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An Ecosystem Valuation for Enhanced Transboundary Water Cooperation in the Kabul River Basin

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The ongoing water conflicts between Afghanistan and Pakistan in the transboundary Kabul River Basin are narrowly focused on quantitative water distributions, which lead to win-lose situations. This study proposes a novel idea of using the biodiversity and ecosystem services (BESS) concept to bring together multiple stakeholders across the KRB and transform the water-sharing conflicts. The study redefines the water management problem in the context of a green water economy and evidence of shared environmental benefits. The study found that the BESS provided by the Kabul River are vital for the livelihood of the residents and the natural flow of water is a win-win situation for both Afghanistan and Pakistan. The study recommends designing PES schemes for the sustainability and shared prosperity of the region. A new perspective on transboundary water conflicts in the KRB is needed, one that focuses on shared environmental benefits and the BESS of the river basin. This new perspective could lead to more cooperative and sustainable water management solutions.

Keywords: Kabul River Basin, Biodiversity and Ecosystem Services, Valuation, Market-based Pricing Method

1. INTRODUCTION

Biodiversity and the ESS is a complex but significant area, which influences the well-being of humans in diverse ways. The ESS can provide provisioning services as well as regulate services. The literature shows different approaches to the of provisioning ESS (Häyhä, Tiina, & Franzese, 2014). Placing an economic value on nature can be a powerful tool as it makes the invisible benefits identifiable. ESS represent outcomes of a natural system which benefits the people. The significance of water as a natural resource and ecosystem provides a wide range of services and various functions as the use of water for drinking, irrigation, or livestock (Radoslav, 2018).

River water services provide numerous benefits in terms of social and ecological facilities, which benefit the people and contribute to the well-being of the area. Globally, in 150 countries, there are a total of approximately 310 transboundary rivers. Water-

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related conflicts are not only frequent but are increasing due to the current worsening situation of water globally. Several water treaties are in place between various countries, yet the conflicts emerge frequently (Wang, et al., 2021). The water politics of transboundary rivers are emerging as a compelling research field in social hydrology. Many international basins are governed by multi-level institutions. Besides, the valuation of the benefits of river systems can positively contribute to efficient river-water management and reduce water-related conflicts and problems (Khan & Zhao, 2019). However, this is not the case with managing the Kabul River Basin (KRB).

The KRB between Afghanistan and Pakistan is not governed by an international agreement and boundary problems, that is, the contested Durand Line, affect the relationship (Yousaf, 2017). Water conflicts in the KRB between Afghanistan and Pakistan have intensified since 2000, coupled with security issues due to the ongoing insurgencies in the region. Growing industrialisation, urbanisation, and climate change which affect the continuity of snow-fed rivers, environmental hazards, and the geo-strategic importance of the area further exacerbate these disputes. The existing transboundary water mechanisms are state-centric and bilateral, exclude other relevant actors, and emphasise water quantity as the basis for water sharing (Yousaf, 2017). These agreements disregard the broader biodiversity and ecosystem services (BESS) of the river basin and what these services could imply in terms of enhancing human well-being. The BESS of water includes biodiversity, provisioning (e.g., food production), regulating (e.g., climate & water regulation), supporting (e.g., nutrient cycling), and cultural services (recreational, spiritual) (Pavan, Wittmer, & Miller, 2014). The value of global BESS was estimated at $145 trillion in 2011 at a time when global GDP was $73.3 trillion[1] (Robert, et al. 2014). Extrapolating to the river basin between the two countries, one can argue that understanding the value of the BESS in the region could lead to a different problem framing and enable integrative multi-level bargaining leading to win-win solutions. While the BESS values the interdependence of humans and nature, it also offers conceptual and empirical tools to communicate with a wide-ranging audience (Robert, et al. 2014) and reveals the cost of damage, it may lead to the commoditisation or privatisation of such resources (Sullivan, 2013). Therefore, an analysis is required for a better understanding of the water BESS (it may still avoid such commoditisation) to evaluate if a change in the behaviour of relevant and powerful actors can be pursued while addressing socio-relational (dispute resolution, capacity building, and inter-generational equity) and ecological (pollution prevention, and the protection of BESS) goals and, thereby, contribute towards the Sustainable Development Goals (SDGs). By embracing economic, ecological, and social-relational mechanisms, the BESS concept connects the environmental system with politics and decision-making as well as fosters interdisciplinary science (Schröter, et al). It enables integrated trans-disciplinary approaches to solve such complex issues by building bridges between science and practice (Robert, 2011). The water conflict arising due to transboundary river basins can be analysed using an ecological valuation. Hence, the focus of this study is on estimating the provisioning ecosystem services on Pakistan's side of the KRB. An objective of the study is to develop an understanding of transforming a win-lose situation into a win-win situation for both parties.

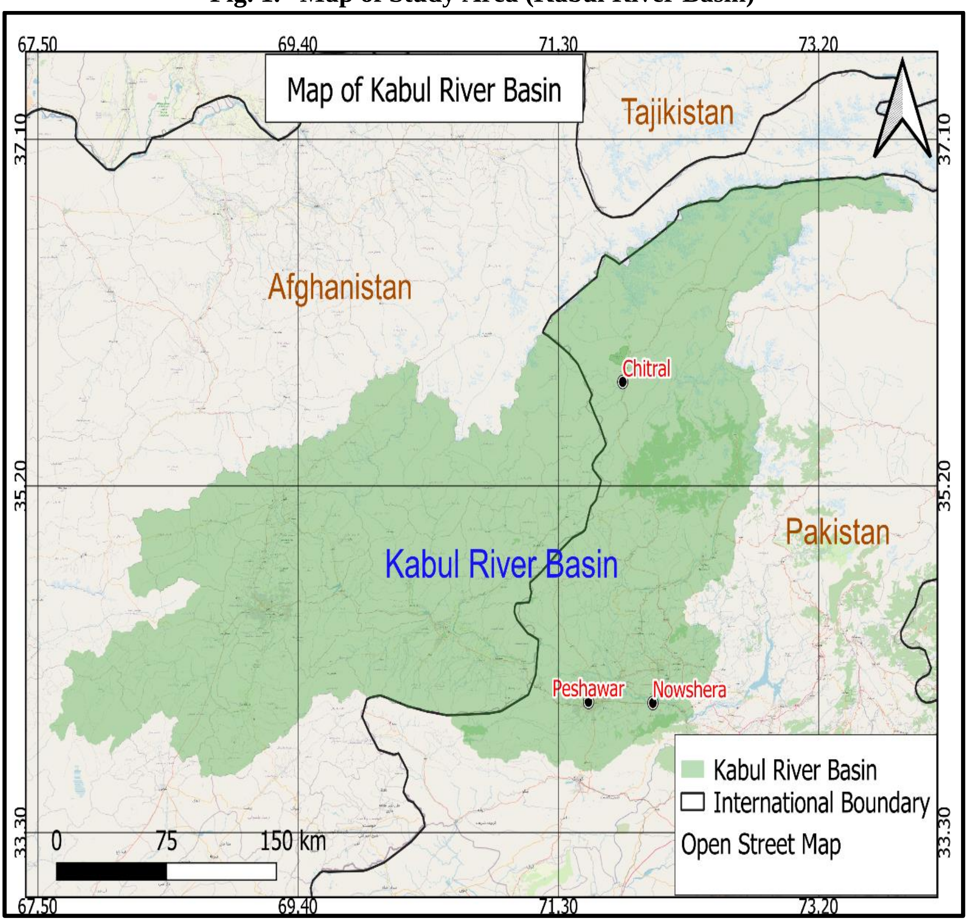
[1]This is because GDP measurement is based on market pricing, whereas BESS considers several market and nonmarket ecosystem services.

2. MATERIALS AND METHODS

2.1. Study Area

The present study carried out an ESS valuation of the KRB in the upstream and downstream areas. The data was collected in two phases. In the first phase, the data was gathered and analysed from district Chitral (upstream). Later, data from Warsak, Charsada, and Nowshera districts (downstream areas) were also combined. Chitral is in northern Khyber Pakhtunkhwa and is considered one of the highest-altitude areas globally. The district has Gilgit-Baltistan in the east, Afghanistan on its northern and western sides, and on the southern side, it is connected with the Swat and Dir districts of Khyber-Pakhtunkhwa (Haidar & Qaiser, 2009). The geographical coordinates of this area are 350 15´ 06" to 360 55´32" North and 710 11´ 32" to 730 51´ 34" East. The size of the area is 14,850 sq. km area and it is inhabited by 447,824 dwellers (Pakistan Census, 2017). The population of the area is heterogeneous and ethnically diverse. There are eleven distinct ethnic groups who speak almost eleven different languages or dialects. More recently, the area has been further divided up into two districts, namely, Upper Chitral and Lower Chitral.

Fig. 1. Map of Study Area (Kabul River Basin)



The Kabul River enters the downstream of Pakistan through the mountains of Mohmand in the Warsak areas of Peshawar.[2] The Kabul River goes through Nowshera and converges into the Indus River at Attock (Khattak, et al. 2016).

For Afghanistan, the Kabul River is also the fourth largest basin which is mainly utilised for irrigation purposes on both sides. The river is fed by the Chitral River, which has its origin in Chitral—the northernmost part of Pakistan. Out of the total 700 km length of the Kabul River, 560 km flows in Afghanistan and remaining in Pakistan (Yousaf, 2017).

The downstream of the Kabul River Basin on the Pakistani side is a lifeline for the people of Peshawar Valley and the Nowshera district. These areas grow fruits, vegetables, and other cash crops. These areas also have different industries which provide livelihood to the local community. The Peshawar Valley is 7,176 km^2 (2,771 sq. mi) in area and is traversed by the Kabul River (Yousaf, 2017). The people of this area constitute Pashtuns and Non-Pashtuns who live along the Kabul River. The Kabul River irrigates areas of Khalsa, Douaba, Daudzai, and other regions of the Peshawar Valley. Some of these areas have fruit orchards in which locals earn millions of rupees annually. In its lower reaches in Pakistan, the Kabul River crosses a region with a desert climate where maximum daily temperatures in early summer often exceed 104 °F (40 °C) and mean monthly temperatures in winter remain above 50 °F (10 °C).

With the increase in the population residing along the Kabul River Basin, the need for drinking and non-drinking water has also increased. Both Pakistan and Afghanistan are heavily dependent on the Kabul River Basin (Yousaf, 2017). For most people, the mainstay of the local economy is agriculture, while other sources of income include fuel woods, medicinal plants, livestock, fishery, mines, minerals, etc.

2.2. Conceptual Framework

There are various techniques available for estimating Biodiversity and Ecosystem Services of rivers and other types of ecosystems. Three main approaches are cost-based, revealed preference approach, and stated preference approach. The cost-based approach considers the cost of provisioning of these services (Grizzetti, et al. 2016). The revealed preference approach is based on actual behaviour, but it only considers the use-values of the resources. Moreover, this can be measured either using direct benefits (such as timber, fruits, water, or other uses) or indirect methods (such as travel cost methods, housing prices, and allied methods).[3] Stated preferences are based on hypothetical scenarios and are usually based on choice experiments or contingent valuation (CV) methods. Additionally, in case of non-availability of site-specific BESS values, the benefit transfer approach is also utilised. The following table summarises BESS valuation methods.

[2] There is also a historic hydroelectricity dam in this area-Warsak Dam.

[3] For a full exposition of the types of valuation methods, see, Freeman (1993) and Reynaud and Lanzanova (2015).

Table 1

BESS Valuation Methods

Ecosystem Services	Category	Value Type	Valuation method	Examples of Economic Goods Provided
(1) Fisheries and aquaculture	Provisioning	Direct	MP, RC	fish catch
(2) Water for drinking	Provisioning	Direct	MP, CV	water for domestic uses
(3) Raw (biotic) materials	Provisioning	Direct	MP, RC	algae as fertilisers
(4) Water for non-drinking purposes	Provisioning	Direct	MP, PF	water for industrial or agricultural uses
(5) Raw materials for energy	Provisioning	Direct	RC	wood from riparian zones
(6) Water purification	Regulation	Indirect	RC, CV	excess nitrogen removal by microorganisms
(7) Air quality regulation	Regulation	Indirect	RC	deposition of NOx on vegetal leaves
(8) Erosion prevention	Regulation	Indirect	RC	vegetation controlling soil erosion
(9) Flood protection	Regulation	Indirect	RC, CV	vegetation acting as a barrier to the water flow
(10) Maintaining populations and habitats	Regulation	Indirect	RC	habitats use as a nursery
(11) Pest and disease control	Regulation	Indirect	RC, CV	natural predation of diseases and parasites
(12) Soil formation and composition	Regulation	Indirect	RC	rich soil formation in flood plains
(13) Carbon sequestration	Regulation	Indirect	RC, MP	carbon accumulation in sediments
(14) Local climate regulation	Regulation	Indirect	RC, MP	maintenance of humidity patterns
(15) Recreation	Cultural	Direct	CV, TC, DC, HP	swimming, recreational fishing, sightseeing
(16) Intellectual and aesthetic appreciation	Cultural	Non-use	CV, DC	matter for research, artistic representations
(17) Spiritual and symbolic appreciation	Cultural	Non-use	CV, TC, DC	existence of emblematic species
(18) Raw abiotic materials	Extra abiotic	Direct	PF, MP	extraction of sand gravel
(19) Abiotic energy sources	Extra abiotic	Direct	PF, MP	hydropower generation

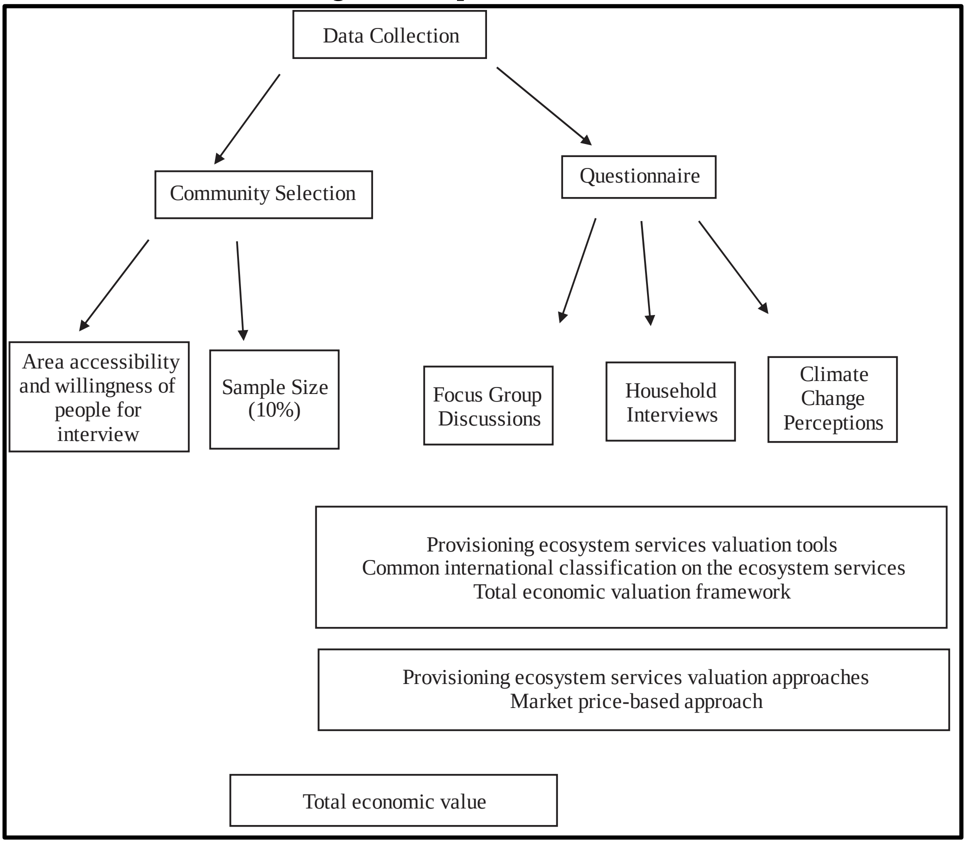
Source: (Reynaud and Lanzanova, 2015). Contingent valuation (CV), Hedonic price (HP), Market price (MP), Production function (PF), Replacement cost (RC), travel costs (TC).

Given the enormous scale of the KRB, the present study relied on the market price-based approach[4] for the valuation of the ESS of the KRB and employed the total economic valuation (TEV) framework suggested by The Economics of Ecosystems & Biodiversity (TEEB, 2010)[5] to value the ESS. However, our estimates of the ESS only include the provisioning and cultural services of KRB. Figure 1 summarises the complete methodology adopted for this study.

[4]This is based on the revealed preference approach and only measures the direct values of BESS.

[5] It is a global initiative to make visible the values provided by the nature.

Fig. 1. Conceptual Framework



2.3. ESS Identification and Economic Valuation

For the economic valuation, the interview responses were collected and compared to each provisioning and cultural ESS typology. These were assigned codes based on the Common International Classification of Ecosystem Services (CICES) (Haines-Young, et al. 2018). The TEV framework is a well-known instrument for economic appraisals of the ESS (Emerton, 2016). The framework is a well-organised way of outlining all the benefits provided by an ecosystem. It reflects the value in economic or other market-based units that can be compared across ESS types. The provisioning ESS is evaluated using this paradigm by applying direct and indirect use values. We used the market pricing method to calculate ESS values. This approach has also been used in previous investigations, such as Murali, et al. (2020), Thapa, et al. (2020), and Grizzetti, et al. (2016). Besides, the variables used in this study are in total conformity with the framework. Therefore, this study used the same framework to measure the ecosystem services provided by the Kabul River in its basin.

2.4. Total Economic Value (TEV)

The overall economic benefit was calculated by allocating the economic value for each provisioning ESS to each home and adding the means and standard errors for each household service (Sköld, et al. 2018). Household earning values were computed from all sources of income, including employment, agricultural production, animals and medicinal herbs sold. These values were then summed up to determine the Gurez Valley's average income (Saeed, et al. 2022). The total economic value of the ecosystem services can be included as a separate section in the GDP as earnings from the ecosystem because the data generated shows that rivers contribute significantly to the economy in different ways, and if there is proper planning and thought process, the income generation from the ecosystem can be increased.

2.5. ESS Valuation Based on Market Price

To determine the value of ESS, the market price-based technique was employed. Because provisioning ESS is frequently sold, market pricing is thought to provide meaningful information on value (Richard, 2019). The same technique was also employed to calculate ESS of the Gurez Valley (Saeed, et al. 2022).

The economic values of the ESS were calculated for the following CICES classes: (i) agriculture crops (e.g., beans and potatoes tomatoes, pulses, onion, barley, wheat, maize, and perennial crops), (ii) livestock, (iii) fuel wood (iv) medicinal plants, and (v) water (drinking and non-drinking uses).

Crop economic values were calculated by taking all the crops harvested each year and multiplying them by their market values. To calculate the ESS value of the agricultural yield, the value of all external inputs, such as chemical fertilisers, labour utilised, and tractor charges were subtracted from the value of the products produced. The economic value of milk was calculated by multiplying the per-litre market value of milk by the number of litres consumed per family per day multiplied by the number of days in a year. The cost of animal husbandry was calculated as the cost of their annual feed. The economic worth of meat was calculated by multiplying the market price of an animal per family by the number of animals sold annually. The annual collection of medicinal plants per family was multiplied by local market prices to evaluate the economic value of medicinal plants. The economic worth of the fuel wood was calculated by multiplying the per-household annual consumption by the local price of the fuel wood.

2.6. Data Collection

2.6.1. *Community Description and Selection*

The entire area of the KRB comprises upstream (Upper and Lower Chitral) and downstream areas from Warsak to Nowshera areas. Therefore, for the present study, 400[6] in-person household interviews were conducted using a pretested questionnaire.[7] The entire sample was then proportionally prearranged as 200 random[8] interviews in the upstream areas and the same number of interviews in the downstream areas.

[6] S=(Z)2*(p)(q)/(e)2

[7] Questionnaire is discussed in detail in the next section.

[8] Even for random selection, local referencing was mandatory. We held key informant interviews to get to know local clans, production types, hamlets, small groups, etc. This is a cultural thing, but still, the randomness element was maintained.

In the upstream areas, further stratification includes the Upper and Lower Chitral area. Upper areas include Boni, Mustuj, Yarkun, and Bragoal Pass, while the Lower Chitral areas consist of Aram Chasma, Darosh, and Ayun-Kalash areas. These specific locations were identified during key informant sessions.[9] The data collection scheme was grounded on the provisioning and cultural ecosystem services of the KBR. Subsequently, a pilot study[10] was completed in the lower Chitral area. The results of the pilot study were utilised to strategise the data collection in the upstream and downstream regions.

In the downstream areas, 200 in-person interviews were conducted based on the same data collection tool. The data were randomly collected in Warsak, the Sardaryab area of the Kabul Riverbank in the district Peshawar, the Jahangira district, and other adjoining areas.[11]

To have a complete sense of the ecosystem services corresponding to cultivated crops, animal feed, vegetables, and the kind and quantity of natural resource harvesting, like wild animal feed, medicinal plants, fuel wood, and wild vegetables, focus group discussions were held with the local representatives.

Data were collected from households and communities based on a structured questionnaire.[12] The details of the collected data in the upstream are given in the following table:

Table 2

Data Collection in the Upstream Region

Area	Number of Questionnaires
Upper Chitral-Garam Chashma	33
Darosh	33
Ayun-Kalash	34
Lower Chitral-Boni	25
Mastuj	25
Yarkun	25
Barogal Pass	25

The number of questionnaires filled in the downstream areas is summarised in the Table 3.

[9] KIIs or key informant interviews were unstructured interviews with the well know local inhabitants. They provided useful information about the local production, household, clans,etc.

[10] We sent our trained enumerators to selected sites in the lower Chitral areas to assess the viability of the data collection method and the initial response to assess the validity and reliability of the questionnaire. Although no major revision of the questionnaire was required, still the feedback from the team was important for us to start the full survey.

[11] These specific locations included Shaghala Payan, Wazir Kalay, Jahangir Pura, Mehmood Abad, Shaghala Bala, Sardaryab, Khan Aala, Sheikh, Jahangira, Mian Issa, Nandrak, Ali Muhammad Kale, Mishak, Akbar Pura, Kheshko Bala, Kheshko Payan, Nizam Pura, Hussain Abad, and Pir Payan.

[12] For this reason, a one-day training session was held for the enumerators to train them about how to approach the respondents, technical aspects of data, moral and cultural issues, and other important protocols of primary data collection.

Table 3

Data Collection in the Downstream Region

Area	Number of Questionnaires
Shaghala Payan, Wazir Kalay, Jahangir Pura, Mehmood Abad, Shaghala Bala	45
Sardaryab, Khan Qala, Sheikh, and other villages	55
Jahangira, Mian Issa, Nandrak, Ali Muhammad Kale, Mishak	50
Akbar Pura, Kheshko Bala, Kheshko Payan, Nizam Pura, Hussain Abad, Piry Payan	50

The respondents were randomly selected depending on the population of the village/area. Separate male and female enumeration teams were dispatched to these areas owing to cultural sensitivity and local norms. The respondents were adults, above the age of 18 years, including males and females. The number of questionnaires in each sub-strata was based on the proportion of the population of each sub-strata.

2.6.2. *Questionnaire*

To complement the data collection process, we also analysed secondary data. The analysis revealed that the most common agricultural products in these areas include wheat, tomatoes, potatoes, beans, maize, barely pulses, onion, rice, and different other vegetables. The inhabitants of the area collect medicinal plants, wild grass, and fuel wood from the non-agricultural land and nearby forests. Some amount of the agricultural product is used for household use, while the rest is sold in the market for income generation. Those households who deal in livestock, mostly use wild grass from the forest, and the non-agricultural land is used as pastures. Nevertheless, to further acquire the information at the household level, a questionnaire was prepared based on the toolkit for ecosystem service assessment (Murata, N., 2016).[13] The questionnaire consisted of four different aspects of ecosystem services, i.e., cultivated goods, the extraction of natural goods, water use, and recreation. The details are discussed in the following section.

Data on the perceived implications of climate change on the ESS, such as the cultivation of crops, animal rearing, the availability of water, etc. were also collected.

2.6.3. *Types of Ecosystem Services*

For the present study, we only considered the cultural and provisioning ecosystem services, which have been further classified into four subcategories, i.e., cultivated/agricultural goods, natural goods, water provision, and recreation services. Each of these is discussed below.

2.6.3.1. Cultivated Goods

Cultivated goods include agricultural goods and perennial crops that are cultivated by farmers on river basins. Cultivated goods in this study include fruits, vegetables, pulses,

[13] Toolkit for Ecosystem Service Assessment (TESSA).

wheat, sugarcane, maize, and other perennial crops in the KRB. The values were obtained by multiplying market prices with the unit minus the cost.[14,15]

2.6.3.2. Natural Goods

Natural goods include all those goods which are not cultivated by farmers or local residents. In this study, natural goods include gym stones, wood for domestic use and sale, fish from the river, medicinal plants, and other important products.

2.6.3.3. Water

Ecosystem provisioning services include water for agriculture and domestic use of the households in the river basin. However, we have only considered water for drinking and other domestic uses. The skirting of the irrigation part (directly) is deliberate to evade the double counting problem as this value is already captured in the market prices of the products. The per-capita household water consumption is based on World Health Organisation (WHO) standards.[16] The values have been calculated as under:

(The gross annual amount of water used from the site, e.g., tonnes/year) x (the unit price of water from an alternative source) – (the unit cost for current water use).

2.6.3.4. Recreation

Recreation services along rivers include tourism and other activities that people undertake during their leisure time. Recreation activities include tourism, boating, water skiing, swimming, fishing, and canoeing. However, we could not access the number of tourists that visit the KRB area.

3. RESULTS AND DISCUSSION

3.1. Identified Ecosystem Services in Upstream and Downstream Areas

The study identified a range of ecosystem services that are provided in the district of Chitral, Pakistan. During the survey, the communities provided information about a list of the ESSES that they use for household use and monetary benefits. The forests of Chitral are a source of fuel wood for local communities, safe habitat for many medicinal plants, wild animals, and fodder for the livestock of nearby villages (Zeb, et al., 2019). All the respondents of the survey were using one or more of the ESS for household purposes and also as a source of finance. The cultivation of different crops, medicinal plants, fodder for livestock, getting fuel wood for household use and selling in markets, the use of surface water for drinking and non-drinking purposes, and fishing were identified as the major ESS used by local communities. The ESS provided by the Kabul River is the main source of livelihood for the local communities in the district of Chitral. The importance of the ESS provided by the Kabul River for the localities of the district of Chitral can be identified by the monetary benefits obtained by the local communities (Saeed, et al. 2022).

[14] These prices were obtained from the growers.
[15] See Appendix 1.
[16] According to WHO, a normal individual consumes 15 litre of water per day.

River Kabul is an important source of various kinds of ecosystem services for the communities living nearby it. Some of the ESS are of more importance in terms of monetary benefits and some are of less importance to the localities (Najmuddin, Omaid, Deng, & Siqi, 2017). This study's results show a high monetary contribution in provisioning ESS to the communities living nearby the Kabul River.

The study identified a list of ESS along the downstream of the River Kabul Basin, i.e., the main services include agriculture, animal fodder, and water.

3.2. Provisioning ESS in Upstream Areas

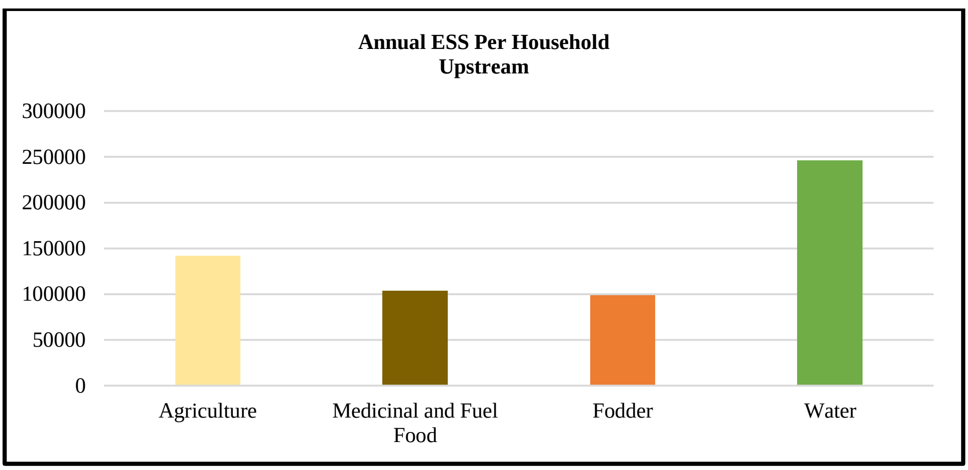
The ESS IS a boon for the inhabitants of the district of Chitral. The most common use of ESS is in agriculture and livestock, i.e., the cultivation of different crops, surface water for drinking and non-drinking purposes, medicinal plants, minerals, fuel wood, animal fodder, fishing, and surface water for non-drinking uses.

Table 4

Population Benefiting from ESS of KRB (Percent)

	% of Population Benefiting				
Region	Agriculture	Fuel Wood for Business	Medicinal Plants	Fodder for Animals	Water
Upper Chitral	100%	94%	64%	100%	100%
Lower Chitral	100%	95%	62%	100%	100%
Overall	100%	94.50%	63%	100%	100%

The table shows the percentage of the population benefiting from the ESS provision in the upper stream (Chitral). In the upper Chitral areas, one hundred per cent of the sampled population were the beneficiaries of agriculture, whereas 94 percent benefited from the fuel wood business, another 64 percent profited from medicinal plants, 100 percent received some portion or all of the fodder needed for their livestock, and 100 percent of the respondents used water provided by the Kabul River for drinking and non-drinking purposes. The trend was similar for Lower Chitral.



3.3. Economic Values

3.3.1. *Upstream Areas of Chitral*

The best ESS in terms of monetary value was drinking and non-drinking water use, which had a value of 246,118[17] ± 753 PKR/household/year ($1,231)[18] based on the sample data collected from respondents. The second-best ESS in terms of monetary value was crop yield, which had a value of 141,979 ± 4,132 PKR/household/year ($710). The third-best income-generating ESS was medicinal plant cultivation and fuel wood. The data shows that the average income generated from medicinal plants and fuel wood was 103,433 ± 1,679 PKR/household/year ($517). Animal fodder was the fourth leading ESS in terms of monetary value. This ESS generate a value of 98,976 ± 2,330 PKR/household/year ($1,012).

Table 5
ESS Valuation of KRB Upstream Areas

ESS Types in Upstream Area (Values)	Agriculture	Medicinal Plants and Fuel Food	Fodder	Water
Per Household	141,979.0094± 753	103,433.35 ± 1679	98,475.05± 2,330	246,117.5± 753

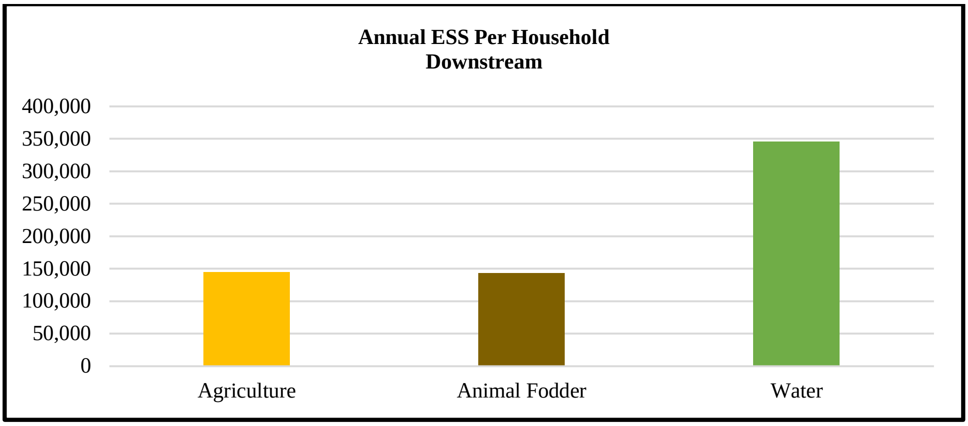
3.3.2. *Downstream Areas—Peshawar & Nowshera*

Table 6
ESS Valuation of KRB in Downstream Area

ESS Types in Downstream Areas (Values)	Agriculture	Animal Fodder	Water
Per Household	143,061.85±3057	143,176.91±1,277	346,030.8±1,120

The survey data reveals the economic value of the ESS from the Kabul River in the lower stream was 641,753 ± 407 PKR/household/year ($3,209). Water was a major part of the provisioning services, followed by animal fodder and agriculture proceeds. The provisioning services of the KRB in the downstream areas were found to be higher than in the upstream area. This is because the income level in the lower stream of the KRB is higher than the income level of the upper stream of the KRB (based on economic activities used by Hassan & Beyer, 2021). The higher income level in the downstream area is due to business spread over a wider area, more employment and income generation opportunities because of easy access to a relatively bigger market in comparison to Chitral, and the more developed industrial sector.

[17] (15 litres per person) x (times the number of of household/day) x (365 days) x (6.5 PKR/litre).
[18] 1 USD = 200 PKR.



The following section delineates information about a particular type of ESS in the upstream and downstream areas.

3.4. Ecosystem Services Categories and Values

3.4.1. *Medicinal Plants*

Medicinal plants obtained from Chitral are more important because of their contribution to curing major diseases. Some of the major medicinal plants cultivated or gathered from the forests of Chitral are *Artemisia maritima*, *Artemisia*, *Brevifolia*, and *Rosa webbiana* are the dominant species, while *Ephedragerardiana* and *Ferula narthex* are also important medicinal plants found in Chitral. The average monetary benefit obtained from the cultivation/harvesting from forests of medicinal plants was 10,136 PKR/household/year. Some of the medicinal plants harvested are used by households, while the rest are sold in the local markets. Some of the medicinal plants are of extremely high value and are sold to bigger herbal markets in other cities.

3.4.2. *Fuel Wood*

Fuel wood is another important ESS provisioning of the Kabul River to the communities living nearby. The total monetary value of fuel wood recorded amounted to 91,228 PKR/household/year ($456). The value of ESS provisioning of the Kabul River exceeded the economic value of fuel wood estimated by Murali, et al. (2020) for the arid regions of the Indian Trans-Himalayan Spiti valley. The estimated economic values for fuel wood were 432 USD/household/year with 11.7 percent of the total economic value produced by the Qurumber National Park. In the KRB, the fuel wood collection varies from valley to valley.

3.4.3. *Agricultural Crops*

Agricultural production is the most important ESS of the Kabul River. The survey shows that the river supports the agriculture sector in its basin. The study shows that Kabul River provided providing ESS worth 141,979.0094±753 PKR/household/year along the upstream, while along the downstream, the river provided ESS worth

143,061.85±3,057 PKR/household/year, amounting to a total agriculture ESS of 56,869,441 PKR/year. River Kabul plays a vital role in providing food security to the localities in its basin by providing irrigation water for agricultural production (Nafees et al., 2018). The availability of water for irrigation purposes is, therefore, pertinent for food security and the sustainable agriculture sector in South Asia. Climate change brings a new dimension to agriculture and food safety in South Asia. Studies suggest that the relationship of climate change with crop production in South Asia could be inverse and may be as high as 18.2–22.1 percent/year (Najmuddin, Omaid, Deng, & Siqi, 2017).

3.4.4. *Animal Fodder*

River Kabul is also a major source of provision of fodder for livestock. The survey shows that the provisioning of fodder ESS was worth 98,475.05± 2,330 PKR/household/year in the upstream area and 143,176.91±1,277 PKR/household/year in the downstream area. The average of these values is $604. The monetary amount of the ESS in the dry area of the Trans-Himalayan Spiti Valley was 523 46.2 USD/household/year, with a total economic share of 13.2 percent, 3,881±360 USD/household/year and 2.6 percent of the total economic value in Tost Nature Reserve, Mongolia, 929±67 USD/household/year and 6.2 percent of the total economic value for nomadic communities in Changtang area, India, and 1,182 ± 177 USD/household and 4.6 percent of the total economic value in Sarychat region, Kyrgyzstan.

3.4.5. *Water Consumption*

Water was found to be the most important and highest valued ESS provided by the Kabul River in the district of Chitral with a monetary value of 246,117.5±753 PKR/household. In the downstream areas, it was 346,030.8±1,120 PKR/household. The average value of the ESS provided in both upstream and downstream areas was $1,480. Water consumption includes both drinking and non-drinking consumption use.

These results are in line with past studies. Begenas watershed in Nepal contributes a major portion of the water used for irrigation and household (drinking and non-drinking) used by the localities (Thapa, Mainali, Schwank, & Acharya, 2020). The study shows that the Indian Trans-Himalaya is a vital source of the existing as well as prospective livestock in Central Asia and South Asia as it contributes 100 percent of water used for livestock purposes.

3.5. Per-Capita Total Economics Value (TEV)

The River Kabul makes a significant contribution in terms of the ESS in its upstream and downstream basins as the results indicate. The total economic value of the provision of ESS of the Kabul River upstream and downstream is significantly high, with an average economic benefit per household of 590,000±340 PKR/household/year ($2,950) in the upstream areas and 641,753.61±407 PKR/household ($3,209) in the downstream areas, averaging $3,080/household/year in both the areas. Our results are comparable to other regional estimates, for example, Din, et al. 2020 & Saeed, et al. 2022. However, our estimates do not include estimates of other services such as hydroelectricity generation, minerals, and tourism. We could not obtain these values due to various issues, such as accessing tourists during survey time and secondary data.

4. CONCLUSIONS

This study was undertaken to assess the idea of the BESS concept to contribute to understanding water-sharing conflict and present an economic valuation of the ESS provisioning of the KRB to redefine the water management problem in the context of green water economy and evidence of shared environmental benefits. The results of this study suggest that the ecosystem services provided by the Kabul River to the localities living nearby are vital and serve as a source of economic protection for the residents of the districts Chitral and Nowshera. The majority of the residents of the KRB are engaged in agriculture and livestock, which are the direct ESS provided by the Kabul River. The river also plays a key role in maintaining the greenery of the forests in the district of Chitral, which are safe habitats for wild animals, some medicinal plants, fuel wood, and fodder for livestock. The study shows that ESS provided by the Kabul River are vital for the livelihood of the residents as the ESS provided are the main source of income for the local population. The ESS values on the Pakistani side of the KRB suggest that merely the provisioning ESS related to the natural flow of water are enormously advantageous for the people living in the KRB area. This study covered only THE Pakistan side of the KRB due to limitations.

5. RECOMMENDATIONS AND POLICY IMPLICATIONS

This study has contributed to evidence of a broad range of shared ESS services and other benefits that the population on both sides of the boundary use. However, the conventional understanding of water sharing is based on water quantities which can obscure a wide range of ESS of the KRB that people depend on. This evidence and knowledge can also bring into discussion other international environmental agreements that both Afghanistan and Pakistan have signed such, as the SDGs 6, 13, and 15 on water, climate change, and biodiversity, respectively as well as other conventions on climate change and biodiversity. Looking at the benefits and environmental degradation from this lens can also create avenues for dialogue and cooperation for fulfilling the environmental commitments of both riparian countries.

In terms of policy implications based on the results, it suggests that the natural flow of water is a solution from which where both Afghanistan and Pakistan can benefit. Based on the evidence of shared benefits of ESS as a result of water flows, dialogue and cooperation between different stakeholders and beneficiaries in both countries can be initiated. These results can be converted into a policy brief by consulting a wide range of stakeholders, especially government officials involved in water management and related sectors. The Kabul River facilitates Pakistan and Afghanistan and the ESS provided by the river are of significant importance to each country as it is the basis for agriculture production and livestock rearing as well as related value chain by creating jobs indirectly. Therefore, both countries need to use the available water sustainably so that both can benefit from it sustainably. We recommend that a Payment for Ecosystem Services (PES) scheme may be designed for the sustainable use of these resources. Since the KRB is also a natural sink of Carbon, we highly recommend that the relevant stakeholder from both sides should also design a mechanism by upholding the natural flow of the river rather than non-cooperation (construction of dams on both sides). The sustainable use of water can enhance the ESS provided by the Kabul River in both countries in all aspects. There is a need for joint research collaboration on these aspects from both sides of the KRB to generate more evidence on shared benefits due to the natural flow of water.

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