Chapter 6
Community "Bio-Rights" in Augmenting Health and Climate Resilience of a Socio-Ecological Production Landscape in Peri-urban Ramsar Wetlands

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Abstract In the climate milieu, peri-urban wetlands are facing the serious threats of habitat destruction, biodiversity loss, and deteriorating ecosystem services owing to anthropogenic pressure and rapidly changing microclimates. Although some of these wetlands are unique socio-ecological production landscapes and seascapes (SEPLS) that ensure the food, water, and livelihood security of urban poor, they remain excluded from mainstream conservation. Ecosystem-based adaptive conservation and wise use by communities are sustainable solutions to protect these SEPLS, wherein the opportunity costs of wetland conservation to the ultra-poor are compensated with payments for ecosystem services. This chapter documents the success of a rights-based, neo-economic conservation model, entitled "*'Bio-rights of commons*", in two such peri-urban Ramsar wetlands, the East Kolkata Wetlands (EKW) and the Deepor Beel Wetland (DBW), both on the brink of extinction. The bio-rights model was developed by the South Asian Forum for Environment (SAFE) under the aegis of the Ramsar Secretariat in 2010 and implemented in the East Kolkata Ramsar wetlands. Perusal of results revealed that in both SEPLS, a rights-based conservation approach could ensure livelihood security as well as health and well-being during post-pandemic stress. A circular economic intervention was enabled at the community-ecosystem interface, through capacity-building in wastewater-fed captive fisheries, ecotourism in wetlands, and organic waste recycling as alternative livelihood opportunities. This compensated for the opportunity costs incurred by the wetland communities in conserving the SEPLS and also ensured community "bio-rights" to the wetlands' ecosystem services. While these efforts steadied biodiversity indices and waterbody permanence of these Ramsar wetlands, they also provided fresh air for the pollution-wracked cities of Kolkata and Guwahati during the

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COVID-19 pandemic, and augmented economic opportunities in fisheries for landless casual labourers migrating back home during the countrywide lockdown. The intervention recommended an operational guideline for policy frameworks in sustainably conserving these wetland SEPLS for enriching biodiversity, human health, and well-being.

Keywords Bio-rights · Peri-urban wetlands · Ecosystem-based conservation · Ecosystem services

1 Introduction

Wetlands provide a plethora of nature's goods and services, constituting unique socio-ecological production landscapes and seascapes (SEPLS) that ensure food, water, and livelihood security, especially for the poor. However, Osinuga and Oyegoke (2019) observed that these SEPLS are still excluded from mainstream conservation and are facing serious threats owing to anthropogenic pressure in the milieu of climate change. This has led to habitat destruction, biodiversity loss, and deterioration of ecosystem services, widening the poverty trap. Bassi et al. (2014) acknowledge that Indian peri-urban wetlands are degrading faster due to both biotic and abiotic threats like drainage and landfill, over-exploitation of fish resources, discharge of industrial effluents, uncontrolled siltation, and weed infestation, and the ill-effects of fertilisers, pesticides, and detergents. Reports in the India Water Portal reveal that the South Asian ecoregion is losing 25 km^2 wetlands per square kilometre of urban encroachment (Bansal, 2020), a rate even faster than the loss of forest cover (Reddy et al., 2018). One-third of wetlands in the Indian subcontinent have already been severely degraded, warranting policies for the management of this critical ecosystem. In the context of climate change, the mitigation potentials of wetlands are very high, though urban planning for the conservation of wetlands in smart cities is meagrely addressed (Mcinnes, 2014).

This chapter documents the success of a rights-based, neo-economic conservation model, entitled "*Bio-rights of Commons*" in two such peri-urban Ramsar wetlands of eastern India, the East Kolkata Wetlands (EKW) and the Deepor Beel Wetland (DBW). These wetlands were on the brink of being removed from the Ramsar list owing to deteriorating habitat health and biodiversity loss (Ghosh & Das, 2020; Saikia, 2019). After successful implementation of the bio-rights project, both wetlands are able to better support the livelihoods of the communities dependent on them for ecosystem services (ESs). The project has contributed to wetland habitat restoration and prevention of biodiversity loss, and simultaneously, sustainable intensification of ESs has substantially contributed to health benefits for the communities during the present pandemic.

EKW is a multifunctional sewage-fed wetland complex, spanning a 12,741-hectare area in the Bhagirathi-Ganga riverine floodplain that naturally recycles nearly 250 million gallons of sewer water and removes around 237 kg of biological oxygen demand (BOD) per day (Bhattacharyya et al., 2012). It was recognised as the world's largest natural resource recovery ecosystem in the fringe of Kolkata Metropolis by the Ramsar Secretariat in 2002. Until 1830, tidal flow from the Bay of Bengal through rivers and rivulets drenched this area with saline water; but in the latter half of the nineteenth century, as the rivers dried out due to siltation, the area started receiving urban wastewater and local communities began wastewater fish farming (Ghosh & Sen, 1987). Since then, local indigenous communities have been traditionally managing the sewer flow to regulate the nutrient load, thereby leveraging the natural resource recovery system of EKW for intensive fisheries and organic farming (Ghosh, 2005). EKW provides an array of ecosystem services to support livelihoods and the wetland environment relating to provisioning of wastewater recycling, food and fish production, flood protection, and more. It also harbours a rich biodiversity of fishes, birds, reptiles, amphibians, and plants (Ghosh, 1990).

DBW is an oxbow lake of the Brahmaputra River, situated in close proximity to the city of Guwahati. It is a typical wetland ecosystem within the Burma Monsoon Forest Biogeography region that provides various goods and services to the local community and animal population of the Rani-Garbhanga reserved forests, which are adjacent to the wetlands and house nearly 120 Asiatic elephants (Mitra & Bezbaruah, 2014). DBW is traditionally managed as a major fish breeding and nursery ground by three indigenous fishing communities for supplying fish stocks to other nearby waterbodies while conserving the local fish biodiversity. Almost 750 households in 14 fringe villages are directly dependent on the wetland for fishing and collection of herbaceous plants (Mahadevia et al., 2017).

Both of these wetlands are declared Ramsar sites. Biophysical and socio-economic studies have been carried out, and management plans for the wetlands have been proposed. Yet, the current approach to management appears fragmented, and innovative ways are needed to conserve and protect the ecosystem services of the wetlands (Mukherjee, 2011). A thorough institutional analysis and responses to demands arising from impacts on wetland ecosystem services due to urban expansion are needed. Moreover, a large number of poor who depend on the ecosystem services of the wetlands are still excluded from the decision-making processes of these SEPLS (Dey, 2008).

This chapter explores a rights-based approach to poverty alleviation and SEPLS conservation. It reviews bio-rights as a community-based neo-fiscal conservation paradigm for protecting ecosystems of global ecological importance by compensating the opportunity cost incurred by the communities living in the vicinity and dependent on the environmental goods and services of the ecosystem. The global average compensation cost would not be difficult to accomplish if technological cooperation and developmental resources were equitably extended to such communities. Bio-rights is therefore a sustainable neo-financing mechanism where the poor can be empowered to protect the ecosystem services that they depend upon. It is envisaged that a better institutional management framework that includes bio-rights can be developed to safeguard the ecosystem services of the wetlands, facing the menace of urbanisation.

2 Methodology

2.1 Intervention Area

The major study was conducted in 2019 in two wetland areas, namely the East Kolkata Wetlands (22.55°N 88.45°E) and the Deepor Beel Wetland (26.13°N 91.66°E) (Figs. 6.1 and 6.2 and Table 6.1). The EKW is a complex of natural and man-made wetlands lying east of the city of Kolkata, spreading over the districts of North and South 24 Parganas in the state of West Bengal, India. The wetlands cover 12,741 hectares at an elevation of 12 m above sea level and constitute one of the largest assemblages of sewage-fed fish ponds including salt marshes, agricultural fields, and settling ponds. The wetlands naturally treat the city's sewage, with a detention period of 35 days, and the nutrients contained in the wastewater sustain fish farms and agriculture in 264 fishery cooperatives.

Deepor Beel is located at an elevation of 53 m above sea level to the southwest of Guwahati city, in the Kamrup district in the state of Assam, India. It is a permanent freshwater oxbow lake, covering 4014 hectares with an average depth of 1.5 ft., that originated from a former channel to the south of the Brahmaputra River. The wetland complex is within close vicinity of Guwahati and fragmented by highways and railroads. It was recognised as a Ramsar site owing to its vast biodiversity and

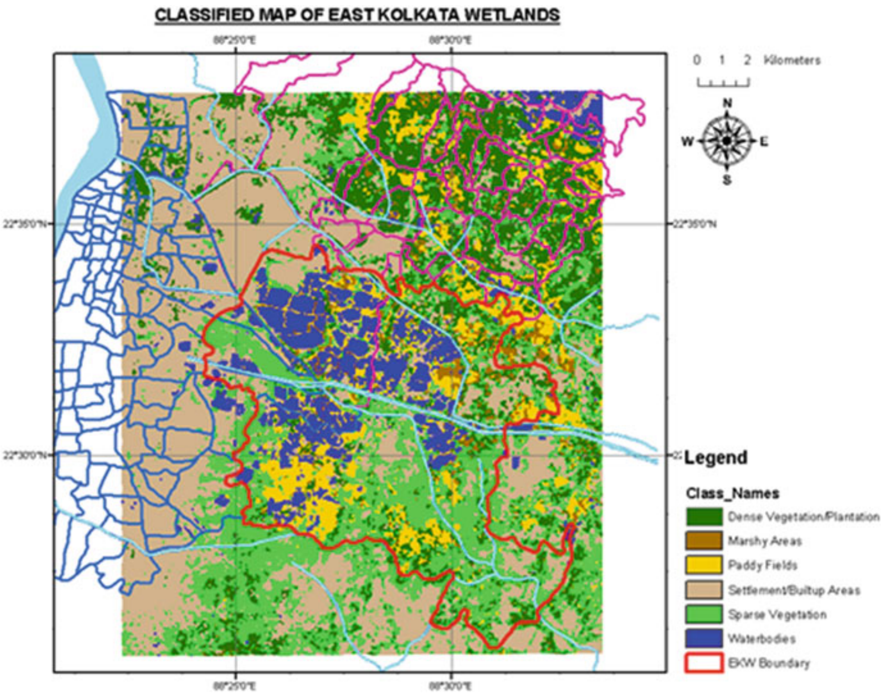

Fig. 6.1 Classified map of East Kolkata Wetlands (source: prepared by author)

Fig. 6.2 Location map of Deepor Beel Wetland (source: prepared by author)

Table 6.1 Basic information of the study area

Country	India	India
Province	West Bengal	Assam
District	Kolkata	Kamrup Urban
Size of geographical area (hectare)	12,500	4014
Number of direct beneficiaries (persons)	1600	1400
Number of indirect beneficiaries (persons)	145,000	45,000
Dominant ethnicity(ies), if appropriate	Indigenous fishers (*Sardar, Koiri*)	Indigenous fishers (*Karbi, Koiborto*)
Size of the case study/project area (hectare)	125	500
Geographic coordinates (latitude, longitude)	22.5528°N, 88.4501°E	26.13°N 91.66°E

ecosystem services that sustain the livelihoods of nearly 1200 households of indigenous communities.

2.2 Geospatial Mapping

Three land-use pattern and land cover (LUP-LC) maps of both peri-urban wetlands were prepared using Q-GIS open-access mapping software and based on satellite images of the base year 2000 and years 2009 and 2019. Maps were analysed and compared to identify both major and minor land-use areas for change detection studies. Following this, random physical surveys and GPS ground truthing were conducted in these areas to validate the GIS maps as well as the ecosystem services of the wetlands. Areas having wetlands that serve agriculture were identified and overlayed on land-use change detection maps. Inferences were drawn on changes in LUP-LC and subsequent changes in the ESs based on the study results.

2.3 Biodiversity and Ecosystem Service Assessments

The Trophic State Index (TSI), a frequently used biomass-related index (Carlson, 1977) that ranges between 60 and 100 on average, was used to estimate the water condition and biodiversity of the waterbodies. The TSI of phosphorus, TSI of Secchi disc depth, and TSI of chlorophyll-a were averaged to arrive at a single index ranging between 60 and 100. Water samples for the analysis of phosphorus and chlorophyll-a were collected from the waterbodies using subsampling methods to form one composite sample from each site (Davies & Tsomides, 2014). Four subsamples of 500 mL each were transferred to a churn spitter and the composite sample was transferred to a 2 L sampling bottle. The bottles were previously cleaned with a detergent devoid of phosphorus, washed with acid, and rinsed vigorously thrice with distilled water (American Public Health Association (APHA), 1995; U.S. Geological Survey (USGS), 2006). For phosphorus sampling the water sample was subjected to perforated digestion followed by ascorbic acid method, 4500E (American Public Health Association (APHA), 1995). Chlorophyll-a was estimated by acetone method. A spectrophotometer was used for analysis. Absorbance was marked at 630 nm (APHA 1995). The units for both chlorophyll-a and phosphorus are microgram/litre. Equations for TSI are as follows:

$TSI(SD) = 60 - 14.41 \ln (SD)$.

$TSI(CHL) = 9.81 \ln (CHL) + 30.6$.

$TSI(TP) = 14.42 \ln (TP) + 4.15$.

Note: TSI is Carlson Trophic State Index, SD is Secchi disc, CHL is chlorophyll, and TP is total phosphorus

Ecosystem services (ESs) were classified into four major categories, namely, (1) provisioning services, (2) regulating services, (3) habitat and supporting services, and (4) cultural services, and were assessed following the TEEB list (de Groot et al., 2010). One of the major objectives was to identify the existing ESs of the peri-urban wetlands, as well as the degree of livelihood dependency on these wetland ESs, with special weightage given to the use of wetlands for agriculture. Surveys of the ESs of the peri-urban wetlands were conducted on 104 waterbodies throughout EKW and DBW, of which 43 support agricultural practices like aquafarming and horticulture. The survey was done by stratified sampling of users of ESs, based on gender, age groups, and livelihood vulnerability index (LVI) scores with a preset questionnaire. Focus group discussions and rapid rural appraisal (RRA) for valuation of ESs were also conducted following standard protocols. Likewise, to identify the livelihood dependency of the peri-urban communities, gender-balanced focus group discussions with 12–15 members were conducted for both the EKW and DBW wetland areas.

2.4 Production Analysis

To estimate and analyse the commercial productivity of the wetlands, spatio-temporal measurements of fish yield were taken in metric tons per hectare every month for both intensive and non-intensive farming practices. Yield data on fish production were collected pre-monsoon, during monsoon, and post-monsoon from six different locations in both the EKW and DBW, and used to determine the mean value and provide trend analysis. Differential data on self-consumption and sale was also collected.

2.5 Sociometric Indexing

The sociometric study is based on primary questionnaire surveys in the peri-urban agricultural areas of Kolkata for EKW and Guwahati for DBW. The target group was families who depend on agriculture for their livelihood. The LVI scores were based on eight major components: socio-demographic profile, livelihood strategy, health, natural capital, social network, food, water, and natural hazards and climate vulnerability (Hahn et al., 2009). Each is comprised of various subcomponents. The LVI uses a balanced weighted average approach where each subcomponent contributes equally to the overall index, even though each major component is comprised of a different number of subcomponents. Because each of the subcomponents is measured on a different scale, each component is indexed first. The steps for calculation included the following:

(a) Balanced weighted average approach where each subcomponent contributes equally to the overall index. As each of the subcomponents is measured on a different scale, it is necessary to standardise each as an index. For this, the following equation is used:

    $\text{Index}_{sd} = \text{Sd} - \text{Smin/Smax} - \text{Smin}$, where Sd is the original value of the subcomponent and Smin and Smax are the minimum and maximum values in the study area.

(b) After standardising each subcomponent, the subcomponents are averaged using the following equation:

    $\text{Md} = \sum \text{Index}_{sd/n}$, where Md = one of the eight major components and $\text{Index}_{sd/n}$ represents the subcomponents that make up each major component.

(c) Once the values of each of the eight major components are calculated, they are averaged to obtain LVI using the following equation: $\text{LVI} = \sum W_M.\text{Md}/\sum W_M$, where W_M is the number of subcomponents in each major component, and LVI equals the weighted average of the eight major components. The range of LVI data is always between 0 and 1.

2.6 Attitude Scaling

In order to quantify perceptions and levels of awareness on nature's goods and services, as well as their significance for sustainable development and livelihood security among the beneficiaries, changes in attitude towards conservation priorities, wise use of wetlands, and overall vulnerability were measured using a five-point Likert scale.

3 Results and Outputs

3.1 Urban Encroachments and LUP-LC Changes

The land-use maps show that there has been significant loss of peri-urban wetland area in both sites impacting the livelihood patterns of the local communities. The results in EKW show an alarming loss amounting to 53.28% of the total wetland area over two decades of time, mainly due to shrinking of wetland boundaries as well as conversion of agricultural land (paddy fields) to forest-like cover (orchards and trees) by 27.44%. However, there has been a nominal increase of 2.7% in built-up areas and fallows compared to the base year 2000. In the DBW complex, wetland loss was 47%, with a 32% increase in built-up areas and waste dumping areas. Field observations showed that owing to loss of wetlands, there has been a shortage in water supply, as ponds and drainage were clogged leading to conversion of agricultural lands to small fragments of horticultural plots. Intensive horticulture was promoted in the fertile land residues as fisheries and paddy production declined. This was furthered by intensive chemical farming for yield enhancement, and later these plots were ultimately converted into orchards and plantations. This land-use change has been more drastic on the urban fringes in both EKW (Fig. 6.3) and DBW.

3.2 Biodiversity and Ecosystem Services

The difference between monsoon and post-monsoon TSI (chlorophyll) was remarkable in EKW, with the eutrophication level during the post-monsoon period surpassing that of monsoon period. In DBW, this phenomenon is reversed, and the monsoon TSI is higher than the post-monsoon TSI. Thus, even during the monsoon when the volume of water flow is higher, the waterbodies stay eutrophicated. This feature in DBW can be explained by the clogged canal system, which serves as both outlet and inlet for this particular SEPLS. The inflow and outflow of water from the waterbody are staggered due to habitat fragmentations. This in turn increases algal mass and phytoplankton growth at a rate not discerned in EKW, wherein sewer water drainage (both inlet and outlet) is traditionally controlled and regulated by the

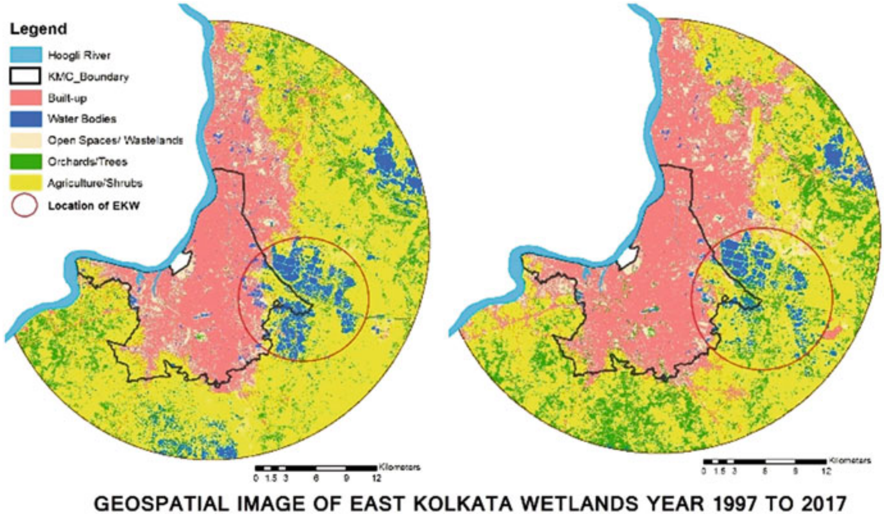

Fig. 6.3 LUP-LC changes in the peri-urban East Kolkata Wetlands (source: Amerasinghe & Dey, 2018)

communities. The post-monsoon TSI levels in EKW are higher than the monsoon TSI levels, showing betterment in the health of the trophic status of the waterbodies in the monsoon period. This is attributed to the diluted nutrients as well as the free flow of excess water during the monsoon period reducing biomass productivity and leading to lower levels of algal bloom and phytoplankton growth.

The average TSI levels of all the waterbodies, in general, are quite high (>80) in both the monsoon and post-monsoon period. This leads to the inference that all the waterbodies are hypereutrophic, which suggests a high production capacity as a result of excessive nutrients with visibility less than 15 cm on a Secchi disc. This leads to excessive growth of algal scum and dominance of bottom-dwelling predatory fish species, and prevents aquatic life from functioning at lower depths, creating dead zones in the subsurfaces, resulting in loss of biodiversity and shortening of trophic levels. Waterbodies in the area in EKW, managed by communities under the bio-rights conservation programme, show borderline eutrophication and a relatively low post-monsoon TSI and a lower nutrient level compared to the other waterbodies, wherein there is a low chance of fish death and hyper-eutrophication as well. Table 6.2 shows some TSI data for substantiating the findings.

The study showed that both wetland SEPLS provide regulating services such as maintenance of local climate and air quality, carbon sequestration, moderation of extreme events such as floods and drought, erosion prevention, maintenance of soil quality, and pollination. Home to a huge number of species, these wetlands help to maintain genetic diversity, and thus also provide habitat and supporting services. Of the four categories of ESs, provisioning services are the most prominent as they directly serve the basic needs of the local community, as well as provide livelihood support to a large population. Major provisioning services include providing space

Table 6.2 Seasonal TSI (chlorophyll and Secchi disc) in EKW and DBW

		Monsoon			Post-monsoon		
Location	Site no.	TSI (Chl)	TSI (SD)	TSI (Av)	TSI (Chl)	TSI (SD)	TSI (Av)
EKW	EK1	71.351882	81.552998	80.3618978	88.5646825	93.18025	82.5570143
	EK2	74.30124	84.552998	81.887169	85.9789184	89.39958	83.083291
DBW	DB1	81.033981	91.806832	85.9066857	80.1892666	89.39958	84.4527717
	DB2	83.274913	88.331686	86.6699869	82.3475607	87.33752	87.6235635

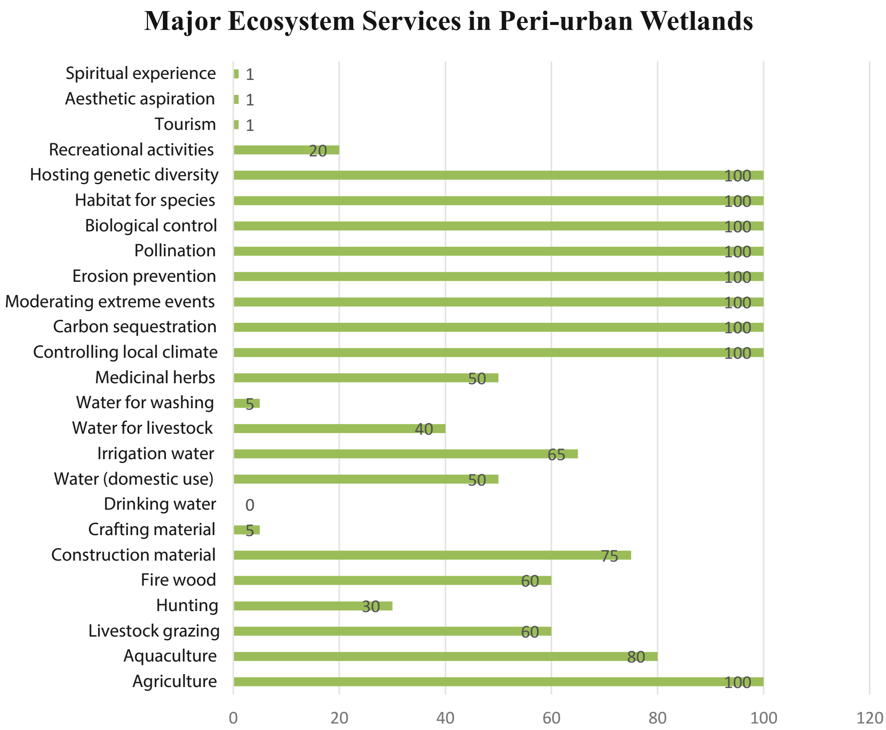

Fig. 6.4 Major ecosystem services of the peri-urban waterbodies (source: prepared by authors)

for agriculture, aquaculture, livestock grazing, and hunting; providing raw materials for firewood, construction, and crafts; providing fresh water for domestic use, irrigation, washing livestock, drinking water for livestock, and commercial washing; and providing medicinal herbs. Land for agriculture and aquaculture are the two most important ecosystem services, followed by water for irrigation, land for livestock grazing, and water for domestic usage. Although cultural services very much exist in the peri-urban wetlands, they are not clearly conceived by the local community (Fig. 6.4).

The results from sociometric studies and FGDs showed that the ESs of the peri-urban wetlands are of huge importance to the peri-urban community. They fulfil the basic needs of the local community as well as serve as a major source of income generation and livelihood. Services such as land for agriculture, aquaculture, and livestock grazing; collection of materials for crafts; and extraction of water for irrigation, livestock washing, and commercial washing provide support for income generation. On the other hand, collection of firewood, construction material, extraction of fresh water for domestic use, collection of medicinal herbs, and collection of food through hunting and gathering fulfil the basic needs of the local people. Aquaculture is the most important livelihood supporting ecosystem service of the peri-urban wetlands in Kolkata, availed by 75% of households, followed by 48.75%

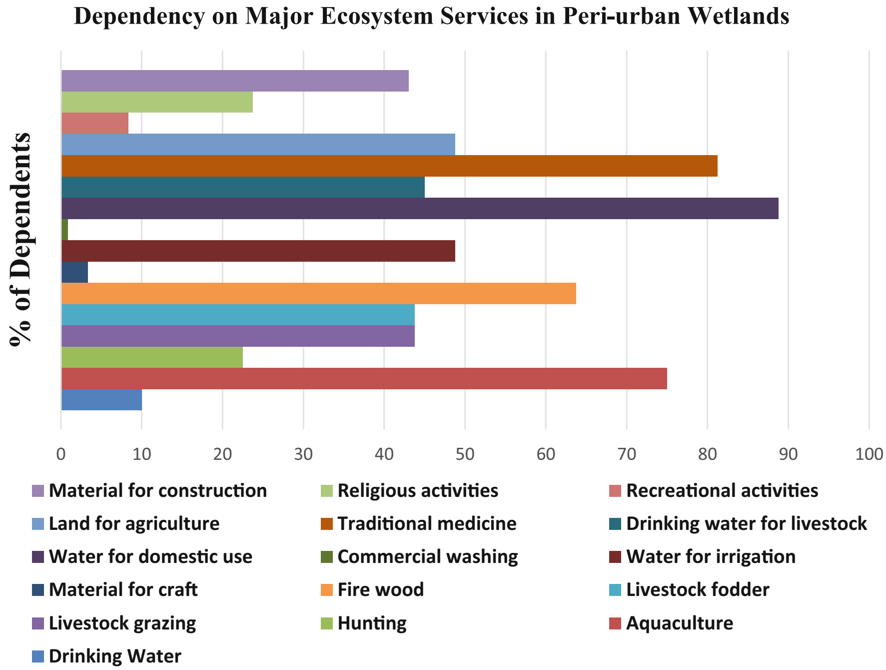

Fig. 6.5 Dependency on ecosystem services of the peri-urban waterbodies (source: prepared by authors)

of households who utilise the wetlands as agricultural space or its water for irrigation, and 43.75% who use the land for livestock grazing. The share of peri-urban households using waterbodies for domestic washing and bathing was found to be 88.75%, and that of households collecting traditional medicines and food from the wetland areas was 81.25%. Likewise, 63.75% of households were collecting firewood, and 43% were collecting construction materials from the wetland areas (Fig. 6.5).

The assessment found that gender equity in accessing the ESs of the wetlands depends on the nature of the service. Females are the predominant users of those waterbodies which are mainly used for domestic purposes and small-scale fish farming at the household level. On the other hand, farming activities in waterbodies that are used for commercial fisheries are mostly dominated by males. When asked to rank the importance of the waterbodies, 73.75% of respondents reported that the waterbodies are of prime importance in their day-to-day lives, as they support their livelihoods and fulfil basic needs as well. Again 68.75% of respondents reported that degradation of the wetlands has affected their livelihoods. Thus, the study revealed that the peri-urban wetland SEPLS are still of prime importance to the peri-urban community. They can be termed the "lifeline" of the peri-urban population.

3.3 Vulnerability and Sustainability Factors

The sociometric study, conducted pre-, post-, and during monsoon periods in 2018–2019, revealed that LVI is the highest in the urban fringes of both wetland SEPLS. Overall, in EKW it was 0.526, and in DBW it was 0.545. In EKW, vulnerability was the lowest for the food security component and also very low for the social network component. This is due to intensive culture fisheries and paddy cultivation in EKW, which causes habitat damage due to overusage of chemical fertilisers and feed, loss of local agro-biodiversity, as well as deterioration of ecosystem services. However, in Deepor Beel, only catch fisheries and livestock rearing support livelihoods. The literacy rate in households near the urban fringe is higher than literacy rates in far-off households. Thus, beneficiaries staying near urban settings have more access to societal networking and feel less vulnerable than those who are settled far from the urban areas, as they do not have at-hand access to urban facilities. For example, residing near urban settlements assures better access to water supply and health services, thereby reducing vulnerability. However, affordability is also an issue for the marginal communities to access these. Unfortunately, this has prompted a trend among marginal households to clutter near urban areas apparently for better access to crucial amenities like health services and water supply. As a spin-off effect, this has led to anthropogenic encroachments and deterioration of the wetland ecosystem services on which these marginal communities usually depend for their livelihood sustainability. Therefore, these chains of events further augment their vulnerability, though they are in close proximity to urban areas. This trend also suggests that due to overcrowding, urban fringes get more polluted and face greater water scarcity and finally access to basic amenities is diminished for the urban poor. Detailed analyses have suggested that when dependency on nature's services is high, socioeconomic vulnerability is also high in areas near to urban settlements. Vulnerability was also found to be high when heads of the household were female or illiterate, as well as for households made up of unskilled family members. Female heads of households are less aggressive in seeking out amenities or services owing to the societal dominance of males, while illiterate and unskilled heads of households were incapable of acquiring opportunities in a competitive environment. Higher dependence on agriculture, migration of male members due to increasing LUP changes, conversion of agricultural to non-agricultural land, and greater proximity to urban areas seemingly increased societal vulnerability, as in the case of DBW. Adopting more than one type of agricultural livelihood is one of the adaptive strategies for agricultural communities in these SEPLS in coping with climate vulnerability and decreasing viability of agriculture. Thus, families having multiple agricultural practices were considered less vulnerable, which is why EKW had a better LVI score than DBW. A community's livelihood vulnerability was found to be related to the degree of displacement of people from their traditional livelihoods, as in the case of EKW. Most families have at least one member in a non-agricultural livelihood, working in unorganised sectors in the urban areas. Due to the lack of reliance on agriculture, the community has adopted such livelihood strategies. Many of the farmers practice farming in leased lands and commute to these places from other parts of the peri-urban areas of both Kolkata and Guwahati. The percentage of households having no fertile land is the highest in DBW, whereas fish farms are sharply shrinking in EKW.

3.4 Bio-Rights: Impact Assessment

The rights-based neo-economic conservation model was initiated by the South Asian Forum for Environment (SAFE) in the year 2016–2017 to recognise the rights of the marginal fishers and farmers in the wetland SEPLS, who are also engaged in the conservation and maintenance of wetland habitat. To improve the wetland habitat, capacities were built in conservation activities among the wetland communities, like maintenance of water quality, regulation of nutrients leading to eutrophication, planting of wetland species for phytoremediation, stabilisation of embankments of lakes, and maintenance of the environmental flow of water. To compensate for the opportunity costs of beneficiaries, they were trained in alternative livelihood opportunities like making handicrafts out of water hyacinth plant fibre, recycling of municipal solid waste that spoils the habitat, and organic family farming.

Assessments were conducted over a 3-year span in 2016–2017 and 2018–2019. The recognition as a formal local institute and the financial inclusion of the beneficiaries entailing insurance coverage and credit linkages compensated for opportunity costs from payments for ecosystem services (PES), thereby assuring livelihood security, financial inclusion, and risk mitigation. Formation of Joint Liability Groups (JLGs) comprised of the fishers and farmers of the wetland communities was initiated for ensuring shared responsibility and a strengthened local institutional framework. Financial inclusion of these JLGs through bank linkage, credit linkage, and micro-insurance coverage spread the risk and ensured economic security as well. Gender equity and women's empowerment were core components of the intervention. Three villages each in EKW (EKW V1, V2, V3) and DBW (DBW V1, V2, V3) were selected for the intervention, comprising a total of 2500 households in the six villages. The villages were assessed on indicators like LVI, increased primary productivity, and revenues earned therefrom, as well as additional man-days created through alternative livelihood opportunities. Impacts on habitat health were accounted for using the Trophic State Index (TSI) in the conserved wetlands.

Review and analysis of data available from 2016 to 2017 and from April to December 2019 showed the striking impacts of the bio-rights intervention on both of the Ramsar wetland SEPLS (Fig. 6.6). These impacts are highlighted below:

(a) Strengthening of local institutions and enabling of risk coverage through micro-insurance and financial inclusion substantially lowered vulnerability in the 3 years of time span.
(b) Community-led conservation in both SEPLS, viz. EKW and DBW, accentuated sustainable intensification of ecosystem services, thereby increasing the returns

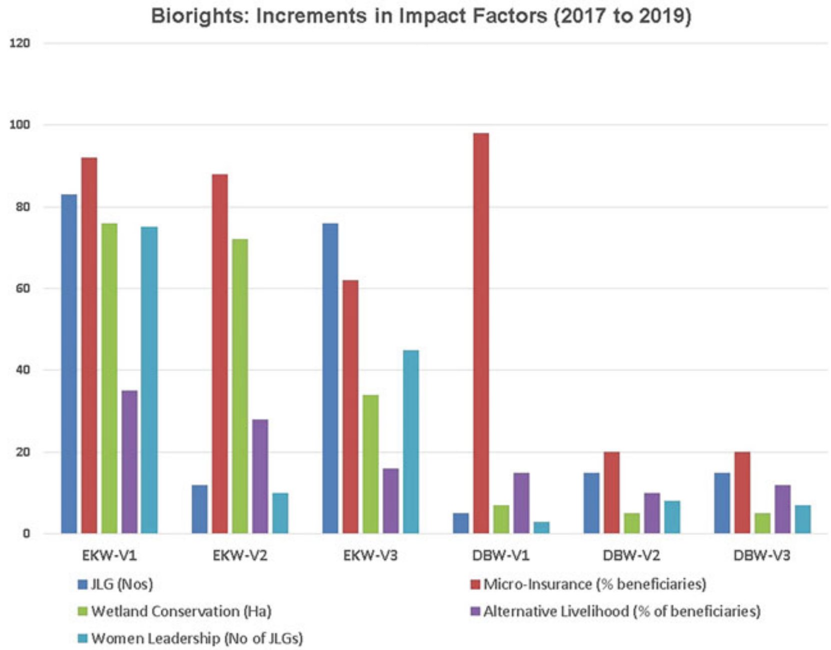

Fig. 6.6 Bio-rights: increments in impact factors (source: prepared by authors)

on revenues, as evidenced by an increase in the per capita income of fishers by 17–20% per year. The bio-rights intervention also leveraged alternative economic opportunities from ecotourism and circular economic interventions for women's entrepreneurship.

(c) Collective responsibility in wise-use practices and shared efforts for sustainable intensification of ecosystem services were more distinct in EKW, owing to the organised patterns of community engagements and robust local institutions. This is thus considered as an indicator of sustainability, accomplished through bio-rights.

(d) Conservation activities in the SEPLS improved habitat health and increased primary production in the area.

3.5 Assessment Studies During the Pandemic Crisis

During the COVID pandemic, announcement of a nationwide lockdown triggered a mass reverse exodus of temporary migrants working as casual labourers and an enormous loss of livelihood in the informal sector. During this crisis, nearly 2000 landless labourers belonging to the wetland communities returned to EKW and DBW. The bio-rights intervention could minimise the adversity both on life and

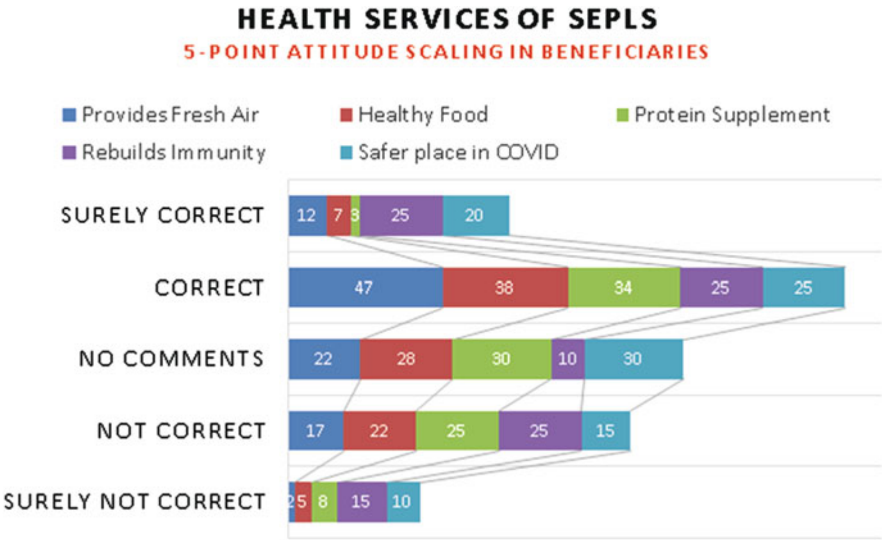

Fig. 6.7 Attitude scaling on health services of SEPLS (source: prepared by authors)

livelihood of these migrants without compromising the conservation objectives. The intervention supported these migrants with some economic opportunities through manual labour work in farming and fisheries, and engagement in the supply chains of the farming sectors. While the intervention extended health support to the urbanites living in the near vicinity by providing protein supplements in daily food from table fish, fox nuts, and duckery products, production of fresh vegetables and local medicinal plants also supported indigenous communities in the wetlands during the crisis. The agro-biodiversity preserved in the local cropping cycles, which are mostly managed by women farmers in the wetland SEPLS, is the source of food and food supplements for augmenting the health and immunity of the local people. This had a great bearing on the lives of these indigenous communities during the pandemic crisis. The urbanites in the vicinity, who visited the wetland ecotourism trails for morning walks and physical activities during "work-from-home" periods in the pandemic, experienced the ambience of fresh air, oxygenated and free from urban pollution. An attitude scaling on the health impacts of these eco-trails is indicated in Fig. 6.7, showing that 50–60% agreed that the landscape rebuilds immunity and provides fresh air, while 37% deemed the protein food supplements made available from these wetlands as important.

4 Outcomes and Impacts

Wetlands, though alienated from mainstream conservation owing to deficient policy frameworks, are unique socio-ecological production landscapes and seascapes (SEPLS) which are significant in the milieu of climate change. This chapter reviews two peri-urban Ramsar sites to put forward ecosystem-based adaptive strategies for conservation and recommends a framework using a rights-based neo-economic approach to compensate for the opportunity costs of wetland inhabitants and dependents. This chapter makes a case for this approach based on the following observations:

(a) It is observed that the vulnerable communities in these SEPLS continually explore opportunities amidst challenges imposed on them, such as during the pandemic when they attempted to reduce the impact of externalities through appropriate resource stocks, extraction, and marketing strategies. Since most of the beneficiaries work in informal sectors, wherein institutional arrangements are somehow fragile and cannot handle onslaughts imposed by large-scale and systemic perturbations, beneficiaries chose either to accept working as casual labourers in urban areas or to change to alternative economic opportunities in urban service deliveries, as evidenced from sociometric assessments in the wetland communities.
(b) Perusal of outcomes from focus group discussions and household surveys in the SEPLS revealed that under economic pressure, responsibilities of risk mitigation move from individual to collective action, enabling the sharing of economic losses by suitably changing livelihood options. However, mechanisms to monitor compliance and enforcement of the norms for collective community action are not easily practised due to a diverse perception of risks. Obviously compensation for loss and damage comes mostly from the use of nature's goods and services. This leads to loss of habitat and biodiversity owing to overuse.
(c) Predictive analyses based on participatory evaluation of ecosystem services and the fate of wetland functions under worst-case scenarios can also greatly help to define best scenarios in bio-rights-centred livelihood promotion coupled with community conservation strategies and related institutional mechanisms developed in the course of implementation of the bio-rights project.
(d) By tracing the biodiversity, community dynamics, and relevance of spatio-temporal changes in LUP and LC, as well as institutional arrangements that have formalised with the management of the EKW and DBW over years of community-based conservations in these two SEPLS, the chapter aspires to explore avenues to design a more inclusive sustainable ecosystem service-based management plan that includes novel concepts like bio-rights.

5 Recommendations for a Framework

Reviewing the determinants of the dependence on wetland ecosystem services by marginal agrarian communities vis-à-vis the impacts of urban encroachment on these peri-urban wetlands in advocating sustainable intensification of primary productivity, a rights-based conservation framework has been recommended for wetlands near urban growth centres for adaptive policy planning (Amerasinghe & Dey, 2018). A brief overview of this framework is outlined hereunder:

1. In recognising the importance of these peri-urban wetland habitats and their services, a normative practice has to be enunciated to measure the economic value of goods and services, ensuring that the estimations are non-ambiguous and non-discriminatory at all levels of policy and practice to leverage the benefits of conserving these wetlands, especially in the climate milieu.
2. The peri-urban wetlands must be recognised by town planners and urban architects as socio-ecological production landscapes, and the returns on investments in intensifying primary productivity in these wetlands must be added to the GDP. This would enable sharing of benefits, and co-benefits earned from the goods and services of the wetlands with the marginal communities to ensure inclusive growth.
3. Ecosystem-based adaptation for conservation of peri-urban wetlands needs to be included as mandatory clauses in town planning and landscaping, leaving no one behind in participatory management, and be recommended for enriching national natural capital like forests and rivers.
4. The lessons learned must be incorporated in the draft for developing National Wetland Policy (conservation and management) in India for inclusion and adoption.

The following facets may be considered for further reference to be included in the draft as well as the knowledge economy. Reference frame for defining community-based wetland conservation strategies and enabling a platform for redressal of issues pertaining to it:

(a) Wetland Conservation

1. Conservation strategies for peri-urban wetlands are to be outlined at the community-ecosystem interface to recognise community governance in conservation, similar to policies and practice utilised in community forest management.
2. The local wetland authority entrusted for the conservation and management of wetland SEPLS has to be inclusive and should have equitable community representation for redressal of issues as well as assure remedial support to ensure equity, reciprocity, and partnership for conservation.
3. A frame of reference is expected to be in place to assure conservation and wise use of peri-urban wetlands through a national policy document, to be referred to as the National Wetland Policy [NWP] to mitigate any or all issues pertaining to conservation and management of these wetlands.

(b) Ownership and commons' property rights

1. With regard to the ownership and property rights of wetland ecosystems, it is recommended that they be private, joint, and/or state owned. Alterations to conservation regulations, changes pertaining to land-use pattern of the SEPLS, or changes in usages would mandatorily need to prioritise commons' bio-rights and conservation of biodiversity to upkeep the ecosystem services for all stakeholders, ensuring equitable access and benefit sharing.
2. In cognisance of the above mandates, ecosystem services of these SEPLS must be recognised as commons' property rights for economic co-benefits,

irrespective of the ownership of the wetlands, whereas efforts for conservation would be recognised as an "equal and reciprocal responsibility" for all facilitating partnership and participation beyond the property rights.
3. The conservation and management regulations and the commons' property rights of wetlands shall not alter with any alteration and/or transfer of ownership rights.

(c) Participatory conservation paradigm and bio-rights of commons

1. Planning procedures for conservation must encourage and facilitate a participatory practice, leaving no one behind to promote inclusive partnership.
2. Implementation of the conservation plan must have a robust monitoring and periodic evaluation (M&E) system and feedback systems for adaptive learning and constructive review of the plan being implemented.
3. In enforcing the implementation plan and considering wise use as conservation priority, the opportunity costs of commons incurred in forgoing the co-benefits of ecosystem services need to be estimated and compensated through novel and uniform financial models. The compensation may be used for either risk spreading or coverage, as may be decided collectively by the participants from time to time.

(d) National Wetland Policy for conservation and management

1. The state must implicate on an emergency basis the propounding of a national reference agenda for conservation and management of wetlands, to be recognised as the "National Wetland Policy" that may consider the details, as discussed above, to be integral to its operational framework.
2. The state must appoint efficient, trained, and empathetic experts as custodians of the policy upon implementation to facilitate the conservation objectives and augment ecosystem services thereto.
3. The policy framework, thus built, must seek concurrence with all national policies for conserving other potential ecosystems to undermine the conflicts of interests and opinions in overlapping jurisprudence and co-parallel regulations, so as to avoid abundance and loss of national natural resources.

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