES) concept is now a popular way of describing the multiple benefits people get from the natural environment. The publication of the Millennium Ecosystem Assessment (MEA) in 2005 raised the profile and the importance of this concept. Ecosystem services can be defined as "the benefits people obtain from ecosystems"[1]. Cultural Ecosystem Services (CES) are one of the four main ES categories from the MEA. The other three categories are: provisioning, regulating and supporting ES. CES are the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences [1], which links directly to mental health and well-being.

Rivers are one of the main sources of freshwater, which is crucial for human existence, yet they also provide a range of other supporting, regulating and provisioning ES for society. In addition, they provide the less obvious and intangible CES. For example, rivers enable social and cultural interactions and, in the process, generate a sense of place and identity for local communities. Rivers also increase the aesthetic and inspirational value of a place and provide the environment for several recreational activities. Despite their importance, rivers remain one of the most threatened and degraded ecosystems worldwide [2,3].

In developed countries, recreational activities are probably one of the most common

CES associated with natural features such as rivers, forests and urban greenspaces [4,5]. In developing countries, however, common CES linked to nature mostly relate to cultural identity and associated activities, i.e., rituals, festivals etc. [1]. Such activities, e.g., rituals which engage people with nature could be used to define cultural practices of a place [6]. Natural features such as rivers or mountains or cultural landscapes enable cultural practices to be undertaken within them. For example, in India rivers are a source of strong spiritual, religious and cultural beliefs, and hence shape cultural practices with many rituals and festivals taking place in the river or on the riverbanks [7,8]. In this way, locals interact with the river to derive its meaning and influence on them as they immerse idols or practice ritual bathing during some religious festivals. India is not alone in this aspect, examples of similar spiritual and religious use of rivers include ritual bathing in Nepal [9] and Bangladesh [10]. There are a range of similar cultural ties worldwide which reveal how nature is shaped and how it shapes humans in different cultural landscapes, e.g., the Swedish mountain landscape and reindeer husbandry by the Sami people [11] and Native Hawaiian communities [12].

CES are underpinned by different social factors, i.e., age, gender, context, religion, relationships and values and they also differ spatially and over time. This makes their understanding rather diverse and complex [13,14]. Their understanding also encompasses multiple perspectives as they involve physical and spiritual human–nature interactions and social constructs, unique to individuals [15]. Such human–nature relationships span over many years and generations, defining individual and community identity and sense of belonging. For example, the traditional native Hawaiian communities interact with their environmental space through cultural farming, fishing, gathering, and hunting for their livelihoods and maintaining connections to their land [12]. In such places, infringement into these environmental spaces would have devastating impact on local communities reliant on intangible CES values that are hard to define or identify.

CES remain insufficiently studied and understood [16,17] due to challenges and difficulties associated with the identification, measurement and assessment of their subjective and intangible attributes such as sense of place, spiritual beliefs and inspiration [18]. Inadequate and inconsistency in CES definitions and typology are argued to be some of the factors that have impacted on the identification of proper methods for CES assessments [11]. Understanding of CES, however, remains important as policy attention is increasingly focused on their benefits to human wellbeing [19–21]. There is a need to assess cultural ES for these to be considered alongside other ES in decision making and planning/natural resource management as well as to foster the implementation of more sustainable water resources development practices and policies. While most of the ES categories have been included in water resource models and decision support frameworks, few models have been developed that integrate CES [22]. For example, a study by Momblanch et al. [23] utilizes a water resource systems model to integrate CES such as recreation and tourism to inform future catchment management measures under uncertain climate change scenarios, while the study by Liu et al. [24] developed a framework that combines water resources management and ecosystem services, including cultural ecosystems to provide a method for water resources management. The inclusion of a full suite of ES could assist decision makers to prioritize and design management approaches that would ensure sustained freshwater ES delivery.

The development of a standard assessment method for CES, just like the other three ES categories, remains a challenge. Conceptual frameworks have been developed, e.g., [14], as efforts towards developing common and agreed approaches to understanding CES at different scales. In general, a robust methodology for the assessment of CES has not been widely adopted as research into this continues to evolve [25]. Since understanding CES involves subjective judgements and individual perceptions [14,26] these have recently been captured through participatory approaches, e.g., cultural mapping and survey-based methods such as survey questionnaires [19]. In some cases, such approaches have been used in combination with others, e.g., survey question-

naire/interviews and focus group discussions to help capture individual and community CES values through narratives, open-ended and close-ended questions. Use of such participatory and discursive approaches also offers the opportunity to explore the different dimensions of CES including their subjective aspects and overlaps.

This paper focusses on identifying CES for the top reaches of the Beas River in India. The aim of this study is to identify the CES provided by the Beas River, to assess how local communities perceive their importance and how they relate to river flows. Continued water resources development in the Beas River due to increasing demand for hydropower, irrigation, domestic, and industrial purposes, puts at risk the ability of such rivers to provide the intangible but crucial ES. To recognize and to bring to the fore the impact of such developments on CES, local understanding and perceptions on the importance of these is vital to inform sustainable water resources development and for the integration of CES alongside other ES in decision making processes.

2. Materials and Methods

This survey was undertaken as part of the SusHi-Wat research project (NERC funded NE/N016394), specifically under the ecosystem services project work package. Prior to the design and delivery of the CES work, fieldwork was undertaken to assess supporting ecosystem services in the same study area [27]. This initial fieldwork, alongside desk-based analysis, provided an understanding on the local stakeholder landscape and assisted in identifying potential participants for the survey. The scope and content of the questionnaire developed for this survey was informed by this initial fieldwork and analysis.

2.1. Study Area

The survey was undertaken in the upper catchment of the Beas River in North India (Figure 1). The Himalayas region in India and its main rivers, which include the Beas and the Satluj rivers, is a key strategic area for water, energy, and the economy of the country. The Beas River originates in the Himalayas in central Himachal Pradesh and its upper catchment area is approximately 12,560 km^2 up to the Pong reservoir (elevation varying from 245 to 6600 m above sea level). It is one of the main tributaries of the Indus River, flowing southwest for 470 km before joining the Satluj River at Harike (Punjab, India).

The Pong dam and reservoir (constructed in 1974) support the provision of a host of ecosystem services in the region, including: flood protection (regulating), hydropower generation (provisioning), and irrigation water supply (provisioning) to semi-arid areas in Punjab; the main granary and, thus, food bowl of Haryana, desert areas in Rajasthan and across India [23,28]. The Beas River is faced with many upstream developments mainly related to hydropower production. An inter-basin transfer of water from the Beas River to the Satluj River occurs at Pandoh Dam, located 21 km upstream of the town of Mandi, which diverts around one third of the total water resources produced in the catchment annually and strongly influences the dynamics of river flows [29]. The Pong Dam is one of the large hydropower projects in the Beas Basin in addition to other several operational hydropower schemes.

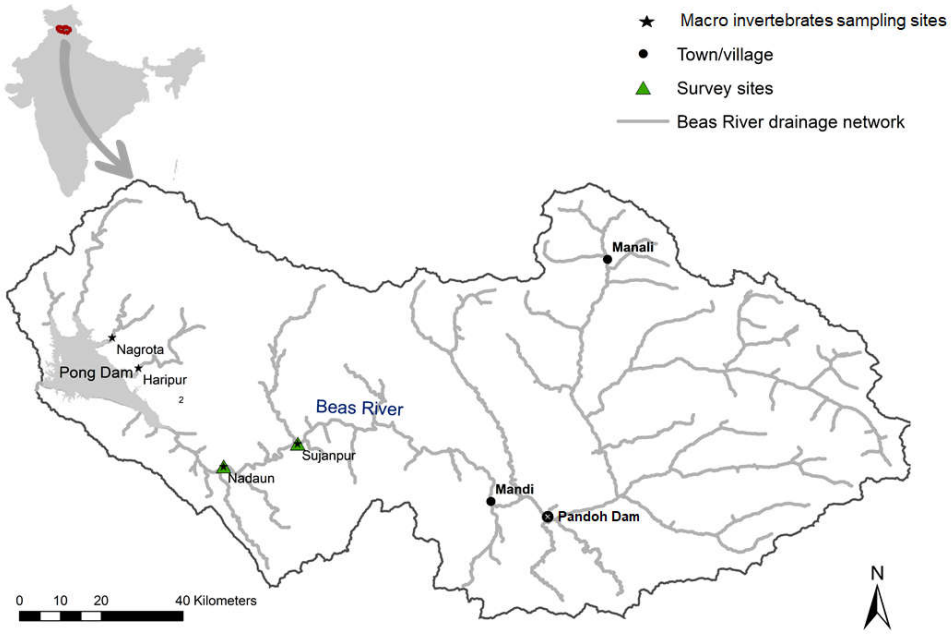

Figure 1. Beas River Basin and its situation (inset top left); the location of the survey sites is indicated.

As indicated in Figure 1, two survey sites, i.e., Naudan and Sujanpur close to the main stream of the Beas River were selected for the survey. Nadaun and Sujanpur are small towns on the banks of the Beas River (India) with a total population of ~ 4430 and 7943 respectively [30] with high literacy levels of over 80%. In general, the main source of income especially in the surrounding villages is mainly agriculture and fishing from the Beas River. Other main sources of livelihood include small scale to medium sized businesses and formal employment [30].

The selection of these survey areas was based on their proximity to the sampling sites for supporting ES [27] and the location of flow gauging stations. Overlapping the location of the assessment of different ES was important for subsequent analyses and development of a basin-wide model, such as linking the historic water levels recorded in the gauging stations to the delivery of CES and other ecosystem services [23] .

2.2. Cultural Ecosystem Services Assessed in this Study

The CES categories and descriptions adopted in this study (Table 1) are mainly based on [19] and the [31] framework. However, in this study some CES categories were bundled together, e.g., Education and Knowledge while these are listed as separate categories in the [31]. The CES categories selected for this study were: (1) more relevant to the study area and (2), could be assessed using survey questionnaires.

Table 1. Cultural Ecosystem Services (CES) assessed in this study.

CES Category	Description
Spiritual and religious values	These are derived from specific places, features, species and practices such as sites for rituals and ceremonies
Education and Ecological Knowledge	This refers to both formal and informal learning opportunities from nature
Inspiration	Inspiration gives rise to feelings of enrichment, enlightenment and reflection and the opportunity to view or imagine the landscape which could inspire music, art, poetry, etc.
Aesthetic values	The beauty of a place derived from seeing, hearing, touching, feeling or smelling of the landscape/nature.
Cultural Heritage, Sense of place and identity	This refers to the sense of belonging to a place and have a historical connection to ancestors, practices or beliefs.
Recreation and Tourism	This refers to various recreational activities provided by nature, e.g., bird watching, swimming, sports, relaxing etc.
Mental and Physical Health	Nature provides space for physical exercise and places that calm and improve moods and sense of well-being – improving both mental and physical health.

2.3. Survey Respondents and Sampling Approach

The participants involved in the study were the local communities located close to the sampling sites (Figure 1) and in vicinity of the Beas River. Respondents were, therefore, those people that have close contact and make frequent use of the Beas River. In each study site, a representation of different age groups (starting from 18 years and above) were targeted and gender was also considered. Given the diverse perceptions on CES, age and gender factors were considered in this study to ensure that such potentially multiple perspectives are taken into account. On this basis, purposive sampling was used, where the surveyed sample is selected in a deliberate and non-random fashion to achieve a certain goal [32]. The goal in this study was to target participants that stay close and rely on the Beas River including gender and age aspects for such participants. Informed consent was sought from the participants prior to undertaking the interviews and the study methodology was approved by the Heriot-Watt University Ethics Committee. Information from the surveys was anonymized and held securely at Heriot-Watt University. In total 62 people were interviewed, i.e., 30 in Nadaun and 32 in Sujanpur. The number of responses achieved in this study was considered adequate, as 20–30 interviews in qualitative studies often achieve the common goal of concept saturation—a point at which no new themes emerge from new interviews [33].

2.4. Data Collection Instrument–the Questionnaire

The use of survey questionnaires is argued to be one of the promising approaches for assessing CES at local level [34]. However, prior to this study no standard questionnaire existed, therefore it was necessary to develop a bespoke set of questions designed to address the aim of the study. The questionnaire (Supplementary Material, S1) designed for this survey comprised both closed and open-ended questions. It included questions related to identifying the main CES from the Beas River and their level of importance to the local communities. Participants were also asked about how CES have changed overtime and the main factors influencing such changes. The questionnaire also included questions on the demographic characteristics of the respondents, i.e., gender, age range and the years they have lived in the study sites. The questionnaires were administered with help from project partners at the National Institute of Technology in Hamirpur (India) due to their experience in social surveys in the study area and their knowledge of the local language and the Beas River. The surveys were undertaken between March and April 2018 (during the pre-monsoon period) over a period of two weeks.

Validation and testing rounds were completed with experts in hydrology, ecology and water management with no background in CES providing critical input to draft versions. They were invited to provide feedback on any unclear questions, and/structure of the questionnaire.

Their comments were considered, and the questionnaire was revised before undertaking the actual survey in the study areas. The validation of the questionnaire by experts in chosen fields was to get an independent view on the questionnaire and to ensure that non-specialists in CES such as targeted communities for the survey could easily understand the questions and provide relevant responses.

2.5. Data Analysis

Descriptive analysis of the collected data was used. Survey responses from closed questions were summarized into percentages and frequency of occurrence while thematic analysis was applied to open ended questions. Data analysis software, i.e., Microsoft Excel and QSR International (Melbourne, Australia) NVivo software, were used to organize/code and handle the collected data.

3. Results

3.1. Demography of Respondents

Overall, males were the most dominant respondents in all age ranges, with males in the age range of 30–39 providing the highest percentage of survey respondents (Figure 2). The highest percentage of female respondents (about 10%) was in the 40–49 years age range. This implies that the views gathered during the survey are mainly from the young economically active age groups in both sites. There were no female respondents below the age of 20 and above the age of 60. This implies that outcomes from this survey do not capture the views of younger females below the age of 20 and older female age groups above 60 years. The dominance of males in the survey could be due to the population structure of the study areas, in which there are more males than females, as well as the limited role of women's participation in such activities in India [35]. India mainly constitutes of a male dominated society with a number of restrictions on women as a traditional norm.

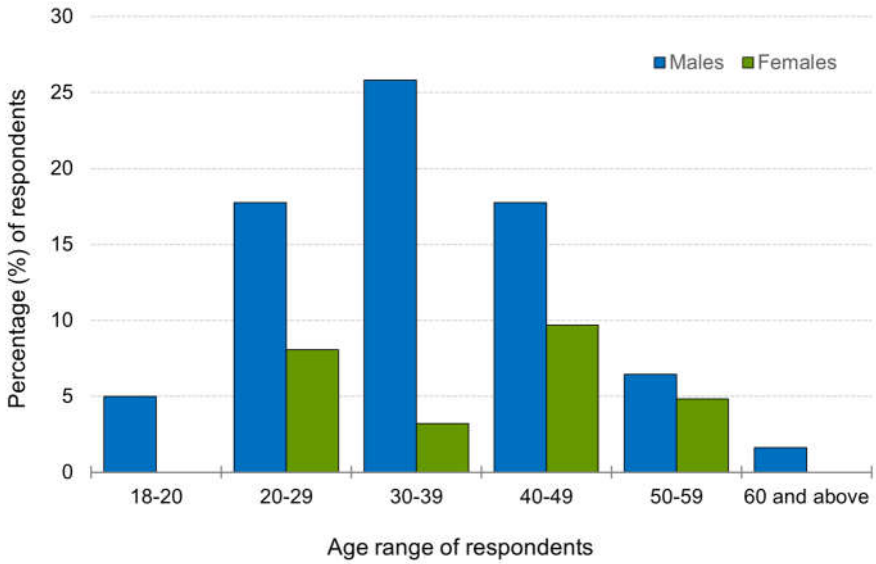

Figure 2. Age and gender distribution of survey respondents in both study sites.

Most respondents have been resident in the survey area for more than 10 years, with around 11% respondents having stayed there for over 50 years (Supplementary Material, S2). In line with the age ranges of the respondents, the majority of respondents have lived in the survey sites for at least more than 20 years. Very few respondents (6) indicated that they had stayed in the study sites for less than 10 years. This implies that the responses

gathered in this study are based on local knowledge and experience from people who have lived in the area all their lives and know the Beas River and its evolution over a significant period of time.

3.2. CES provided by the Beas River

Overall, most CES were listed as either 'absolutely essential' or very important to the communities in both study sites in the Beas River. None of the CES were identified as not important or of little importance. Spiritual/religious ceremonies and rituals, aesthetic values and inspiration were identified as 'absolutely essential' cultural benefits from the Beas River by all respondents (Figure 3), and the cultural heritage/sense of place was deemed as 'absolutely essential' by 84% of respondents. Physical health benefits were the least appreciated with 35% respondents allocating them 'average importance'. There were, however, slight differences between the two sites, e.g., mental health and cultural heritage were less relevant in Nadaun compared to Sujanpur while recreation and tourism and educational knowledge were rated as more important in Nadaun than in Sujanpur (Supplementary Material, S2).

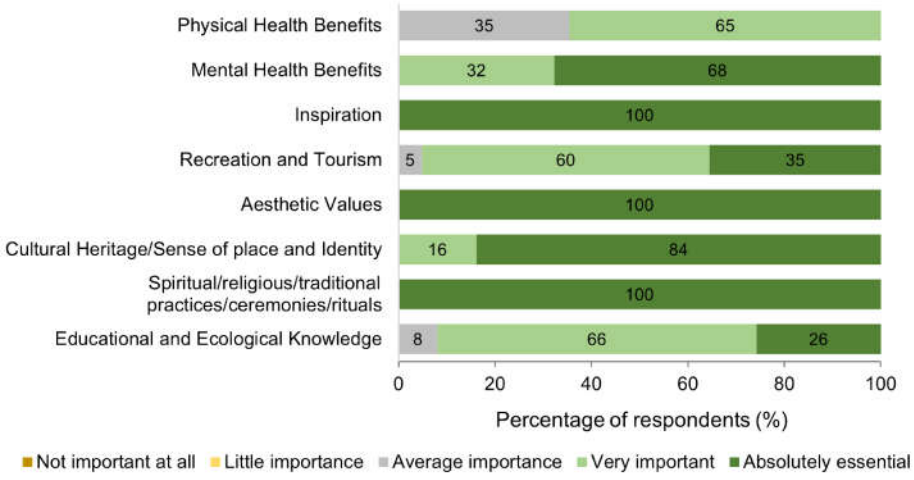

Figure 3. Importance of different cultural ecosystem services in both study sites in the Beas River.

3.3. Water Levels and CES in the Beas River

Fluctuations in water levels in the Beas are mainly influenced by the monsoon season and other upstream abstraction activities. Findings show that such changes in water levels in both study sites impact on the delivery of some CES. Aesthetic benefits of the river appear to be mostly realized during the post monsoon and monsoon period when the water levels are high or very high (Figure 4). CES associated with low water levels were physical health benefits, mental health benefits and recreation and tourism. However, for some CES like inspiration, sense of place/identity, religious ceremonies and education and ecological knowledge, the majority of respondents from both study sites indicated that the enjoyment of these is not influenced by changes in water levels in the Beas River (Figure 4).

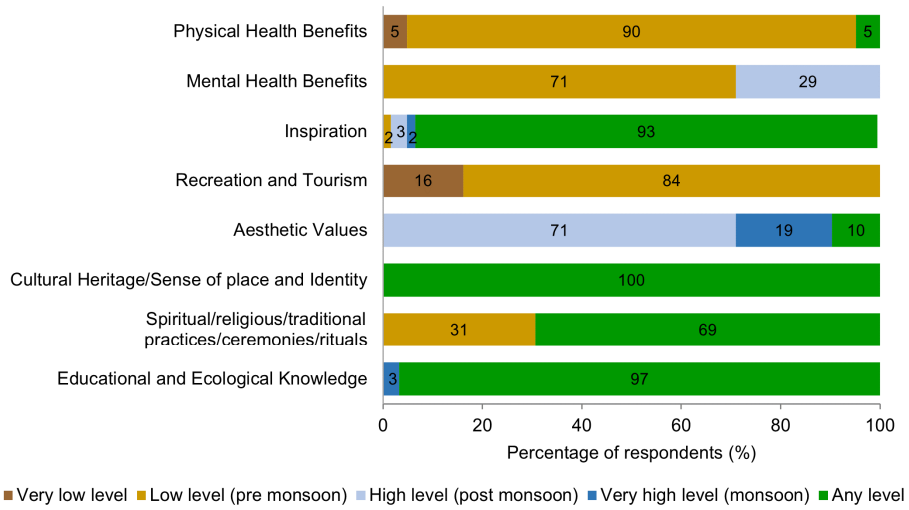

Figure 4. Water levels in the Beas River at which most CES are gained in both study sites.

All respondents in Nadaun also indicated that spiritual/religious cultural benefits are gained at any water level while in Sujanpur, about 63% of respondents indicated that this cultural benefit is mostly gained during the pre-monsoon season when the water levels are low (Supplementary Material, S2).

3.4. Ceremonies in the Beas River

Due to the unique spiritual and religious values attributed to rivers in India, the survey included a specific section to gather further details on this CES. The table below (Table 2) shows the different types of religious/spiritual/traditional ceremonies conducted in the Beas River as well as the attending gender, age groups, approximate attendance numbers, the event location in relation to the river and the time of the year when these are undertaken. Religious ceremonies can be considered as relevant events as they are attended by over 500 in most cases in both Nadaun and Sujanpur, with populations of 4430 and 7943 respectively. The riverbanks and the main channel of the Beas River play a vital role in all of them, except one (i.e., Holi mela) (Table 2). Some ceremonies involve the immersion of idols (e.g., Ganeshi Chaturthi, Figure 5) or bathing (e.g., Baisakhi vrat) in the river, while others use the riverbanks to access the river (e.g., during funerals ash remains of the deceased are scattered into the river) or to establish traditional markets (e.g., fairs).

Most ceremonies are undertaken during the pre-monsoon period except funerals which are done anytime of the year and a post-monsoon festival in Nadaun (Table 2). Findings also show that most ceremonies are attended by both males and females of all age groups except one female-only festival in Sujanpur and funerals which are only attended by males.

Table 2. Ceremonies/festivals conducted in the Beas River.

Survey Site	Type of Ceremony/Ritual/Traditional Practice/Festival	Allowed Gender	Allowed Age Groups	Location of Ceremony and Use of River	Number of People Participating	Time of the Year for Ceremony
Both sites	Funerals	Males	All age groups	On the riverbank, ash remains scattered in the river	less than 100	Anytime of the year
Sujanpur	Baisakhi vrat	Females	20–59 years	On the riverbank including bathing in the river	100–300	April (pre-monsoon)
Sujanpur	Nalwar fair	Both Males and females	All age groups	Traditional markets on the riverbank	over 500	April (pre-monsoon)
Sujanpur	Holi mela	Both Males and females	All age groups	Sujanpur - town centre near the river	over 500	March (pre monsoon)
Nadaun	Fair	Both Males and females	All age groups	Traditional markets on the riverbank	over 500	March (pre monsoon)
Nadaun	Ganeshi Chaturthi	Both Males and females	All age groups	Includes immersion of idols in the river	over 500	September (post monsoon)

Figures 5 and 6 below show typical idols immersed into the river during some festivals and a funeral proceeding (with the smoke indicating the cremation site), respectively. The pictures were captured by the lead author during the field visit in November 2017.

Figure 5. Some of the materials immersed in the Beas River during cultural rituals/ceremonies. (**a**) floating red material remnants and (**b**) statues/idols in the riverbed (source: lead author, 2017).

Figure 6. A funeral captured during the field visit in Sujanpur (source: lead author, 2017).

3.5. Changes in the Beas River Overtime and Associated Changes in CES

All respondents from both study sites indicated that during the time they have lived in the study sites, they have witnessed changes in the Beas River. The most significant change mentioned by almost all respondents in both sites was the reduction of the river flows (Figure 7). This was attributed to construction of dams upstream, rainfall reduction and glacial area reduction.

Another observed change, although not much frequently mentioned was the pollution of the river with solid waste. Such accumulation of waste was partly attributed to religious ceremonies that involve immersion of materials into the river.

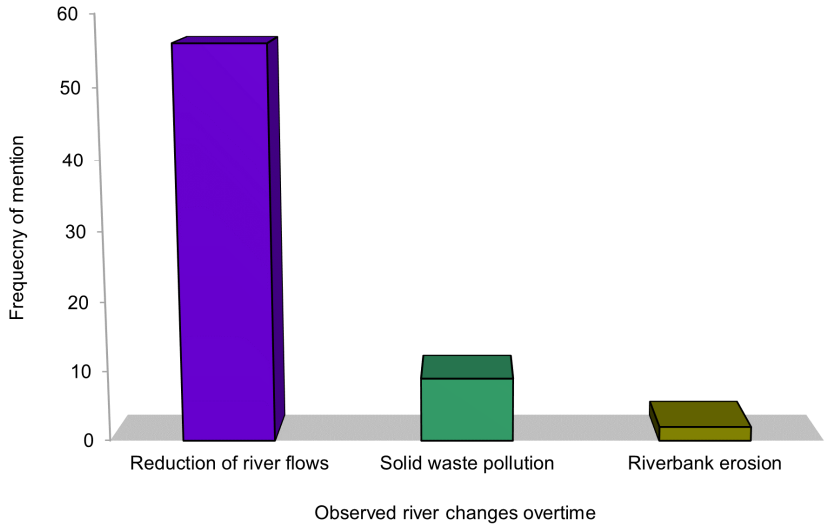

Figure 7. Observed changes in both study sites in the Beas River overtime.

These observed changes in the Beas River were also linked to changes in some CES. As shown in Figure 8, CES that have significantly decreased over time were aesthetic values, and recreation and tourism as indicated by most respondents. The majority of respondents in Sujanpur (93%) (Supplementary Material, S2) also indicated that educational and ecological knowledge benefits of the Beas River have also decreased over time. As shown in the figure below, most respondents indicated that some CES have not changed over time. This particularly applies to those CES identified as absolutely essential to local communities such as religious ceremonies, sense of place and identity and inspiration.

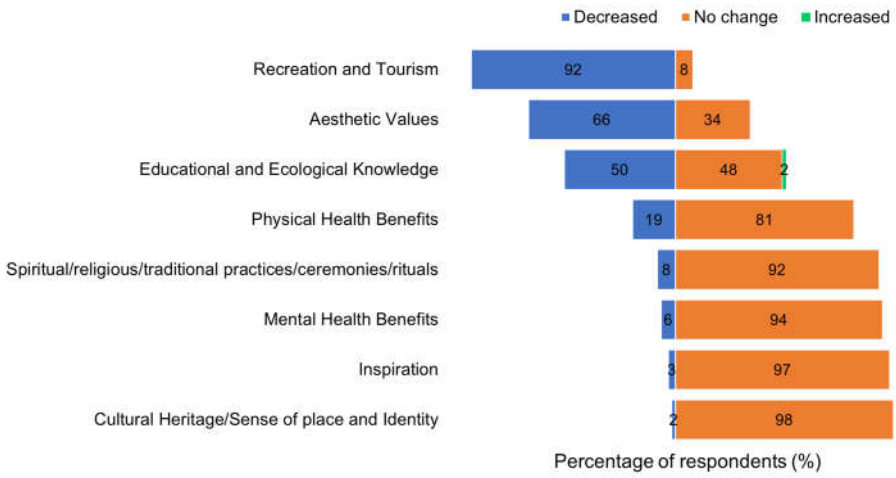

Figure 8. Observed changes in CES in both study sites in the Beas River overtime.

4. Discussion

The Beas River is crucial to the functioning of surrounding local communities as it lies in the core of their cultural practices. Religious and spiritual benefits, including ritual bathing, immersion of idols and funeral practices, were indicated as one of the most important CES that local communities gain from the Beas River. Attached to this was also the cultural identity and sense of place associated with the Beas River as indicated by most respondents who have lived in the area since birth. Findings from this study confirm and reflect strong ties between communities and rivers in India where some rivers are worshipped as deities [36], and highlight the importance of incorporating transcendent CES into water management decision making processes [36,37]. This contrasts with the importance given to spiritual and sacred CES in relation to rivers in other parts of the world, which is significantly lower compared to other CES such as recreation and bequest [4,5]. As revealed in other studies, e.g., [38], the most important perceived CES in the Baltic sea were recreation, habitat and landscape while spiritual and religious CES were rated lower. Similarly, a study by Rall et al. [39] in the city of Berlin (Germany) showed that respondents rated recreation, aesthetics and biodiversity as the most important CES. This reflects the contextual nature of CES and the different ways in which people in different countries relate to nature.

CES are noted to be the only ES category that can be linked to all aspects of human wellbeing, i.e., security, health, good social relations and the basic materials for good life [40,41]. This implies that the beliefs associated with CES from the Beas River, such as spiritual beliefs can contribute to positive outlook, bring a sense of happiness, encourage social interactions and cohesion and giving a sense of purpose in life, all of which contribute to mental health and wellbeing in general. Similarly, in urban settings, blue-green spaces, e.g., parks are regarded as a key source of good mental health, e.g., through stress reduction and wellbeing [42].

However, human modifications of river systems through activities such as dam constructions and inter basin water transfers negatively impact on the delivery of freshwater ES; including CES [43]. This could pose a threat to the enjoyment of CES associated with rivers and, hence in the process, impact on human wellbeing. Human engineered river modifications alter the natural flow regime of a river [44,45]. The alteration of the natural flow regime impacts on downstream biotic community, instream habitats all of which contribute to various ecosystem services [41,46].

Despite the importance of CES to the communities, the Beas River continues to be impacted by both human and natural factors. The Beas River is a highly regulated river. Construction of hydropower dams, upstream inter-basin water transfers and abstraction

activities were identified by the survey respondents as the main anthropogenic factors contributing to reduced river flows. Although the reservoirs in the Beas River such as Pandoh abate flooding and high river flows during the monsoon [23], they impact on downstream river flows as most respondents indicated a notable reduction in river flows over time. Such upstream activities have impacted on some CES especially those associated with high river flows such as aesthetic values. This also means that; with continued reduction in river flows, sources of livelihood for local communities such as fishing from the Beas River (provisioning ES) might be impacted overtime.

The detailed analysis of historical flows in the Beas River at Nadaun indicates a possible decreasing trend in river flows but it is not statistically significant and shows an increase in the duration of high flow events [27]. Projected climate change impacts on the hydrology of the Beas basin, are subject to large uncertainty related to the considered emission scenarios and climate models [23]. Some studies indicate an increase in the mean annual runoff due to increased monsoonal precipitation, snow and glacier ice melt but a decrease in meltwater contribution in the long term [29,47], while others project lower river flows during the monsoon period [48–50]. Moreover, new hydropower projects are under construction and are likely to impact on the flow levels locally by diverting water for significant distances before discharging it back to the river.

In any case, results indicate that flow changes in any direction can threaten CES linked to high/very high flows (e.g., aesthetics and mental health benefits), low flows (e.g., recreation, and physical and mental health) or enjoyed under any flow conditions (e.g., spiritual/religious and heritage/sense of place) by limiting the access to the river and its banks. For example, some practices or festivals are conducted during or after the monsoon period when the water levels in the river are high. Times of high CES supply can be referred to as, "hot moments" for CES delivery. Such hot moments [7] for these CES might be impacted as there might be too much or not enough flow for idol immersions and ritual bathing. Such changes will also have varying impact on gender and age groups as the utilization of the river for some practices is based on these factors (Table 2) and such practices are irreplaceable. Thus, there may be an impact to the 'absolutely essential' CES such as religious/spiritual ceremonies, even though they are believed to remain valuable to communities regardless of water levels in the river, reflecting the value of mere existence of the Beas River to the locals [51].

The current water policies and management approaches in the Beas River are focused on maximizing provisioning ES such as water supply for hydropower, irrigation and drinking water, with limited consideration of the suite of ES especially the intangible ES [52]. This points to the need for integration of all ES categories for sustained water resources development that supports cultural ties and practices that lie within the core of local communities within the Beas River Basin. Management approaches such as environmental flows [53] and inclusion of local stakeholder communities in water allocation decisions could ensure that downstream human and ecological needs are taken into consideration [29].

The current focus on maximizing provisioning ES in the Beas River could be attributed to limited appreciation of rivers as ecosystems that provide crucial ES including less obvious CES, support livelihoods and human well-being in India [8], which stresses the relevance of the present study. Furthermore, unbalanced power dynamics, between decision makers and local communities could be contributing factors. Decision makers such as policy makers have more power to set up development infrastructure such as dams and canals which could be obstructing CES for the less powerful local communities. Partly due to the reluctance of decision makers to apply bottom-up approaches [54] but also due to the lack of standardized methodologies, the application of the ES concept in water resources management is still patchy [55].

The two CES identified in this study as being sensitive to changes in river flows in the pre-and post-monsoon seasons, i.e., recreation and tourism and aesthetic values, respectively, have been integrated into a basin wide water resource systems model to as-

sess a suite of freshwater ES under current and future climate scenarios [23]. This related study assumes that the 10th to 90th percentile interval of river flows in the past provides the benchmark conditions for people to enjoy these services and assesses the impacts of climate change in relation to the percentage of time that future simulated river flows fall within the aforementioned percentile interval. The main findings show that CES will be affected not only by changing climatic conditions but also the management of water resources from the Beas River as current management approaches and policies are focused on maximizing provisioning ES. This demonstrates the importance of survey-based studies to determine how freshwater is used in the delivery of CES and how they interact with other ES categories, contributing to bringing CES to the attention of decision makers for consideration in the analysis of climate change and water management impacts to support inclusive, just and sustainable water resources management.

This study reveals complex human–nature interactions in the Beas river system. The high demand and preference for provisioning ecosystem services in the Beas River reflects tradeoffs within and between ES categories [56,57] and arguably more bias, intentionally or unintentionally, towards provisioning ES compared to CES. Similarly, within CES categories the prioritization of spiritual/religious CES by local communities and associated activities which inadvertently impact on the aesthetics of the Beas River further reflects tradeoffs within the CES categories. Ritual bathing and other cultural/religious practices in the river mean that the river is also negatively impacted by such human–nature interactions. As revealed in the study by Tyagi et al. [58] water quality assessment in the Ganges River (India) after the Maha Kumbh festival showed alarming levels of fecal contamination and increased cases of water borne diseases. Water quality issues in rivers in India is a challenge due to such cultural and religious practices [59]. The pollution of the river from solid waste disposal and bathing rituals also impacts on the water quality regulation ecosystem services and instream biodiversity (supporting ES). This demonstrates different ES interactions and relationships as changes in one type of an ES is also likely to impact on other ES [56] and poses a challenge as to how this could be addressed without compromising the entwined cultural and spiritual ties to rivers in India. Our suggestion is to consider the multi-layered and cascading impact of water resources development on different ES including the intangible CES.

Arguably, CES from the Beas River are equally important if not more than some of the tangible ES, as it has been demonstrated in studies in other rivers [60,61]. However, there are challenges associated with assessing CES which could raise questions on the benefits identified in such studies. As in other CES assessments, findings from this study are based on individual perceptions and, hence, are subjective. In response to this fact, the selection of respondents, the design of the questionnaire survey and the collection of responses, were done to ensure the representativeness and relevance of responses that provide robust and useful information which brings CES to the fore for management attention and decision making. However, socio-cultural valuation methods are not exclusive for CES and some studies argue that they should be used to assess all ES if the aim is to engage with stakeholders and include local knowledge [62]. Moreover, incorporating CES into decision making requires the use of multi-criteria analyses to account for different categories of ES, which further increases the subjectivity of the analyses as weights have to be selected to reflect the relative importance of each ES. This should be, ideally, defined through participatory processes with all relevant stakeholders [60,63]. Thus, full ES assessments are inherently subjective, as they should engage stakeholders at multiple stages beyond the development of surveys.

5. Conclusions

The aim of this study was to identify the CES provided by the Beas River in India, to assess how local communities perceive their importance and how they relate to river flows. Findings show that the Beas River provides several CES to local communities but among these, spiritual/religious ceremonies and rituals, aesthetic values and inspiration

were indicated as absolutely essential to the local communities. These absolutely essential CES remain valuable to local communities regardless of water levels in the Beas River, reflecting the value of the mere existence of the river to the locals. However, the changes in flows overtime due to both human and climate change related factors threaten the enjoyment of various CES in the future. It can be concluded that the Beas River is crucial to the functioning and livelihoods of local communities as it lies within the core of their cultural/religious/spiritual practices.

Bringing to the fore the impact of predicted changes in rivers on the most valued but intangible CES is important in informing decision making and management action. Although there are still challenges in measuring and quantifying CES, this study provides a method that can facilitate their assessment for inclusion alongside other ES in whole systems approaches. This would avoid bias towards other ES categories and unintended tradeoffs in the utilization of rivers and would also ensure that rivers are managed in a way that caters for social, political, cultural and hydrological contexts.

Supplementary Materials: The following are available online at www.mdpi.com/2073-4441/13/4/535/s1, S1: Survey questionnaire, www.mdpi.com/xxx/s2, S2: Survey results graphs for each study site, Figure S2.1: Gender distribution of survey respondents, Figure S2.2: Age distribution of survey respondents, Figure S2.3: Numbers of years survey respondents have lived in the area, Figure S2.4: Importance of different cultural ecosystem services in the Beas River, Figure S2.5: River water levels at which most cultural ecosystem services are gained, Figure S2.6: Observed changes in the Beas River overtime, Figure S2.7: Observed changes in cultural ecosystem services in the Beas River, Figure S2.8: Identified causes of changes in the Beas River.

Author Contributions: S.N. prepared the original paper draft which was reviewed and edited by all authors prior to submission; S.N. designed the data collection instrument and facilitated the data collection and analysis process; L.B. and A.M. conceptualized the method in which cultural ecosystem services could be included within the larger basin model and they also led the discussion section of the paper. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the UK Natural Environment Research Council, grant number NE/N016394/1 and the APC was funded by Heriot-Watt University.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of Heriot-Watt University (12 March 2018).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are openly available in Heriot Watt University Research Portal (PURE) at https://researchportal.hw.ac.uk/en/datasets/cultural-ecosystem-services-in-the-beas-survey-data, DOI 10.17861/bd0929c3-9009-470c-a9bb-86e71fa1850c .

Acknowledgments: This work is part of the Sustaining Himalayan Water Resources in a changing climate (SusHi-Wat) research project and we acknowledge funding support from the UK Natural Environment Research Council (NERC; grant numbers NE/N016394/1 and NE/N015541/1) and the Indian Ministry of Earth Sciences (MoES) under the aegis of the Newton-Bhabha scheme. We are also grateful to our project partners IIT Roorkee, NIT-Hamirpur, NIH-Roorkee, and IISc-Bangalore, the British Antarctic Survey and the Bhakra-Beas Management Board. Special thanks go to our project partners at NIT-Hamirpur for helping with administering the questionnaire.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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2021-02-19
MDPI
https://doi.org/10.3390/w13040535
Ncube S, Beevers L, Momblanch A. (2021) Towards intangible freshwater cultural ecosystem services: informing sustainable water resources management. Water (Switzerland), Volume 13, Issue 4, 2021, Article number 535

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