



Detailed Project Report for the Evaluation of Ecosystem Services for Kalpasar Dam



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1 Introduction

Wetlands in arid and semi-arid areas are seasonal and often water-stressed during the dry period. Biotic adaptations under such conditions are typically opportunistic, with critical life-cycle activities synchronized with the seasonal variations in hydrology. Landscape features, hydrology, and land-water interactions are prime determinants of a wetland ecosystem's structure and function, influencing the nature of ecosystem goods and services. In India, the total value of ecosystem services, of around 13.1 million ha of wetlands, is estimated to be ₹665 billion (\$14 billion) annually. The Economics of Ecosystems and Biodiversity – India Initiative (TII), launched by the Ministry of Environment, Forests and Climate Change (MoEFCC), aims to highlight the economic consequences of losing biological diversity and the associated decline in ecosystem services. The TII effort is to make the hidden values of ecosystems explicit to support their mainstreaming in economic development policies and programmes. Gujarat, located on the western coast of India, possesses the longest coastline among all Indian states, measuring nearly 1663 KM (20% of the country) and the most comprehensive shelf zone covering about 184,000 KM. The Arabian Sea surrounds the coastline. The main feature includes two Gulfs, the Gulf of Khambhat and the Gulf of Kachchh, and the open coast of Saurashtra facing the Arabian Sea. Further, Gujarat is the only state on the west coast of India with coral reefs. The other ecosystems present on the coastline are seagrass, seaweeds, mangroves, beaches, and coastal dunes.

Regarding economic interdependence and globalization, Gujarat has emerged as a crucial linking node of the existing sea line of communication across the seas. It is near the outlet to regions of West Asia, Africa, and Europe on its western flank. The Saurashtra region constitutes the most significant section of the Gujarat Coast. The Saurashtra region comprises 11 districts: Amreli, Bhavnagar, Botad, Devbhoomi Dwarka, Gir Somnath, Jamnagar, Junagadh, Morbi, Porbandar, Rajkot and Surendranagar. The coastal districts are Jamnagar, Devbhoomi Dwarka, Porbandar, Junagadh, Gir Somnath, Amreli and Bhavnagar. The Saurashtra region hosts various economic activities due to its proximity to the Arabian Sea, including noteworthy strides in agriculture, manufacturing, port-related activities, mining and quarrying, salt production, fishing and aquaculture tourism. Despite their positive impact on Saurashtra's regional economy, these economic developmental activities also produced environmental and ecological challenges to the health of the region's coastal areas. Several threats to the ecological security of the Saurashtra region have emerged as a consequence of illegal mining, dredging, reclamation of the seaward side, effluent discharge into estuary

areas, coastal erosion, heavy construction activities relating to ports, oil terminals, chemical industries, pipelines, oil refineries and oil spilling due to offshore and onshore oil exploration etc. In addition to such pressure, climate-related changes and their negative impact on the coastal areas, such as sea-level rise, tropical cyclones, drought, flood, coastal erosion, and so on, have emerged as potential challenges to the physical environment as coastal communities.

The Saurashtra region of Gujarat has been experiencing severe droughts for a few decades due to a reduction in the groundwater table and freshwater scarcity. To meet the freshwater demand for drinking and irrigation, the Government of Gujarat proposes an ambitious project called the Kalpasar Dam Project, which involves constructing a ~30 km long dam across the Gulf of Khambhat and creating a freshwater reservoir by storing the runoff of 10,000 million cubic meters of water from east-flowing rivers, namely Sabarmati, Mahi, Dhadhar and Narmada rivers on the upstream of the Dam. This project location is influenced by a higher tidal range (~9m) and currents (velocities ~3 m/s) at the head of the Gulf. It involves constructing a ~30 km earth dam across the Gulf of Khambhat to create a massive freshwater coastal reservoir for irrigation, drinking and industrial purposes, with about a 2 km concrete spillway for emptying saltwater or flood water. A 10-lane road and a 2-lane permanent way for rail transport were planned over the Dam, reducing the travel distance from 350 km around the Gulf to 50 km across the Gulf. Also, the project involves flood protection in the upstream area, freshwater supply to the Saurashtra region, and renewable energy for the lift irrigation system. The project site is in the Moderate Seismic Zone, about 700 km west of the Gulf from the Makran fault. Over the years, the Kalpasar Department of the Government of Gujarat conducted several studies with various international and national organizations and consultants, from Engineering Investigations to the Design of the Dam. However, this proposal evaluates the ecosystem service of the project area.

The present study seeks to contribute to TII by uncovering the values of ecosystem services and the biodiversity of wetlands in the context of the arid landscape of Gujarat. The Kalpasar Project envisages building a 30 km dam across the Gulf of Khambhat in India to establish a vast freshwater reservoir for irrigation, drinking and industrial purposes. This project aims to establish a ten-lane road link that will also be set up over the Dam, significantly reducing the distance between Saurashtra and South Gujarat. Upon implementation of the Kalpasar project, the fisheries will be developed in fresh and saltwater lakes. The project provides for infrastructure investment to support two large major Carps hatcheries. The aim is to create a freshwater reservoir in the Gulf of Khambhat by constructing a dam connecting the east and west banks of the Gulf. In the reservoir, the runoff from Sabarmati, Mahi, Dhadar, and

Narmada will be stored, together with the waters from the Saurashtra rivers discharging into the Gulf of Khambhat.

India is bestowed with three gulfs: the Gulf of Kachchh, the Gulf of Khambhat and the Gulf of Mannar. Gujarat, one of India's most extended maritime states, prides itself on taking up the Gulf of Kachchh and Gulf of Khambhat within its boundaries. Both the gulfs owe their peculiarities regarding physiography, hydrography, Biodiversity, and the surrounding confluences. The Gulf of Khambhat is oriented with its tail towards the north and mouth towards the south. The Gulf of Khambhat, covering about 3,120 sq km, is situated between 21°00' N and 22°18' N latitudes and 72°15' E and 72°45' E longitudes. The Gulf of Khambhat has geomorphology, hydrodynamics, and high tidal amplitude peculiarities. The funnel-like structure of the Gulf has a wide mouth and narrow head. This feature makes the Gulf second in the world regarding tidal amplitude. Several rivers, including major rivers of Gujarat like Narmada, Tapi, Sabarmati and Mahi, open in the Gulf, draining water and alluvium to the Gulf and coastal area. The wide range of population density and growth variation reflects the heterogeneous status of natural resource base, agriculture and other economic activities/ development. Within its adjoining talukas, the Gulf supports an approximate population of 4.3 million per the 1991 census.

1.2 Need of the study

Wetlands are essential in the hydrological and bio-geochemical cycles because they store and recycle large amounts of water and nutrients for long periods. Landscape features, hydrology, and land-water interactions are prime determinants of wetland ecosystem structure and function, influencing the nature of ecosystem goods and services provided. Inland wetlands are commonly formed among depressions in the landscape, where freshwater runoff can accumulate. Rainfall, surface runoff, groundwater conditions and tidal movements in the connecting channels of coastal wetlands determine hydrological characteristics. Hydrologic factors, such as depth, duration, amplitude and timing of flooding, operate at different scales in the context of a landscape. As there are reciprocal interactions between spatial patterns and ecological processes, wetland values depend on the hydro-geomorphic location where they are situated (Mitsch and Gosselink, 2000). Wetlands in arid and semi-arid areas are seasonal and often water-stressed during the dry period. Biotic adaptations under such conditions are typically opportunistic, with critical life-cycle activities synchronized with the seasonal variations in hydrology. The system exhibits a production bloom at the onset of the wet period that triggers different food-chains, uniquely exploited by higher animals such as migratory birds that temporarily nest and breed in these areas.

However, water availability during this critical wet season is often further restricted due to competing upstream demands. Landscape characteristics in the catchment areas are influenced by policies and programmes, which, therefore, need to be analyzed for their impacts on the wetland, particularly in arid and semi-arid regions. Human use of seasonal wetlands is also adapted uniquely, often revealed through seasonal fishing and tourism. Responding to seasonal and annual fluctuations through the appropriate deployment of time and resources is traditional knowledge passed down through generations of families in the same occupation, organized in India as castes. Typical caste groups in traditional livelihood professions often pose challenges in development planning, mainly where natural resources are seasonally available.

Ecologically insensitive development planning has often ignored or under-estimated the importance of traditional use values of such wetlands or, worse still, much more intangible non-use values of various ecosystem services and biological diversity. For instance, declaring wetlands as 'Protected Areas' extinguishes traditional user rights if enforced or else leads to open access conditions if not enforced. Such policies and development plans inevitably force a 'choice' between conservation and development rather than exploring an inclusive, sustainable development pathway. While effort is now being made to integrate the value of biodiversity and ecosystem services from wetlands into development plans for the region, it is apparent that, along with various structural changes, credible estimates for such values are a prerequisite. This research attempts to explain the valuation of ecosystem services for the Kalpasarr Dam project, which will create opportunities and a market given the existing natural resources and ecosystem.

1.3 Objectives

The overall idea is to assess the valuation of the ecosystem services of the Kalpasarr Dam Project. These are classified as (a) Provisioning, (b) Supporting, and (c) Cultural aspects in the valuation techniques. The study also seeks to identify threats to conservation and provide management options for the wise use of wetlands based on quantifiable trade-offs using insights from economic valuation of ecosystem services and Biodiversity.

2 The Approach & Methodology

In methodological terms, the study covers four significant aspects: (a) understanding of ecological and economic settings of the study areas in terms of three significant uses - the prawn fishery, salt production, tourism and solar power generation possibilities; (b) documentation of ecosystem values; (c) economic valuation of use and non-use values, and (d) understanding of significant drivers that are altering the essential ecosystem goods & services and the market. The study relied on (i) a literature review, analysis of secondary data and consultations and (ii) intensive primary data collection using household sample surveys. The primary surveys were undertaken mainly to ascertain the economic values of four use and non-use values of the ecosystem related to prawn fishing, salt production, tourism and Biodiversity. We applied the market value approach for the valuation of prawn fisheries and salt production, while for the valuation of tourism, we adopted a travel cost approach. However, the contingent valuation method (CVM) was applied to the ecosystem's non-use value. Except for salt, where secondary time series data was used for valuation, other values were determined by conducting primary household surveys. The data collection was done during 2023. The Approach is given in Table 1.

Table 1: The Approach

Study Aspect	Data/Information Collection Approach	Valuation Method Applied
Biophysical & socio-economical description	Secondary data collection and the review of the literature	-
Description of landscape-level drivers of change	Secondary data and the review of the literature, household survey	-
Economic Valuation of Ecosystem Services	Secondary data collection and Primary survey	Market Value Assessment / Travel Cost and Contingent Valuation Methods

Source: Author

Ecosystem services provide many and varied benefits to humans from the natural environment and any ecosystem. All ecosystem services can be grouped into four broad categories: provisioning (production of food), regulating (control of climate and diseases), supporting (nutrient cycling), and cultural (recreational benefits). Ecosystem services are critical to human beings' lives, which directly and indirectly provide essential materials and benefits to the sustainable development of human society and the environment (Costanza et al., 1997). Much

research has been conducted in classifying and evaluating ecosystem services and analyzing the relationship between ecosystem services and land use changes (Deng et al., 2013; Li et al., 2013). Bockstael et al. (2000) examined the measurement method of the economic valuation of ecosystem services and the analysis and generalization of the system. Groot et al. (2002) presented a conceptual framework and typology for describing, classifying and assessing ecosystem functions, goods and services clearly and consistently. Farber et al. (2002) illustrated the concept of ecosystem service value and evaluation methods, which provided a theoretical basis for government decision-making. Howarth and Farber (2002) examined the role of the value of ecosystem services (VES) concept in measuring trends in human well-being. Chee (2004) critically reviewed the framework, tools and approaches that can be applied to estimate the economic value of ecosystem services, comprehensive management decision-making in social and economic benefits, etc., from an ecological perspective.

According to the report of Millennium Ecosystem Assessment (MEA), it showed that human activities have induced more rapid and extensive changes in ecosystems over the past 50 years compared to other periods, mainly due to the rapidly growing demands of humans for food, fresh water, timber, fibre and fuel etc. This has resulted in a substantial and largely irreversible loss in the diversity of life on the earth. The future capability of ecosystems to provide these services is determined by changes in socioeconomic characteristics, land use, Biodiversity, atmospheric composition, and climate (Metzger et al., 2006). Among these factors, land use conversions were identified as the most significant factor driving the changes in ecosystem services, affecting human well-being and threatening the survival of other species (Geneletti, 2013). It was also identified that the changes in the extent and composition of different land-use types significantly impacted the provision of ecosystem services, biodiversity conservation and returns to landowners (Polasky et al., 2011). Land use changes typically affect the capacity of ecosystems to provide goods and services to human society, thus resulting in significant changes in ecosystem service supply (Schroter et al., 2005). Further, recent studies of ecosystem services mainly focus on large-scale comprehensive systematic analyses of ecosystem service function and value assessment. In contrast, quantitative research on ecosystem services on a small scale is relatively less.

In this research project, taking the Kalpasar Dam Project as the study area, combined with land use datasets with the information on ecosystem services, we aimed to evaluate the ecosystem services values (ESVs). The study area is an ecologically fragile area where water resource plays a crucial role in sustaining ecosystem services, and in return, the improvement of ecosystem services will help alleviate the water scarcity pressures (Deng and Zhao, 2015;

Wu et al., 2015, Li et al., 2015); thus, the comprehensive analyses can support the exploration of sustainable land use management for mitigating the impacts on water scarcity and ecosystem services. The project's key objective is to collate and analyze qualitative and quantitative data relating to the coastal region's significant environmental issues and challenges in evaluating ecosystem services. The identified ecosystem services are given in Table 2.

Table 2: The identified ecosystem services for the study include the following indicators:

Ecosystem service	Secondary service function	Farmland ecosystem	Forest ecosystem	Grassland ecosystem	Waterbody ecosystem	Other ecosystems
Support Services	Food production					
	Production of raw materials					
Regulating services	Climate regulation					
	Waste disposal					
Supply services	Retention soil					
	Biodiversity					
Cultural services	Provide aesthetic landscape					

We will use secondary and primary data collected from household levels to evaluate ecosystem services. The pre-tested questionnaire is presented in Appendix 1 of the report

2.2 Valuation of Wetland Ecosystem Services

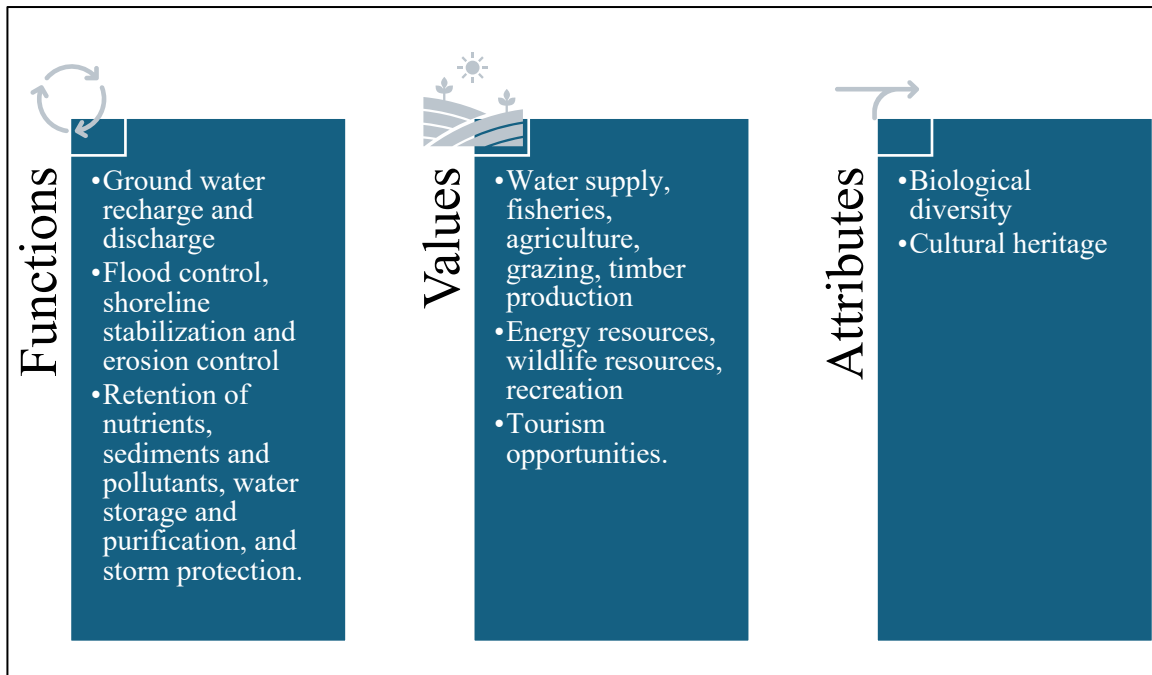
Wetlands are among the most productive ecosystems associated with abundant water, nutrients and sunlight. Natural variability of the same, both on spatial and temporal scales, also creates conditions for high biological diversity. Wetlands, therefore, provide an array of benefits. These benefits could be grouped into three categories, namely, functions, values, and attributes, as shown in Figure 1. The ecosystem is the complex of living organisms and the abiotic environment with which they interact at a specified location. Biodiversity is the sum of organisms, including their genetic diversity and how they fit into communities and ecosystems. According to the Millennium Ecosystem Assessment (MEA 2005), 'ecosystem services are the benefits people obtain from ecosystems. Thus, the term "ecosystem services" implies nature's contribution to various "goods and services", which could be classified under four categories presented in Figure 2. There are different approaches to determining and delivering the value of wetlands. These are presented in Figure 3.

Economic valuation distinguishes between use and non-use values, meaning current and potential users or future users. Typically, use values involve human interaction with resources, whereas non-use values do not. The framework of total economic valuation, as applied to wetlands, is illustrated in Tables 4 and 5. Use values are grouped based on direct or indirect

use. The former refers to the most familiar uses: harvesting fish, collecting fuel wood, and using wetlands for recreation. Direct uses of wetlands could involve both commercial and non-commercial activities, with some of the latter activities. They are often necessary for the subsistence needs of local populations. The various regulatory ecological functions of wetlands may have crucial indirect use values. Their values derive from supporting or protecting economic activities that have directly measurable values. The indirect use value of an environmental function is related to the change in the value of production or consumption of the activity or property it is protecting or supporting; however, this un-marketed contribution goes unrecognized financially and is only indirectly connected to economic activities.

Total Economics Value (TEV) is the benefits derived from ecosystem services' direct, indirect, and non-use values. This framework disintegrates TEV into use value and non-use value. The use value refers to the goods humans use for consumption and production, such as fish and raw materials. The use value is again classified into direct and indirect use values. Direct use value can be applied to the goods and services directly used, such as fish, seaweeds, recreation, etc. Indirect use values are the services used as the intermediate for the final good, like biological control services for food production. Existence value is knowing the recourse exists, even if they are not using it. The option value is the future value of ecosystem services, where currently, there is no utility from it. (Alcamo, J., et al.2003, Wattage P, 2010).

Figure 1: Functions, value and attributes



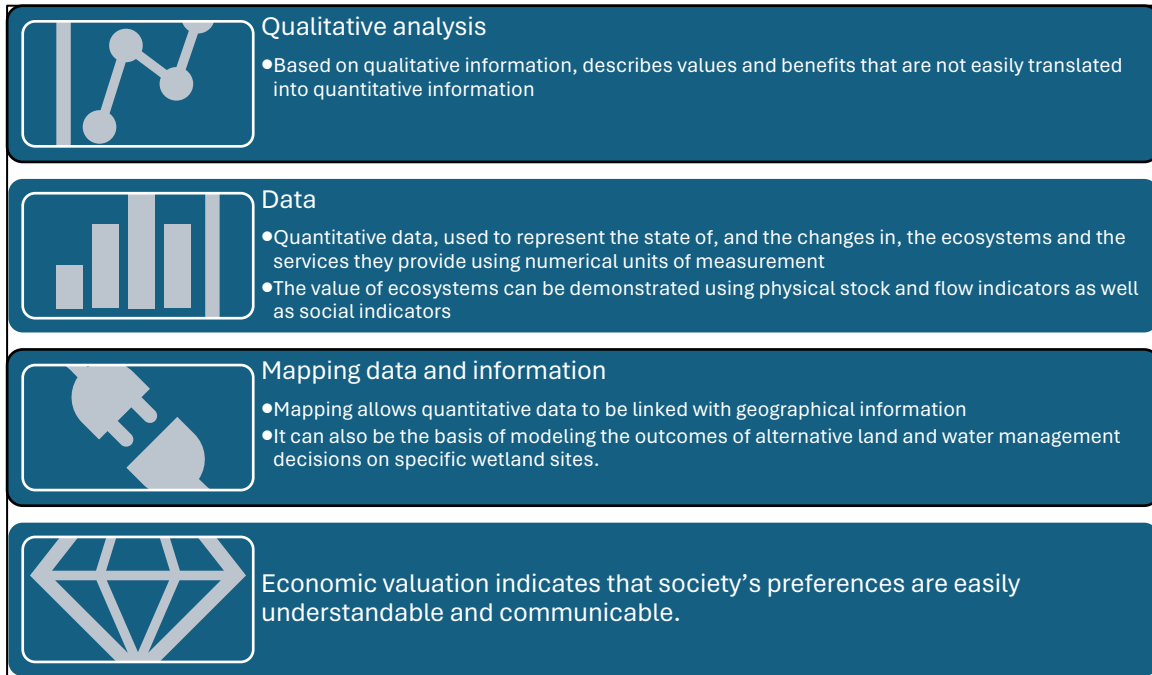
Source: Author

Figure 2: Services of ecosystems

Provisioning Services	Regulating Services	Habitat Services	Cultural and amenity services
<ul style="list-style-type: none"> • Food • Water • Raw materials • Genetic and medicinal resources 	<ul style="list-style-type: none"> • Air quality • Climate • Moderation of extreme events • Regulation of water flows • Waste treatment • Soil fertility 	<ul style="list-style-type: none"> • Migratory species • Genetic diversity 	<ul style="list-style-type: none"> • Recreation and tourism • Cognitive development

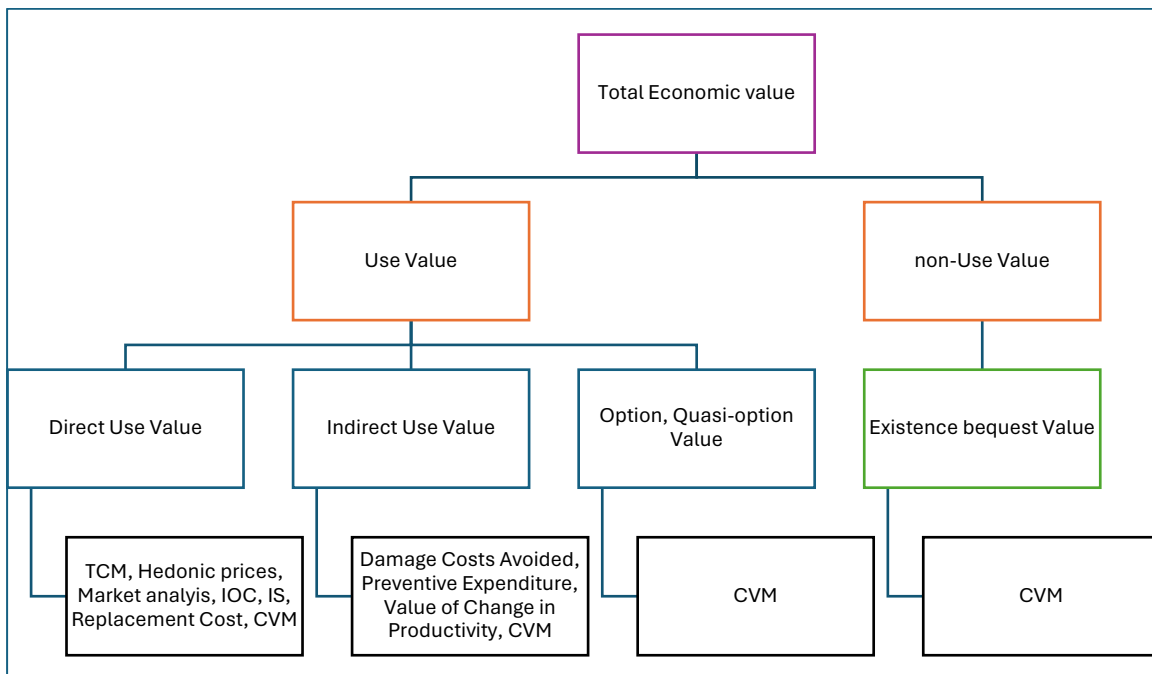
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Figure 3: Approaches for analysis



Source: Author

Figure 4: Framework of wetland values and valuation methods



Source: Author

2.3 Valuation Techniques

Environmental valuation is an applied domain encompassing various techniques for measuring the intrinsic and instrumental value of different components of the environment. There is a consensus amongst economists and policymakers that environmental goods must be assigned some meaningful price to reflect their value and indicate their scarcity. Several sophisticated methods now exist due to significant development in the field over several decades. We can categorize it into revealed preference, stated preference and benefit transfer.

Revealed Preferences methods: Revealed Preference methods rely on market information to infer consumers' preferences from the choices they make in the marketplace. These methods include but are not limited to the market price technique, hedonic pricing, and travel cost. Each of these methods involves studies conducted in an actual market setup using market data (in the form of wages, travel costs, visitor frequency and so on) to derive a value for the corresponding environmental good or service.

Market Price Techniques: In theory, market price techniques apply to any ecosystem good or service that can be freely bought or sold. They are beneficial for valuing the resources and products harvested directly from ecosystems.

Travel Cost Techniques: Travel cost techniques are thus most commonly applied to ecosystems that have a recreational value.

Hedonic Pricing Techniques: Hedonic pricing techniques are most commonly used to examine differences in property prices and wage rates between two locations which have different environmental qualities or landscape values

Stated Preference Methods: Stated Preference methods are based on constructing a hypothetical market to elicit individual preferences. The Contingent Valuation Method (CVM), conjoint analysis and Choice Modeling fall under this category.

Contingent Valuation Techniques: Contingent valuation methods might, for example, ask how much people would be willing to see their water bills increase to uphold quality standards, what they would pay as a voluntary fee to manage an upstream catchment to maintain water supplies, how much they would contribute to a fund for the

conservation of a beautiful landscape or rare species or the extent to which they would be willing to share in the costs of maintaining important ecosystem water services.

Conjoint Choice Experiments: This approach has the advantage of simulating real market situations, where consumers face two or more goods characterized by similar attributes but different levels of these attributes and are asked to choose whether to buy one of the goods or none of them

Benefit Transfer: Benefit transfer is transferring the value associated with a previous study that deals with environmental quality change to a similar change at a policy site. Benefit transfer is used when there is too little or expensive time.

2.4 Understanding the Valuation of Marine and Coastal Ecosystems

Marine and Coastal Ecosystems (CMEs) are known to be the most productive, diverse and valuable ecosystems on Earth. Coastal ecosystems provide us with a wide variety of goods and services and are closely linked to the welfare of human beings. Most marine activities are well connected to the coastlines, and this is because of the easy accessibility and difficulty in accessing deeper parts of the oceans. CMEs services are essential for human well-being and economic development. The CMEs provide many environmental services like food, climate regulation, primary production, water circulation, nutrient cycling, storm protection, cultural benefits, etc.

Table 3: Definitions based on Millennium Ecosystem Assessment, 2003

Category	Central Concept	Boundary Limits for Mapping
Marine	Ocean, with fishing typically a significant driver of change	Marine areas where the sea is deeper than 50 meters.
Coastal	The interface between ocean and land, extending seawards to about the middle of the continental shelf and inland to include all areas strongly influenced by the proximity to the ocean	The area between 50 meters below mean sea level and 50 meters above the high tide level or extending landward to a distance 100 kilometres from shore. Includes coral reefs, intertidal zones, estuaries, coastal aquaculture, and seagrass communities.

In his paper, Barbier EB, 2012) states that CMEs worldwide are disappearing rapidly and are undervalued or ignored when development decisions are made. It is thus important to understand the economic value associated with the ecosystem services provided by the CMEs. The main challenges faced in measuring the value of the ecological services of CMEs are: 1) even though it is a non-renewable resource, it has renewable service flows; 2) indirect

use value of services arising from the CMEs are not marketed 3) beneficial flow of services are affected by the degradation 4) challenges in measuring the future value of the services. Kavikumar K S et al., 2022 estimated the macro-level value of ecosystem services by Indian CMEs in 2012-13 using different methods. Direct market pricing was done to estimate marine fisheries, seaweeds, coastal minerals and salt, seawater desalination, seawater industrial cooling, and carbon sequestration of mangroves and seagrasses. Benefit transfer was used for coastal mangrove protection, and the avoided cost method was used for coastal shipping services. Even though it didn't estimate some of the services provided by CMEs, like marine bio-pharmaceuticals and bio-prospecting, erosion control, and cultural and spiritual value, it was the first of its kind in the case of India, and it is estimated ₹1.9 trillion total value of ecosystem services from CMEs.

Jobstvogt, N et al., 2014 studied the cultural ecosystem services of the marine ecosystem before the UK government established a Marine protected area. This paper states that use values are mostly underestimated in market studies because it's free or inexpensive and don't consider the ecosystem's non-use value. So, the stated preference method (CE and CVM) is better. A travel cost-based CE method was used to find the use value, and a CVM was used and analyzed using random utility theory for non-use and option values. A total of 1332 participants were surveyed, 76% of whom were divers, and the rest were anglers. Excluding protesters, around 1075 participants' data were analyzed. The WTP in travel cost to diving was £7.52, and angling was £ 20.78. In CVM, the WTP is a donation for protecting a marine area from future degradation; the divers stated an average WTP of £8.82 and anglers an £8.29. O'Connor E. et al. 2020 in their study tried to estimate the non-market benefit value of deep-sea ecosystem restoration of the Dohrn Canyon in the Bay of Naples using a contingent valuation method. A CVM is used to access the individual preferences and WTP, and it was then used to estimate the average WTP of the individual for the Dohrn Canyon restoration. A survey was done with a total of 1060 respondents. A two-stage sample selection probit model and an average WTP are reported with and without the protest votes and from the sample selection model. The average WTP of €34.69 per person was estimated using a two-stage bivariate sample selection model, and €127 million was calculated as the WTP by the adult resident of that region in an annual year.

Taylor and Longo, 2010 in their paper show that nutrient loading in the marine ecosystem causes environmental damage, which affects the organisms associated with it. The study aims to find the value the residents of Varna Bay attach to see a change in the recreational damages caused by the algae boom in Varna Bay. It doesn't consider other use and non-use values, only recreational ones. It uses the conjoint choice experiments technique, and the attributes

used for the experiment were visibility, duration, congestion and tax amount. A random parameters logit model was used for analysis. The study shows that people prefer a low level of congestion, no period of algae bloom, and high visibility. The average WTP for increased visibility and no algae bloom was €9.73; for high visibility, a six-week algae bloom was €3.52. Vesterinen J et al. (2010) try to estimate recreation participation and the benefits of water quality improvements for the Finnish coast of the Baltic Sea. Modelling participation and participation frequencies for each activity in water recreation in the first stage and the worth of one water recreation excursion was estimated using the travel cost method in the second stage. By the travel cost method, the benefit per person per trip was assessed as around €6.30–8.30, and people travelling by car showed a higher estimate of €18.90–19.00. The hurdle model showed that the water quality of nearby water bodies affected recreational activity positively. Estimated participation rates, days and benefits per activity: a 1-meter reduction in water quality will reduce the recreational benefits by 29-113 million, and an increase in 1-meter water quality will increase the consumer surplus by €31-129 million annually.

Atkins, J.P. and Burdon, D. 2006 tried to find the cost and benefit of the Randers Fjord reduced eutrophication in Denmark. The study uses the contingent valuation method to investigate the WTP to reduce eutrophication. Initial findings show that the resident's value reduced eutrophication in Randers Fjord. For the improvement, the residents' WTP was €12.02 per month for ten years for a hypothetical action plan and showed a potential of €5.5 million per month from the region. Tan, Y et al., 2018 looked into the value of coastal wetland restoration in Ximen Island Special Marine Protected Area, China. A choice experiment method was proposed, and 201 individuals were surveyed. The result showed a significant value associated with coastal wetland restoration and better-educated young people are more likely to provide support. Compensating surplus for modest, moderate and ambitious coastal wetland restoration was ¥302.30, ¥434.25, and ¥551.29 per respondent, respectively.

Badola and Hussain, 2005) tried to estimate the cyclone damage to the Bhitarkanika mangrove ecosystem avoided in three Indian villages. The villages were selected in a way that 1) the village has mangrove cover (Bankual), 2) the village doesn't have mangrove cover and embankment (Singidi), and 3) the village has embankment but not mangroves (Bandhamal). A sample was collected based on the socio-economic status, damages caused to assets, and flooding characteristics. Based on a rating, damages to houses were highest in Singidi and lowest in Bankual. Saline water intrusion into houses was highest in Bandhamal and lowest in Bankual, and Saline water intrusion into paddy fields was highest in Singidi and lowest in Bankual. Total monetary loss per household (TML) was highest in Bandhamal (US\$

153.74), followed by Singdi (US\$ 44.07) and Bankual (US\$ 32.31). The study shows that the Mangrove ecosystem plays a vital role in storm protection.

Table 4: Summary of Valuation Studies

Author	Motivation	Valuation technique	Result
Kavi Kumar K S et al., 2022	To estimate the macro-level value of ecosystem services provided by CMEs in India.	(a) the direct market valuation approach. - provisional services (b) the travel cost method. -recreational services (c) benefit transfers: - remaining types of services	CME services in India were estimated at around ₹1.9 trillion in 2012-13, where the share of provisioning services, regulating services, and recreation services account for 20%, 35% and 45%, respectively
Jobstvogt, N et al., 2014	To estimate the cultural ecosystem services value of marine biodiversity for establishing marine protected areas in the UK	(a)travel-cost based choice experiment method. -use value (b)contingent valuation method -non-use value	The WTP in travel cost to diving was £7.52, and angling was £ 20.78. In CVM, the WTP is a donation for protecting a marine area from future degradation; the divers stated an average WTP of £8.82 and anglers a £8.29.
O'Connor, E., et al 2020	To estimate the potential non-market benefit value of a deep-sea restoration	Contingent valuation method	The result shows an average WTP of €34.69 per person and €127. Million per annum per adult resident was estimated to restore the canyon ecosystem.
Taylor and Longo, 2010	To assess the value, residents of Varna Bay attach to see the change in recreational damage associated with algal blooms caused by nutrients flows into Varna Bay	Choice experiment	The amount of algae blooms was found to be necessary, and the participants, on average, are willing to pay €9.73 for high visibility and no algae bloom at all and €3.52 for high visibility and algae bloom lasting for six weeks.

Table 4: Summary of Valuation Studies (Contd...)

Author	Motivation	Valuation technique	Result
Vesterinen J, et al. (2010)	Estimating the benefits of protecting inland and coastal waters.	Travel Cost Method	By travel cost method, the benefit per person per trip was estimated at around €6.30–8.30, people travelling by car showed a higher estimate of €18.90–19.00, and a one-meter improvement in water quality will increase the consumer surplus €31-129 million annually.
Atkins, J.P. and Burdon, D., 2006	benefits and costs of reduced eutrophication of the Randers Fjord in Denmark	contingent valuation method	For the improvement, the residents' WTP was €12.02 per month for ten years for a hypothetical action plan and showed a potential of €5.5 million per month from the region.
Tan, Y et al., 2018	value of coastal wetland restoration in Ximen Island, China	choice experiment method	The compensating surplus for modest, moderate, and ambitious coastal wetland restoration was ¥302.30, ¥434.25, and ¥551.29 per respondent, respectively.
Badola and Hussain, 2005	To access the value of damage cost avoided by the storm protection function of the Bhitarkanika Mangrove ecosystem.	Damage cost avoided	The village with a mangrove ecosystem was least affected by the cyclone, and the total monetary loss per household was lowest in Bankual (US\$ 32.31), a village with mangrove cover.

Table 5: Value classification of wetland systems

Use values (Production/Consumption)			Non-use Values
Direct Use Value	Indirect Use Value	Option and Quasi-Option Value	Existence Value
Fish and related	Nutrient retention	Potential future (direct and indirect) uses	Biodiversity
Agriculture	Flood control	Future value of information	Culture, heritage
Fuelwood	Storm protection		Value for future generations
Recreation	Groundwater recharge		
Transport	External ecosystem support		
Energy	Shoreline stabilization		

Source: Adopted various literature

2.5 Ecosystem Service Values of Indian Wetlands

The total value of ecosystem services from wetlands in India is estimated to be ₹665 billion (\$14 billion) annually, and the average is ₹38,000 (\$800) per hectare (Mani, 2014). However, these estimates are heterogeneous and significantly depend on the socioeconomic and economic opportunity and access to the market. These valuations are also based on site-specific values other than generic ones. A conservative figure states India has around 13.1 million ha of wetlands, including inland, coastal, mangroves and rivers. Using the global average reported by Costanza et al. (1997), these ecosystems' total intangible service values would be around ₹7,151.08 billion per year. Including the ecosystem service values of the country's 55.1 million ha of paddy fields, the total values go up to ₹14,396.80 billion annually. In other words, if we protect and maintain the country's wetlands as they are today, we get indirect services/ benefits worth ₹14,396.80 billion. It is to be noted that this is much higher than the annual receipt shown in the national budget (₹5,639.91 billion) for 2007 - 2008.

2.6 Valuation of Biodiversity – methods and Key issues

Direct reliance on the ecosystem and Biodiversity is higher for emerging and developing economies. The bottom of the pyramid population, primarily identified as BPL in the Indian economy, relies on the direct benefits of ecosystem services related to food and non-food dependencies. Therefore, understanding these services' impact and value chain is critical to sustainable economic and ecosystem services. Economic valuation of Biodiversity is crucial

as it provides a valuable channel to highlight and quantify the benefits of Biodiversity. Placing monetary values on Biodiversity and its ecosystem services allows biodiversity benefits to be directly compared with other development scenarios.

Table 6: Key wetland functions, values and valuation approaches

Ecological function	Economic goods and services	Value type	Commonly used valuation method
Flood and flow control	Flood protection	Indirect use	Replacement cost Market prices
Storm buffering	Storm protection	Indirect use	Replacement cost Production function
Sediment retention	Storm protection	Indirect use	Replacement cost Production function
Groundwater recharge/ discharge	Water supply	Indirect use	Production function, Net factor income, Replacement cost
Water quality maintenance/ nutrient	Improved water quality	Indirect use	CVM
	Waste disposal	Direct use	Replacement cost
Habitat and nursery for plant and animal species	Commercial fishing and hunting	Direct use	Market prices, Net factor income
	Recreational fishing and hunting	Direct use	TCM, CVM
	Harvesting of natural materials	Direct use	Market prices
	Energy resources	Direct use	Market prices
Biological diversity	Appreciation of species' existence	Non-use	CVM
Micro-climate stabilization	Climate stabilization	Indirect use	Production function
Carbon sequestration	Reduced global warming	Indirect use	Replacement cost
Natural environment	Amenity	Direct use	Hedonic pricing, CVM
	Recreational activities	Direct use	CVM, TCM
	Appreciation of uniqueness to culture/ heritage	Non-use	CVM

Source: *Compiled from literature review*

Ecosystems require a minimum quality to maintain the ecosystem functioning, which allows for many essential ecosystem functions. Below critical threshold levels, uncertainty and

irreversibility define the functioning of ecosystems. Also, restoring such ecosystems is likely to be very difficult and costly. Missing markets, Imperfect markets and Market failures are essential points in evaluating the role of Biodiversity in economic valuation. Also, uncertainty involving the demand and supply of natural resources will likely affect the sustainability and choice of development alternatives in the future. Loss of Biodiversity will result in loss of functioning and, consequently, loss or degradation of these ecosystem services. The travel cost method is widely used to value amenities as recreational opportunities through expenditures on area visits. In other words, the approximate economic value of Biodiversity in any given location is reflected in the “travel cost” incurred by tourists visiting the area. From a more extensive literature survey conducted for this research, we have identified and documented the critical elements related to explaining the economic valuation of ecosystem services and the critical biodiversity-related functions of wetland and their valuation approaches in Table 7.

Table 7: Key biodiversity-related functions of wetland and their valuation approaches

Function	Economically valuable goods and service	Technique used to quantify the value of the service
Habitat for aquatic species	Improvements in commercial and/or recreational fisheries either on or offsite. Non-use appreciation of the species (habitat)	Net factor income, replacement cost, travel cost or contingent valuation
Habitat for terrestrial and avian species	Recreational observation and hunting of wildlife (bird watching & bird hunting). Non-use appreciation of the species (habitat)	Travel cost or contingent valuation
Biomass production and export (both plant & animal)	Production of valuable food and fibre for harvest	Net factor income

Sources: Compiled by author

Ecosystem services evaluation mainly includes monetary evaluation and non-monetary evaluation. The economic evaluation method aims to estimate the total monetary value of biomass provided by ecosystems, mainly including the alternative marketing method and marketing simulation method. An alternative marketing method is taking ecosystem services as a product to estimate the market value of itself or its alternative products. The marketing simulation method evaluates the ecosystem services through the virtual market by adopting a series of methods, such as a questionnaire, to explore people’s willingness to pay for certain ecosystem services and indirectly evaluate their economic value.

Table 8: International evidence of valuation of ecosystem services

Ecosystem	The unit value (1997) \$/ha/ yr	Unit value (2011) \$/ha/ yr	% Change 2011-1997
Estuaries	31509	28916	-2593
Wetlands	20404	140174	119770
Lakes/rivers	11727	12512	785
Forest	1328	3800	2462
Grassland	321	4166	3845

We adopted the classic quantitative valuation method of ecosystem services forwarded by Xie et al. (2008) and appropriately used it for the site-specific context. Applying the ecosystem service value coefficients to evaluate the ecosystem services of each land use type, we calculated the total ecosystem services values (TESVs), which is the sum of the significant nine ecosystem services values of all sub-ecosystems obtained by multiplying the area of each sub-ecosystem by the total coefficients (VC_i) of corresponding sub-ecosystem type i , shown as follows:

$$TESVs = \sum_{i=0}^n A_i \times VC_i$$

In addition to the above estimation process, we will use the Willingness to Pay and Willingness to Accept approaches to evaluate the ecosystem services. These include applied econometrics and apply statistical analysis.

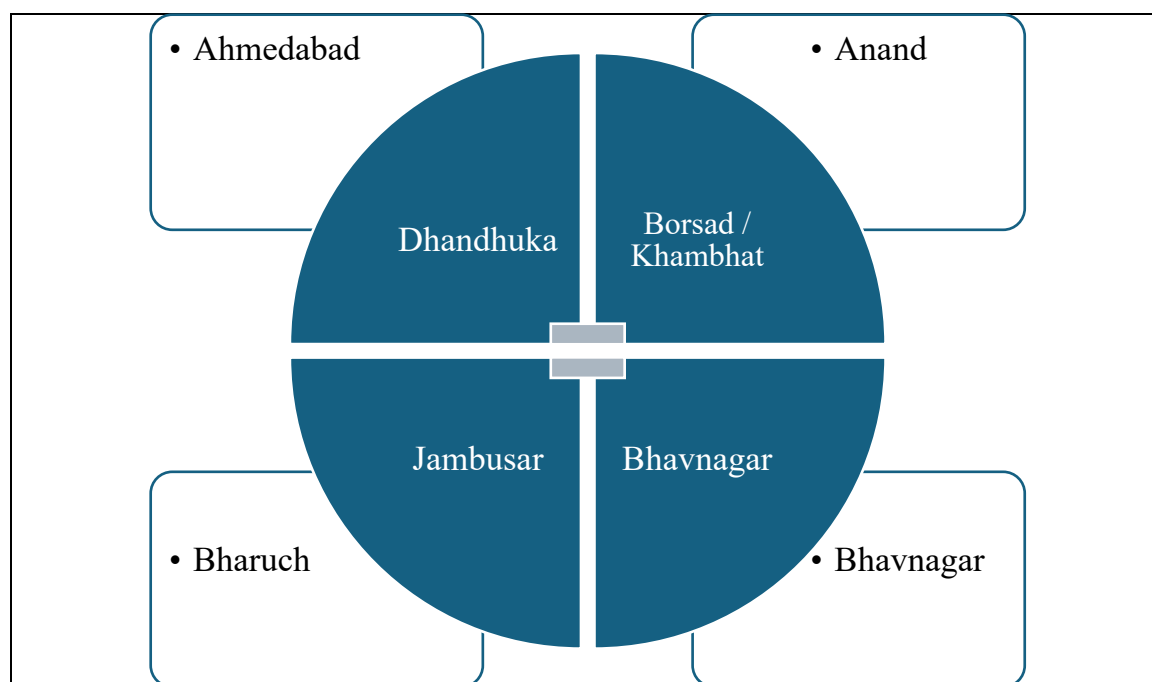
3 The Study Area

The selection of study areas is presented in Figure 5. Dhandhuka is a municipality in the district of Ahmadabad, Gujarat. Dhandhuka is divided into nine wards, and elections are held every five years. The Dhandhuka Municipality has a population of 32,475, of which 17,001 are males while 15,474 are females, as per a report released by Census India 2011. The population of Children aged 0-6 is 3747, which is 11.54 % of the total population of Dhandhuka (M). In Dhandhuka Municipality, the Female Sex Ratio is 910 against the state average 919. The Child Sex Ratio in Dhandhuka is around 858 compared to the Gujarat state average of 890. The literacy rate of Dhandhuka City is 81.39 %, higher than the state average of 78.03 %. In Dhandhuka, Male literacy is around 89.44 %, while female literacy is 72.62 %.

Dhandhuka Municipality has a total administration of over 6,350 houses and supplies basic amenities like water and sewerage. It is also authorized to build roads within Municipality limits and impose taxes on properties under its jurisdiction.

Borsad is a Municipality city in the district of Anand, Gujarat. The town of Borsad is divided into 12 wards, and elections are held every five years. The Borsad Municipality has a population of 63,377, of which 32,798 are males while 30,579 are females, per a report released by Census India 2011. The population of Children aged 0-6 is 7636, 12.05 % of the total population of Borsad (M). In Borsad Municipality, the Female Sex Ratio is 932 against the state average 919. The Child Sex Ratio in Borsad is around 929 compared to the Gujarat state average of 890. The literacy rate of Borsad City is 88.05 %, higher than the state average of 78.03 %. In Borsad, Male literacy is around 93.03 % while female literacy is 82.71 %. Borsad Municipality has an administration of over 12,203 houses and supplies basic amenities like water and sewerage. It is also authorized to build roads within Municipality limits and impose taxes on properties under its jurisdiction.

Figure 5: Selection of study areas



Jambusar is a Municipality city in the district of Bharuch, Gujarat. Jambusar is divided into nine wards, and elections are held every five years. The Jambusar Municipality has a population of 43,344, of which 22,474 are males while 20,870 are females, per a report released by Census India 2011. The population of Children aged 0-6 is 5155, which is 11.89 % of the total population of Jambusar (M). In Jambusar Municipality, the Female Sex Ratio is

929 against the state average 919. The Child Sex Ratio in Jambusar is around 936 compared to the Gujarat state average of 890. The literacy rate of Jambusar City is 82.36 %, higher than the state average of 78.03 %. In Jambusar, Male literacy is around 88.90 %, while female literacy is 75.31 %. Jambusar Municipality has an administration of over 8,343 houses and supplies basic amenities like water and sewerage. It is also authorized to build roads within Municipality limits and impose taxes on properties under its jurisdiction.

The Municipal Corporation governs Bhavnagar, which is part of the Bhavnagar Metropolitan Region. Bhavnagar is located in Gujarat, India. Bhavnagar city's estimated population in 2024 is 841,000, while Bhavnagar metro population is estimated at 859,000. The last census was conducted in 2011, and the scheduled census for Bhavnagar city in 2021 was postponed due to Covid. The current estimates of Bhavnagar city are based on past growth rates. As per provisional reports of Census India, the population of Bhavnagar in 2011 was 593,368. Although Bhavnagar city has a population of 5,93,368, its urban/metropolitan population is 605,882. In the education section, the total number of literates in Bhavnagar city is 446,905, of which 246,326 are males and 200,579 are females. The average literacy rate of Bhavnagar city is 84.70 per cent, of which male and female literacy was 90.15 per cent and 78.85 per cent. The sex ratio of Bhavnagar city is 921 per 1000 males. The child sex ratio of girls is 844 per 1000 boys.

3.2 Sample Characteristics

During the survey of both phases, data were collected from 600 households. However, we also gathered data from the plots in these areas. The list of villages surveyed is given in Annexe 1. A total of 15 different habitat types were sampled during the entire survey (Table 9). The most frequently sampled types were Riverine Open, Dense Scrubs, and Shrub Savannas. A total of 8 mangrove sites were also surveyed, along with 28 other sites representing aquatic bodies and salt pans.

Furthermore, these sites were also sampled from different terrain types. Most sample sites have flatter terrain followed by undulating and hilly areas, as they are situated in the coastal regions. The field survey collected information on different habitat parameters and anthropogenic pressures at every sample point. The conditions were evaluated, and scores were scored between 0 and 5 for this. The percentage distribution is given in Table 9.

Table 9: Details of sample plots (in%)

Habitat Type	Terrain Type			Total
	Flat	Hilly	Undulating	
Agriculture	98	1	0	100
Dense Scrub	48	15	37	100
Grassland	21	48	31	100
Mangrove	100	0	0	100
Open Scrub	32	6	62	100
Open Scrub with Waterbody	88	0	13	100
Riverine Dense Scrub	75	0	25	100
Riverine Open Scrub	25	25	50	100
Riverine	98	0	2	100
Riverine Shrub Savanna	100	0	0	100
Salt Pan	100	0	0	100
Shrub Savanna	30	50	20	100
Shrub Savanna with Salt Pan	100	0	0	100
Tree Savanna	33	37	30	100
Water Body	100	0	0	100
Grand Total	74	6	20	100

Table 10: Sample Locations

Districts	Taluk	Village	Districts	Taluk	Village
Ahmedabad	Dhandhuka	Bavliyari	Anand	Khambhat	Vadgam
Ahmedabad	Dhandhuka	Kamatalav	Bharuch	Jambusar	Devla
Ahmedabad	Dhandhuka	Mingalpur	Bharuch	Jambusar	Islampore
Anand	Borsad	Badalpur	Bharuch	Jambusar	Nahar
Anand	Khambhat	Akhol	Bharuch	Jambusar	Zamdi
Anand	Khambhat	Khadodhi	Bhavnagar	Bhavnagar	Bhumbhali
Anand	Khambhat	Lunej			

Table 11: Sample Locations

Districts	Tree Canopy	Shrub Cover	Shrub Cover	Grass/
	Cover	(<50 cm)	(>50 cm)	Herbaceous Cover
Ahmedabad	2.50	1	1.4	3.7
Anand	1.80	1.8	2.7	1.2
Bharuch	0.70	1.7	2.6	2.3
Bhavnagar	2.30	2.1	1.8	2.9

Zero means no cover or absence of pressure; 5 means dense cover or very high degree of pressure. Table 8 is based on earlier studies on these areas presented. The sample locations and the diversity parameters are presented in Table 9, and the taluka list is given in Table 8.

3.3 Socio-Ecological Trends

Rainfall is the most important climatic factor that influences the ecology and economics of the area. The average annual rainfall data suggests variation in rainfall among the study area. Hence, the probability of ecological impact in the study area is heterogeneous. However, if one takes a decadal trend, we see that the mean annual rainfall has been decreasing due to the impact of climate variability. This can also be linked to the changing landscape of this region in general and the study area in particular.

Table 12: Rainfall Pattern in the Talukas

District	Change in Avg. Rainfall	
	mm	%
Ahmedabad	-19.9	-3.2
Anand	45.0	7.3
Bharuch	-75.2	-8.7
Bhavnagar	46.5	8.7

Source: State Water Data Centre, Gandhinagar

3.4 Acqua-Economics/Acquanomics

From the primary data collection, ten species of prawns/shrimp and eighteen fish species were reported in the study areas. As these areas are sensitive to the endemic prawn species, the general understanding was related to the impact of Biodiversity on these species. Creeks are critical for these species' growth and population; hence, ecosystem restoration or technology adoption remains vital for these areas. When one looks at fishing as an employment

generation activity, the fishing is conducted by the villagers, who migrate the population from nearby villages. Hence, these activities will not directly impact migration but will affect local economies. As reported in our sample, fisherman communities' networking in households can be between 1200 to 1500 households. This explains the interhousehold dependency of households in collective decision-making and can be used as a critical element in policy and technology adoption. As reported by the households, rainfall and water demand are related to these activities and are essential for better water governance in these areas.

Significant issues related to these activities are as follows:

- Inflow of seawater
- Inflow of rainwater
- Essential food items
- Access to fishing grounds (institutional mechanisms and policy)

The data reveals three to five tons of catch per family annually, which can range in gross income from ₹1.6 Lakh to ₹1.8 Lakh. This turns out to be somewhere between ₹2000-₹3000 per day, assuming the activity lasts 60-70 days of fishing.

Fishing is critical for the growth of this region. Hence, through the implementation of this project, technology-related help and market access must be increased for the fishing population for economic development and ecological sustainability.

Solar evaporation of sub-surface 'brine' is the primary method used for salt production. This is the traditional method of inland salt production. The salt production areas are the dry beds of the wetland. At an aggregate level, more than 8000 families depend on these activities across villages in the coastal part of the study areas, resulting in between 28-35 lakh tons of salt production.

The proposed Dam will bring technology spillovers; hence, the salt production technologies can better help the salt farmers adopt the new technologies, produce more salt, and boost the export market for the Indian economy. These new technological spillovers will also help create entrepreneurial skills among salt workers and farmers to connect with the Make in India initiative of the Government of India.

3.5 Land-economics

Land use is based on the functional dimension of land for different human purposes or economic activities. Thus, in a sense, the land use system of any given area is significantly controlled by its ecology. In the present context, some categories of land use with strong ecological connotations include forests, barren areas, pastureland, culturable wasteland, fallow, and agricultural lands. The forest area generally declined in several talukas. However, the area under the barren category gets increased. The area under pasture lands fell in the study area along the Gulf of Khambhat. The area under culturable waste showed different trends across the talukas. In the land use statistics, data on fallow lands is recorded in two major categories- the current fallow and other fallow. The two were summed up and presented as total fallows for the present purpose. While, cumulatively, there is a decline in the area under the fallow category, individual talukas behaved differently. The net sown area indicates the actual land area under cultivation and thus does not account for multiple crops from a single parcel of land.

Forest areas are one of the positive indicators of a region's health and environment. Thus, information was collected on the extent of different categories of forests in each taluka. However, the non-changing trend of the data did not allow for a trend analysis. Dhandhuka, Vagra, Umbargaon and Jalalpore talukas support more than 3000 ha of area under forest categories. Five talukas also possess vidis (grasslands) under reserved or non-reserved categories. The talukas do not consist of any wildlife Protected Areas (viz., National Parks and Sanctuaries).

What seems critical for the land and forest economics Taluka level data is vital. This must be published annually, and access should be centralized for further detailed analysis.

3.6 Agriculture and Allied Economics

Data on cropping patterns and areas under irrigation from different sources have been collected from secondary sources. The area is under four major crop groups, viz. Cereals, pulses, oilseeds & cash crops were analyzed to explain the agricultural activities of these regions. There has been a decline in the average areas under cereal crops among regions; however, cash crops have increased over time. Except for cash crops, all the crops showed a declining trend in the 19 talukas along the Gulf of Khambhat. Tanks, canals, and dug wells remain significant sources of irrigation in these areas. Groundwater remains the primary source for irrigation, followed by canal irrigation. Overall, the total area under irrigation increased over the years, but the growth of irrigation sources varies across talukas. An

increase in irrigation and decrease in agricultural output suggests (a) there is a shift from agricultural to non-agricultural employment, (b) crops are dependent on rainfall along with irrigation, and (c) agriculture needs technology and energy support in these areas.

The quality of groundwater and technology support for irrigation-led agriculture must be increased for better agricultural production. This project may also link solar and wind energy generation across the coastline for affordable agricultural energy access.

Based on the secondary analysis of the census data, there is an increase in the livestock population. Primary livestock in these areas include cattle, buffalo, sheep, and goats. Livestock is one of the growing industries in India. Trade of livestock and F&B related to livestock can be one of the ways to increase the production and market for the livestock economy.

This Dam will be one of the sources that will reduce the distance between markets, and hence, agriculture and livestock markets will integrate. This will bring economic and market integration with increased access to domestic markets.

3.7 Infrastructure Economics

Environmental changes result from the dynamic interplay of socioeconomic, institutional, and technological activities. Other than population growth, urbanization, intensification of agriculture, etc., a critical driver of environmental degradation is rising energy use for economic development and transportation. Lack of access to clean, affordable energy and overuse of fossil energy adversely affect people with low incomes and the environment. So much so that global climate change issues are directly linked to the disproportionate use of fossil energy. The electricity consumption data along the Gulf of Khambhat showed widely varied values. However, there is an increased consumption level of electricity in the area. This suggests an economic development in these areas and dependence on energy as one of the primary resources. The type and quantity of fuel used seriously affected environmental health because using higher proportions of fossil fuels as primary energy sources contributes to air pollution. Energy and fuel demand is increasing in the transport, industry, agriculture, and domestic sectors. This gives an enormous scope for decarbonizing these sectors by adopting cleaner energy sources.

This Dam should aim at microgrid development in the village to become energy-independent and surplus. Renewable energy production, either solar or wind (small scale), can make this area energy-independent and sustainable.

Road network development enhances mobility and is critical for the economic growth of a region. However, inappropriately planned, designed and constructed road networks can aggravate the conditions of the poor people and could harm the natural and socioeconomic environment. Some of the expected impacts of ill-planned road networks include damage and fragmentation of habitats for wildlife, change in hydrological regime, wetland shrinkage, pollution, etc. There is continuous growth in the development of road networks across study locations.

3.8 Biodiversity and Tourism Economics

The sample area is unique due to its marked seasonal dry and wet phase dynamics. The landscape is poorly studied and researched in terms of understanding Biodiversity. Nevertheless, it is reported to have four major physiographical entities- the saline flat Rann, small islands (bets), fringe areas and tidal creeks. This area also supports a rich assemblage of species - more than 250 species of plants, 33 species of mammals, 180 species of birds, 29 species of herpetofauna, etc. In industrialization, most biodiversity values are threatened due to direct and indirect resource dependency. Livestock grazing, salt production, appropriation of fresh water from catchment and creek resources, etc., are some of those causes. However, Biodiversity is directly related to tourism's higher number of tourists and income generation. Better Biodiversity will attract more tourism and increase the economic growth of this region. The proposed Dam will improve connectivity. However, the plan should aim to conserve Biodiversity, create micro-ecological spots, and raise awareness of circular economy, parks, and restricted areas to preserve Biodiversity and the ecosystem.

Better management, sustainable market integration, and ecology integration will lead to higher sustainability growth in this area.

4 Environmental valuation techniques relevant to the present study

We conducted a random sampling approach for the household survey in the study area. We used a semi-structured household questionnaire prepared using existing literature. The questionnaire is presented in the Annexe 1 of the report. The questionnaire was developed, pre-tested, modified, and finally employed in all the fishing settlements. We also discussed the effectiveness and understanding of these issues at the local level with the institutes in Gujarat. The study has collected information on household demography, income from different sources, fishing assets, fishing methods, quantity of fish catch and willingness to pay for ecosystem services. The sample household characteristics are presented in Table 11.

Table 13: Sample Household Characteristics

Avg. Age of Respondent	Avg. years of fishing experience
54.5	33.0
51.0	25.5
49.7	38.4
39.3	36.5
31.1	34.6
40.5	31.3
33.5	29.0
31.0	27.0
37.6	23.4
54.0	26.0
52.5	7.5
41.4	30.1

4.1 Use and Non-use Value of Biodiversity

One of the objectives of the study is to estimate the use and non-use values of Biodiversity. Regarding use-value, we measured tourism value using the Travel Cost Approach. For the non-use value of Biodiversity, we employed the Contingent Valuation Method (CVM) to estimate Willingness to Pay (WTP) for conservation and management of ecosystem services. Although not directly dependent upon the regional ecosystem, the farmers influence its ecology by changing agricultural practices, including water harvesting, using chemicals and fertilizers, and shifting cultivation from traditional to cash crops. Thus, as part of the assessment of drivers of change. The key issues covered under that survey include present agricultural activities, changes in irrigation source and extent, especially in terms of the use of the canal, changing land use, application of chemicals and perception about the impact of these extensive alterations on the ecology, mainly the wetland system. A summary of data collection schemes, valuation methods and sample size for different aspects of the study is presented in Table 12.

Table 14: Summary of data collection approach

Study Aspect	Data Collection and Data Types	Valuation Method Applied
Biophysical & socio-economical description	Secondary data collection, review of literature	-
Description of landscape-level drivers of change	Secondary data collection, review of literature and consultations with subject experts; household survey	-
Economic Valuation – Prawn fish	Secondary data collection and primary survey	Market value assessment
Economic Valuation – Salt	Secondary data collection and Primary survey	Market value assessment
Economic Valuation – Tourism	Secondary data collection and Primary survey	Travel cost
Economic Valuation – Biodiversity	Review of Literature and Primary Survey	Contingent Valuation Method

4.2 Use Value

To capture the total value of prawn fisheries, we estimated it to be at least 6,688 tons. Dry prawn is done with some fraction of the total prawn in select locations. The estimated aggregate values using data from the primary survey are presented in Table 13 and are as follows:

- The Gross Market Value from prawn fisheries is estimated to be ₹646 million.
- The cost for each ton of fresh prawn catch is estimated as ₹20,156.
- The cost of making one ton of dry prawn is ₹1.94 lakh.
- The net market value of fresh and dried products is estimated at ₹718 million.
- Historical data (1996-2021) estimated an average annual catch of 3645 tons

Table 15: Fresh and Dry Fish Value at Market (Predicted)

Type	Gross Market Value (₹ Million)	Cost per ton (₹)	Net Market Value (Million ₹)
Fresh	781.13	27,342	571.92
Dry	97.43	1,06,441	41.16

Historical data reveals that this region produces an average of 30-40 lakh tons of salt annually. The landing site market price of salt is between ₹550-600 per ton. At this price, the gross market value of salt production estimates can go up to ₹2000 million. The average annual per household WTP of farmers, fishers, and salt makers in rural areas and other occupations in

the study area is around ₹390, ₹280, ₹870, and ₹710, respectively. We also extrapolated these average WTPs to the total households of respective occupational groups. Thus, the total annual non-use value of Biodiversity is estimated at around ₹137 million.

Total costs include different fares and fuel charges, as well as all the accommodation costs, food, entrance fees, and engagement in the marketplace. In addition to the above, we also estimated the opportunity cost of time once the Dam is constructed. Thus, we estimated per capita travel expenses as ₹9000, ₹21000 and ₹75000 for local, national and foreign tourists, respectively. Similarly, the average per capita opportunity cost of time was estimated to be ₹4000, ₹5000, and ₹30000 for local, national, and foreign tourists, respectively.

With better facilities, hotels and recreation facilities, science parks, and new bird-watching centers, the tourism sector of this region will help increase the local population's income. It will also boost the local and nearby markets as one of the preferred destinations for ecosystem-related tourism. This will allow cultural exchange and learning by such services' regional, national and international consumers.

4.3 Non-Use Value

Non-use biodiversity value was estimated through the contingent valuation method, which elicits households' willingness to pay for ecosystem conservation with multiple additions. The results of this exercise are presented in Table

Table 16: Willingness to Pay of Households

Respondents	Total HH	Avg. Annual WTP (₹ per HH)	Total WTP (Million ₹)
Rural	290489	348.98	101.4
Fishers	1300	226.13	0.29
Farmers & Allied Employed	281689	336.36	94.75
Overall	344782	396.65	136.8

Finally, the study area's use and non-use values were estimated to benefit approximately ₹1,500-2,000 million in the short run. Furthermore, the net present value (NPVs) for these goods and services is ₹28,000 – ₹30,000 million. These numbers will change over time, with inflation between 4-8 per cent annually. However, with market access and technology change, these numbers will be higher between 8-10 per cent depending on the state and national policies on economic development. These estimates demonstrate that the study area has significant economic value, which is critical for the survival of the local economy in such semi-arid regions of Gujarat.

4.4 Sensitivity to Wetland Sustainability

The study estimated that the building of the Dam may have initial issues related to the threat to the wetlands' sustainability. However, water engineering is a critical policy that should be considered. Water comes from various sources, namely (1) surface runoff from catchment areas, (2) rainfall that landed directly on the surface, and (3) saline seawater. For a sustainable flow of benefits, these water sources need to be maintained, along with the Dam development project. If the flow of water is maintained and managed, the threat to the sustainability of the wetland and the ecosystems will be drastically reduced. Habitat formation, economic activities, flora, and fauna are related to the availability of drink quality water and the appropriate storage of rainwater.

Table 17: Causes of Loss and Degradation

Causes	Estuaries	Open coasts	Flood Plains	Freshwater marshes	Lakes	Peat lands	Swamp forest
Biotic Effects			↑	↑	↑		
Construction of Physical Structures	↑	↑	↑	↑	↑		
Aquaculture Externalities	↑	√	√	√	√		
Domestic Externalities	↑	↑	↑	↑	↑		
Agriculture Externalities	↑	↑	↑	↑	√	↑	↑
Navigation Externalities	↑			√			
Drought Externalities	↑	↑	↑	↑	√	√	√
Erosions Externalities	↑	↑	↑			↑	
Solid Waste Disposals	↑	↑	↑	√			
Ground Water Abstraction			√	↑			
Climate-Induced Externalities	↑	↑				√	√
Structural Externalities	↑	↑	↑	↑	↑		
Mining Externalities	√	√	√		↑	↑	↑

↑ Important cause of degradation and loss; √ Present, but not a significant cause of loss
Source: From Literature Review, compiled by the author.

The storage of rainwater can help not only with irrigation but also with other economic activities. Major threats recorded are:

- An increase in salt pans directly impacts the degradation of fish habitat, which is one of the economic activities of this region. Therefore, appropriate policies must be formulated to maintain the salt pans while keeping the fish habitats and their growth.
- It can provide irrigation water in more than 500 villages by making the canal more efficient.

5. Conclusion and Key Recommendations

The Gulf of Khambhat is considered one of the critical natural systems of the Gujarat state. In administrative terms, the Gulf is bordered by 19 talukas belonging to 9 districts. The last census (2001) suggests that about 4.73 lakh people live in these 19 talukas. Due to its geographical positioning, physical and oceanographic characteristics, and prominent human population around, the Gulf is vulnerable to various anthropogenic activities, including rapid industrialization and coastal infrastructure development projects, jeopardizing both ecological and livelihood securities along these regions and realizing that for the effective planning and management of various natural resources and critical ecological systems in and along the Gulf of Khambhat, it is crucial to understand the trends of multiple drivers (economic, ecological, sustainability) and response variables including the state of floral and faunal species. Keeping the above in view, this study attempts to evaluate and estimate the economics of ecosystem services.

Despite many secondary data limitations for consistency and periodicity of reporting, we suggest that they help make aggregate-level policies. However, the Government should make policy for data governance at the village level for socioeconomic, geographical, land-use patterns and ecological details. A population census is critical; hence, a census of other parameters is needed. Better data can help in making informed policy decisions. The finding of this study is one of the first attempts by the Government to understand the non-use and user value of ecosystem services. Each project impacting the sustainability and ecosystem should encourage such studies. However, repetitive and time-series data can be beneficial for generalizing the findings of this research and arriving at the monetary valuation of ecosystem services. These can be used in calculating the Green GDP, a concept that will help achieve most of the Sustainable Goals (SDGs) and sustainable development, achieving economic growth. Higher surveys at the household level will also make households aware of the issues and implications of most of the critical infrastructure development by the state and the aggregate economy.

The next step in this area of research is to compare all talukas in these regions with a population survey and rank them in terms of each of the ecological services. This will also help in targeting individual SDGs.

5.2 Key Recommendation

It is recognized that the catchment area largely falls under several districts and has a mosaic of private and shared resources in protected area systems or open-production systems. Hence, data and governance and linking institutions in these areas with crucial goals of explaining the economics of ecosystem services is critical. These activities include:

- Develop Guidelines and Frameworks at Block Level and explain the cost and benefit of infrastructural projects.
- Discuss results and implications of Government initiatives in detail with all stakeholders
- Identify critical indicators and provide an estimate of each micro-ecosystem service with a market value, even if it is approximate.
- Make projects suitable for the local communities and suggest techno-economic movement in the market as we progress in economic development.
- Increase communication with stakeholders and institutions related to policy change.
- Make horizontally and vertically integrated policies with the Dam and other economic activities.
- Craft better tourism policies and policies for setting up appropriate avenues for salt workers.
- Seasonal variation of output and prices should be maintained by creating a Village Information System, which will give details of ecological indicators such as rainfall, windspeed, etc.

5.3 Policy Implications

The study identifies many important policy issues that need to be understood and addressed to use resources wisely in the study areas:

- The conflict between the production and protection nature of economic activities that arise due to ecological dependency.
- To link sustainable production practices and design better protection policies in sectors that generate externalities.
- To establish an ecosystem valuation system at the Block Level.
- Have a better tourism policy linked to a sustainability framework and biodiversity

conservation in Australia and New Zealand.

- Local communities can be used to adopt better technologies such as clean energy, microgrids, and new employment generations.

Consent Form

I, [*respondent's name*] _____, hereby give my permission to [*field investigator*] _____ employed by **Dr. Santosh Kumar Sahu** (*researcher*) to allow me to respond to a questionnaire and quote my responses in a scholarly research paper and for the project report. I understand that this work is for government purposes and will be dealt with confidentiality. I also understand that I waive any claim for copyright to this material should the researchers ever publish it in a scholarly journal or in electronic format online. No remuneration will be given to the respondent for taking the survey.

I understand that the Research Title is **Detailed Project Report (DPR) for the Evaluation of Ecosystem Services for Kalpasar Dam**, and it is undertaken by the National Centre for Coastal Research, **Ministry of Earth Sciences**

I also understand that the researcher, hereby named **Dr. Santosh Kumar Sahu**, will maintain my **anonymity** regarding my responses to Questionnaire items.

By signing this consent form, I am indicating my understanding that (a) I am 18 years or above; (b) participating in a research study; (c) my participation is completely voluntary and that I can withdraw my consent at any time without penalty; and (d) I do not have to answer any questions I do not want to answer.

I have read and understood the information on this form and have had any questions answered to my satisfaction

Signature _____

Date _____

Contact of Researcher:
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Indian Institute of Technology, Madras

Evaluation of Ecosystem Services

As a part of

Development of Detailed Project Report of Kalpasar Dam Project being undertaken by the National Centre for Coastal Research, Ministry of Earth Sciences

A-Block 1: Survey Identification Details					
A1	Name of the		A5	Name of Respondent	
A2	Survey schedule no		A6	Mobile number of respondent	
A3	Location code		A7	Date/month of Survey	
A4	Sampling code				

B-Block 2: Identification Details					
B1	District		B9	Any protected/preserved site nearby (Yes [1]/No [2])	
B2	Name of Block/Taluk		B10	If yes, the Name of the site	
B3	Name of Panchayat		B11	Nature of the site	
B4	Village/ Hamlet Name		B12	Distance to the site (in KM)	
B5	Nearest Beach		B13	Nearest CHC (in KM)	
B6	Nearest Beach (in KM)		B14	Nearest PHC (in KM)	
B7	Nearest Mangroves		B15	Nearest Government school (in KM)	
B8	Nearest mangroves (in KM)		B16	Nearest Police station (in KM)	

C-Block 3: Household Information							
C1	Religion						
	Hindu(1), Christian (2), Muslim (3), Jain (4), Others (specify)						
C2	Social category						
	General / Forward caste (1), Backward classes (2), Most Backward Classes (3), Scheduled Caste (4), Scheduled Tribe (5)						
Id. No.	1-Name	2-Relation with Head	3-Age	4-Sex	5-Level of Education	6-Occupation	7-Salary/income
C3							
C4							
C5							
C6							
C7							
C8							
C9							
C10							
C11							
C12							

D - Block 4: household amenities						
D1 -House Type (Kattcha [1], Semipukka [2], Pukka [3])		D2- Size of house (Sqft.)	D3 - No. of Rooms	D4 - How old is the house?	D5 - How long have you living in the house? (in years)	
Articles		Yes [1]/No [2]	Articles	Yes [1]/No [2]	Articles	Yes [1]/No [2]
D6 - TV			D7 - Heater		D8 - Motor Bike	

D9 - Water pump		D10 - Car		D11 - Radio	
D12 - Mobile/ Telephone		D13 - Computer		D14 - Bullock cart	
D15 - Boat (Motorized/Unmotorized)		D16 - Bicycle		D17 - Inverter	
D18 - Fishing net		D19 - Fan		D20 - Refrigerator	
D21 - Other [Specify]		D21 - Other [Specify]		D22 - Other [Specify]	
E - Block 5: Annual income and its share					
E1	Household Annual income				
Mention the share of Household Annual income from the following sources in percent?					
Source of Income				Share of Household Annual Income	
E2	Agriculture (%)				
E3	Coastal and marine allied activities (%)				
E4	(i)Salt pans (%)				
E5	(ii)Fisheries and related activities (%)				
E6	Non-agricultural activity including Wage/salaried employment (%)				
E7	Income from Remittances/pension/rent/ lease (%)				
E8	Others (specify) (%)				
E9	Total		100 %		
Mention the share of Household Annual Expenditure from the following sources in percent?					
E10	Household Annual Expenditure				
Source of Expenditure				Share of Household Annual Expenditure	
E11	Food grains (%)				
E12	Education(%)				
E13	Health (%)				
E14	Purchase of durable goods (%)				
E15	Tobacco/liquor (%)				
E16	Agriculture related activities (%)				
E17	Fishing (%)				
E18	Salt pans related activities (%)				
E19	Other _____ %				
E20	Total		100%		

F - Block 6: Salt pan		
F1	Do you have salt pan?(Yes [1]/No [2])	
F2	If yes area in acre?	
F3	How many years since started the activity?	
F4	Average yearly profit?	
F5	Are employed in salt pan? (Yes [1]/No [2])	
F6	If yes how many days in a year?	
F7	If yes wages per day?	
F8	Any plans of quitting?	
F9	Why?	
F10	What are the major occupational health issues?	

G - Block 7: Fishing		
G1	Are you a fisherman? (Yes [1]/No [2])	
G2	Where do you fish? (Inland[1]/Marine[2]/Both[3])	
G3	How many years since started the activity?	
G4	Do you own a boat?	
G5	Average yearly profit from marine?	
G6	Average yearly profit from inland?	
G7	Any plans of quitting?	
G8	Why?	
G9	What are the major occupational health issues?	

H - Block 8: food and health		
H1	Are you a Vegetarian? (Yes [1]/No [2])	
H2	Do you eat any kind of fish?(Yes [1]/No [2])	
H3	If yes, marine[1], freshwater[2], Both[3]	
H4	Do you eat any kind of marine or coastal ecosystem based food?	
H5	Prevalent disease	
H6	Absentee in work due to disease (no. of days) –	
H7	Absentee in school due to disease (no. of days) –	
H8	Any member passed away in the last 5 years (Yes [1]/No [2])	
H9	Any member hospitalized in the last one year (Yes [1]/No [2])	
H10	Approximate yearly medical expenditure incurred -	

I - Block 9: Water and sanitation		
I1	Source of water for drinking purposes (Tap water [1], Well water [2], Tanker-truck[3],Any other source [specify])	
I2	Source of water for other purposes (bathing, washing clothes etc. (Tap water [1], Well water [2], Tank water [3], Any other source [specify])	
I3	Do you pay for the water? (Yes [1]/No [2])	
I4	If yes, how much per litre?	
I5	Who is responsible for water collection? (Men [1], Women [2], child [3]) (Write all those apply)	
I6	How much time it takes to fetch water?	
I7	Salinity in the drinking water? (No salinity [1], Low salinity [2], high salinity [3])	
I8	How is the water purified? (Direct use [1], Boiling [2], Water purifier [3], other [specify])	
I9	Demand for drinking water supply: (More than sufficient [1], Sufficient [2], Less than sufficient [3])	
I10	Does your house have toilet facility? (Yes [1]/No [2])	
I11	If yes, what type? (Flush [1], Dry pit latrines [2], Others specify_____)	
I12	Do you share it with neighbours? (Yes [1]/No [2])	
I13	Is it provided by government of India? (Yes [1]/No [2])	

Block 10 : Energy		
J1	What type of energy source do you use for Cooking purposes? (LPG [1], Kerosene [2], Fire woods [3], Electricity [4],Dung cake[5],Others[specify]) (Write all those apply)	
J2	Is the cooking done in? (Inside the house[1], Separate building[2], Outside the house[3], other _____[4])	
J3	How much LPG used per month on an average? In kg	
J4	Do you think the LPG price is normal?	
J5	Do you changed to any other source from LPG? (Yes [1]/No [2])	

J6	If yes, specify?	
J7	Amount of firewood collected per month?	
J8	Market price of firewood	
J9	Does your house have an electricity connection? (Yes [1]/No [2])	
J10	If yes, then the source of electricity: (GSECL [1], Solar[2], Generator [3], Other [specify])	
J11	Is there power cut in your area? (Yes [1]/No [2])	
J12	If so how much hour per month on an average?	
J13	Average monthly usage?	
J14	Cost per unit	
J15	Does electricity consumption goes up during summer? (Yes [1]/No [2])	
J16	If yes by how many units?	
J17	If no, what is the reason? (No electricity in my area[1], Can't afford [2], satisfied with current situation[3], others specify_____)	
J18	Would you like to access electricity? (Yes [1]/No [2])	

K - Block 11: Infrastructure							
1. Infrastructure facilities available in the village							
K11	Post Office		K12	Worship Place		K13	Health Club
K14	Police Station		K15	Public Tap		K16	Public Ground
K17	Waiting Shed		K18	Public Library/Reading Room		K19	Other (Specify)
K110	Comfort Station		K111	Public Booth		K112	Other (Specify)
2. Educational facilities available in the village							
K21	Anganwadi		K22	Middle School		K23	College
K24	Primary School		K25	High school		K26	Other (Specify)
3. Medical facilities available in the village							
K31	Govt. Hospitals (Allopathy/Ayurvedic/Homeopathic)		K32	Dispensaries			
K33	Private Hospitals (Allopathy/Ayurvedic/Homeopathic)		K34	Nothing			

4. Government benefit schemes in operation							
K41	Prime Minister RojgarYojna		K42	Jawahar Rojgar Yojna		K43	NREGA
K44	Anganwadi		K45	IRDP		K46	Any other
K47	Nothing						
5. Type of public transport and frequency							
K51	Bus		K52	Six- seater		K53	Jeep
K54	Rickshaw (Cycle/Auto)		K55	Other [specify]		K56	Other [specify]

L - Section B

Sl. No	Have you visited the following places in Gujarat?	1- Yes [1], No[1]	2-Name of the site	3- How far is the site?	4- How many times did you visit the site in the last 1 year?	5-Mode of transport?
L1	Beach					
L2	Mudflats					
L3	Mangroves					
L4	Salt pans					
L5	Forest					
L6	Any other [specify]					

List the species and quantities collected per month from the natural resources (Marine and coastal system). If further Processed, which parts of the species are utilized

Sl.No	1- Species	2 - Parts of species/ plant / tree collected	3 - Quantities collected per month (mention units used)	4 - Distance from home	5 - Direct use or further processed	6 - processed products	7 - Proportion for own consumption and for sale
M1							
M2							
M3							
M4							
M5							

When are the season for species/tree/plant collection, and processing products (months)

Sl.No	1-Species Collection	2-Seasons	3-Processing products	4-Seasons (which months)
N1				
N2				
N3				
N4				
N5				

When are the season for species/tree/plant collection, and processing products (months)

Sl.No	Environmental Problem	Severe -1, Important – 2, Not Important – 3, Don't Know-4
O1	Solid waste	
O2	Water Pollution	
O3	Water supply	
O4	Sanitation	
O5	Degradation of water bodies	
O6	Deforestation	
O7	Deterioration of grazing land	
O8	Drainage/stagnant water	
O9	Flooding/ Inundation	
O10	Groundwater depletion	
O11	Groundwater salinity	
O12	Air pollution	
O13	Any other?	

Project related		
P1	Are you a member of any non-governmental organization (NGO) with interest on the environment? (Yes [1]/No [2])	
P2	Attitude towards the project (In favor [1], Not in favor [2], Do not know [3], will not answer[4])	
P3	Your opinion about the implementation of the project (Start immediately [1], Can be delayed [2], Neutral [3]], Do not know [4], will not answer[5])	
P4	Loss of job due to the project if any(Yes [1]/No [2])	
P5	Whether the project beneficial to the economic development of the area (Yes [1]/No [2])	
	What benefit do you think you get from this project	

P6	[1] Quality of life improvement (Yes [1]/No [2])	
P7	[2] Amenities like schools, shopping malls etc (Yes [1]/No [2])	
P8	[3] Medical facility improvement(Yes [1]/No [2])	
P9	[4] Others (specify) (Yes [1]/No [2])	

	Yours is a project-affected household (Yes [1]/No [2]),	
Q1	If yes, how?	
Q2	1. Plot (s) taken	Area:
Q3	2. Salt pan	Area:
Q4	3. Fishing lost	Quantity:
Q5	4. Local business	In rupees
Q6	5. Shop (s) lost	Numbers:
Q7	6. House (s) lost	Numbers:
Q8	7. Others (loss of firewood etc.)	

	What do you think as the benefits associated with the Dam?	1- Immediate	2-Future benefits
R1	1. Infrastructural development		
R2	2. Freshwater (Quantity)		
R3	3. Freshwater fishing (Quantity)		
R4	4. Salinity reduction		
R5	5. Electricity generation		
R6	6. Local business (In rupees)		
R7	7. Others		

Below is a list of benefits from the Kalpasar dam. Please indicate how you feel about them by ranking them from most (1) to least (5) important.

- S1. Freshwater for drinking and Irrigation
- S2. Reduction in travel distance between Kala talav and Aladar
- S3. Energy generation from solar and wind
- S4. Industrial development
- S5. Ground water quality
- S6. Freshwater fisheries and allied activities
- S7. Employment generation
- S8. Desalinization

Below is a list of problems that may arise from the Kalpasar dam. Please indicate how you feel about them by ranking them from most (1) to least (5) important.

- T1. The disappearance of coastal and marine ecosystem
- T2. Risk of eutrophication
- T3. Loss of habitat for some species (birds)
- T4. Salt pans closure
- T5. Loss of employment related to marine and coastal ecosystem
- T6. Problems during the construction period.

We now ask you to imagine that the government is planning for some coastal and marine ecosystem management related to employment generation, travel and tourism. You will be asked to choose between different scenarios based on the levels given in the table below. You will be presented for a total of 8 choice situations. In each choice situation you will be given an option set. Please choose the most appropriate option for you.

Attributes	Details	levels
Coastal and Marine flora and fauna	Plants and animals that are seen in the marine and coastal ecosystem	Low, medium, high
Maintenance work	Cleaning and maintenance on trails and beach	Low, medium, high
Water quality	Sea water quality	Low, medium, high
Commercial fishing	Access to commercial fishing	Low, medium, high
Beach and mudflat recreation	Recreational activities	Low, medium, high

WTP	Willingness to pay for the different choice	MIN, AVERAGE,MAX
-----	---	------------------

Imagine now that the government is planning to manage the coastal and marine ecosystem, and you have been asked to choose one project. You will have to pay a one-time amount for this management, which will be your willingness to pay. Which of the situation below would you choose?

U1- Choice set 1

	1-Current status	2-Alternative 1	3-No Change
Coastal and Marine flora and fauna			

U2-Choice set 2

	1-Current status	2-Alternative 1	3-No Change
Maintenance work			

U3-Choice set 3

	1-Current status	2-Alternative 1	3-No Change
Water quality			

U4-Choice set 4

	1-Current status	2-Alternative 1	3-No Change
Commercial fishing			

U-5Choice set 5

	1-Current status	2-Alternative 1	3-No Change
Beach and mudflat recreation			

U6	1-Current status	2-Alternative 1	3-No Change
WTP	-		

U7- How certain are you of the choice you made? Please indicate on a % certainty scale, 0% being the lowest and 100% being the highest.

