RESEARCH REPORT

Valuation of Mangroves in PQA Indus Delta: An Econometric Approach

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CONTRIBUTORS

Mr. Talib S. Karim Executive Director EMEC

Researchers

Dr. Shahid Amjad. HoD Environment and Energy Management IoBM
Muhammad Ajaz Rasheed Assistant Professor Economics Dept. IoBM
Mirza Aqeel Baig, Assistant Professor, Economics Dept. IoBM

Project Management

Dr. Samra Javed Assistant Professor, Director ORIC (EMEC) IoBM

Technical Support

Mr. Ghulam Qadir Shah (IUCN)
Mr. Ali Dehlavi CCAP (WWF-P)

Field Enumerators

Mr. Shahzad Ali Channa Environment and Energy Management (MBA Student)
Mr. HabibUllah khan Durani, Environment and Energy Management (MBA Student)
Ms. Maryam Asim Khan Environment and Energy Management (MBA Student)

Data Analysis

Mr. Irfan Lal Economics Dept. IoBM
Mr. Zia Ullah Economics Dept. IoBM

Administrative/Financial Services

Ms. Seher Rafiq EMEC
Mr. Midhat Nadeem EMEC

Indemnity/Disclaimer

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1. Foreword

The coastal and offshore areas are one of the most important national assets of a country where socio-economic activities are highly concentrated. Coastal and Marine resources have an immense potential in contributing towards national economic growth and development. Coast and oceans supports biological diversity, maintain hydrological cycles, regulate local climate, build soils, distribute heat energy we receive from the sun, recycle the essential nutrients, absorb and breakdown pollutants. Any major perturbation (climatic change/sea level rise) or change to the ecological balance of established communities would destabilize species diversity, which would reduce its efficiency in the flow of energy. Coastal areas are significant from economic view point they serve. Mangroves ecosystems provide benefits and offer products and services. These benefits and services include Products of Direct Economic Value: Fish, Hydrocarbons, Minerals, Desalinated water provisioning - food and fiber production. Products of Natural System (intangible) unrecognized services Supply of rich nutrients to support productivity, nursery and breeding grounds of fish and shellfish. Coast-dependent activities: such as, habitats for wildlife to a variety of terrestrial, aquatic and marine forms, marine transport and shipping, beach related activities, ports and harbor etc.

People in coastal areas tend to use the resources unsustainable by clearing trees for fuel and fodder for animals often find themselves in situation when the coastal ecosystem productivity diminishes and can no longer support their livelihood. These coastal communities migrate in large numbers to cities, increasing the pressure on the urban environment.

A well-coordinated national program of monitoring marine ecosystems should be initiated. Biological resources are renewable and even increase with proper management and conservation techniques. The importance of developing coastal marine resources in Pakistan has not been fully perceived, an integrated management approach is needed.

Shahjehan S. Karim
President

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Project Management Team

3. Summary

Mangroves are well known for their high biological productivity and their consequent importance to the nutrient budget of adjacent coastal waters. They export organic matter, mainly in detritus form (leaf litter) to the marine environment, thus providing a highly nutritious food source for themselves and for animals found in the mangrove areas, as well as for those in neighboring estuarine and marine ecosystems. Coastal communities benefits in a multitude of ways from Mangrove ecosystems. Collectively, these ecological functions are known as ecosystem services. Ecosystem services are regularly involved in the provisioning of food and services and the decomposition of organic wastes that supports the growth of mangroves and aquatic life.

We have focused on direct as well as indirect benefits of mangrove ecosystems. Direct uses of mangrove are fisheries, timber, fuel-wood, fodder, construction and tourism situated in Indus delta (PQA). In this regard, this study employs the market price method which is the most obvious way of measuring economic value of nature if one has only information about how much fish, crop, livestock, wood etc (direct use in short) can be obtained from the natural habitat. We have used 4% population growth rate (generally the rural/poverty areas having higher population growth as compare to national average) for our estimates. According to our estimates, Ibrahim Hyderi is the most populous area and Laat Basti has the least population. While the total population estimates of our study area are 2,076,606. The average household size is 12.

The Port Qasim Authority (PQA) has administrative control over the 4,900 ha of land above the high water line and 64,000 ha of mangrove forests, mud flats and creeks. The major land use of the area adjoining the site includes industrial zones and port areas. In addition to supporting offshore fishery, mangroves act as a natural barrier to shoreline erosion. Degradation of mangrove would destabilize the economic potential and the livelihood of communities' which include services and benefits offered by the mangrove ecosystem of the Indus deltaic area, Loss of Mangroves in the Indus Delta may threaten the survival of the natural resources and there by the livelihood of a large number of fishermen. The current mangrove cover in the Indus delta and the PQA shows an increase in mangrove forest from 94.18% (2005) to 97.35% in 2015 by 3.17%.(SPOT X 2015). The tree heights of the dominant mangrove species *Avicenna marina* in PQA at seven randomly selected locations ranged from small sapling to over 6 m. in heights. The mangroves density ranges from 4-9/10m^2. The ANOVA results indicate significant difference ($p<0.05$), between mangrove (Avicenna marina) tree heights observed at seven locations in PQA.

There is a positive correlation between mangrove tree heights and Carbon dioxide sequestered (R2 = 0.903) and tree diameter (R^2 = 0.848) in well-established Avicenna marina

trees. According to our results one cm diameter of mangroves tree leads to increase of approx 0.84 kg carbon biomass and one meter mangroves height leads to increase 6.9 kg carbon biomass within the PQA study area of Indus delta. On an average the carbon biomass content of mangrove trees in PQA was estimated to be 33.795 tons/ha. Clearing of mangroves can rapidly result in significantly reduction of carbon stores.

Most of the household (78 percent) in the PQA area use gas as primary fuel for cooking. They use mangroves as fuel wood when gas pressure is too low and cooking is not possible or for domestic celebrations/functions. The mangroves are mostly used as fuelwood (in cooking), the household in the PQA area use 134,853 Maund (40Kg) per month valued at an estimate of PKR[1] 26.97 million per month (Price of fuel wood in the PQA area PKR 200/Maund).

Mangrove leaves are a source of food for cattle and camels and are considered to be very nutritious. On the basis of our survey, we have calculated cattle grazing of mangroves equal to 2 million kg per year and at PKR15 per kg the economic value of it, is estimated a little above PKR 31 million. Mangroves were once used extensively for grazing in these locations; there has been a significant decline in this usage. The reasons are the reduction in the number of household animals in these areas. Our sample estimates that only 5.5% households carry domestic animals. The highest number of household carrying domestic animal was in Laat Basti where it was 10.6%.

The survey data indicate reductions in the fishery catch as reported by the locals. 52 households out of 85 responded a very significant reduction in fish catch, similarly another 19 out of 85 responded to a significant reduction in fish catch, this shows 83% percent responded to a reduction in catch had occurred. Only one household reported insignificant (no) change in fish catch. Using market price approach total market value of fish products is estimated at PKR 4.47 billion/year (USD 42.19 million/year). Fish products include Fish, Shrimp and Crab. Annual market value estimates for total fish, shrimp and crab catch are PKR 2.824 billion/year (USD 26.65 million/year), PKR 1.179 billion/year (USD 11.19 million/year), and PKR 0.46 billion/year (USD 4.35 million/year), respectively.

Apart from nutrient export, mangroves also contribute to offshore fisheries by acting as nurseries and shelters for many species of commercially important finfish and crustaceans. While a positive correlation between mangrove areas and fish productivity is acknowledged. The overall Productivity in the mangrove areas is reported to be high (365-780gC/m2/year, IOC 1994), which accounts for greater potential for fisheries yield in the PQA (64,000ha) mangrove area. Fish Biomass Production has been estimated at 36,640mtC/year, valued at PKR 6.40 billion/year (USD 60.34 million/year). The export of organic matter, is mainly in the

[1] PKR: Pakistan Rupee

form detritus matter to the marine environment, The mangroves community, thus provides a highly nutritious food source not only for themselves but also for the Benthic and terrestrial animals found in the mangrove areas.

The diversity index is a tool for measuring the health of the ecosystem was employed to the epipelagic fauna in the PQA mangrove ecosystem. Both the diversity (H') and evenness (J') show relatively lower values. The PQA is a designated industrial area, creeks system are a disturbed due to industrial activity. The species diversity (H') and species richness (J') for Benthic Marine Invertebrate (MBI) are relatively low, and may impact the flow of energy from lower trophic to higher trophic level. Rehabilitation and conservation of mangroves ecosystem in PQA is essential for sustained biological productivity in the region.

Out of four locations surveyed for tourism activity in PQA area, only one location (KhalifaJat Paro), the communities reported use of their boats for tourism purpose. Out of 18 boats (Hora type with outboard engine), 11 were engaged in tourism activity, which is around 61% of boats stationed at the village. The total value of tourism income generated per year is estimated at PKR 4.6 million/year (USD 43,319/year)..

The total market value of mangrove in our targeted area is estimated at PKR 6.75 billion/year (USD 63.73 million/year)[2] in which fish products (Fish, Shrimp and Crab) are the main source of income with a market value of PKR 6.39 billion/year (USD 60.34 million/year), Fuel wood contributes 0.323 billion/year (USD 3.05 million/year), fodder's annual market value is PKR 3.11 million/year (USD 0.294 million/year). Though this area has great tourism potential but only KhalifaJat Paro reported tourism worth mentioning with PKR 4.59 million /year (USD 43,319/year). The total values calculated for our study area in (PQA) shows mangrove products and service is estimated at USD 1,363 /ha/year)[3]. That does not differ from values calculated from other parts of the world.

There is a need for an integrated management approach to conserve and manage Mangrove ecosystem in the PQA and adjoining area of the Indus delta. Mangroves Restoration work has been initiated in Port Qasim Industrial zone by public and private sector organizations. There is a need to Foster greater Cooperate Social Responsibility for the betterment of mangrove ecosystem. Using the ecosystem management approach, the Government of Sindh/PQA/SEPA/CDA and other organizations should prepare a mangrove Utilization / management plan illustrated with maps and statistics, cost benefit analysis of the mangrove areas on short, medium and long term basis. The ecological role of mangrove ecosystems in the Indus Deltaic area of Port Qasim Authority (PQA) is, economically and socially significant. Clearing of mangroves can rapidly result in significantly reduction of carbon stores. The current study emphasizes the importance of mangrove vegetation and its

[2] Exchange rate: USD 1 = PKR 106.
[3] Total study area in PQA is 64000 ha.

planting efforts for economics, social benefits and for sequestration of carbon dioxide as a counter measure to mitigating the impacts climate change in the tropical coastal domain.

4. Introduction

The mangrove ecosystem of the Indus Delta is perhaps unique in being the largest area of arid climate mangroves in the world and is characterised by 17 major creeks and innumerable minor creeks, mud flats and fringing mangroves (Meynell and Qureshi 1993). The coastal morphology is characterized by a network of tidal creeks and a number of small islands with sparse mangrove vegetation, mud flats, swamps, and lagoons formed because of changes in river courses. The Port Qasim Authority (PQA) has administrative control over 64,000 ha of mangrove forests of the Indus Delta, mud flats and creeks. PQA has 4,900 ha of land area above the high water mark (+3.4m. ESIA Engro Vopak report 2014).The major land use of the area adjoining the site includes industrial zones and port areas. The numerous estuaries and creeks connecting to the sea which characterize the tidal delta and marshy mud flats, do not receive the same quantities of nutrients that they used to get in the past to support the growth of mangroves the largest single mangrove ecosystems in the tropical coastal environments. In the Indus Delta mangrove ecosystem, eight species of mangroves have been reported in the past. The *Avicenna marina* is the dominant species of the mangroves in the Indus Delta (Amjad and Khan 2011). The Mangroves are highly nutritious food source for marine fauna. Mangroves provide a habitat and breeding ground for a variety of marine life, particularly fish, shrimps and crabs.

Coastal communities benefits in a multitude of ways from Mangrove ecosystems. Collectively, these benefits are known as ecosystem services. The ecological role of mangrove ecosystems in the Indus Deltaic area of Port Qasim Authority (PQA) is, economically and socially significant. The Mangroves are well known for their high biological productivity and their consequent importance to the coastal community in terms of services and products of direct and indirect values. Mangrove Ecosystem services include provisioning of food and services and the decomposition of organic wastes. They export organic matter, mainly in detritus form of leaf litter to the marine environment, thus providing a highly nutritious food source for themselves and for the Benthic and terrestrial animals found in the mangrove areas, as well as for those in neighboring estuarine and marine ecosystems. Apart from nutrient export, mangroves also contribute to offshore fisheries by acting as nurseries and shelters for many species of commercially important finfish and crustaceans. Degradation of mangrove in PQA would destabilize the economic potential and the livelihood of communities' which include services and benefits offered by the mangrove ecosystem. Rehabilitation and conservation of mangroves ecosystem in PQA is essential for sustained biological productivity in the region.

The PQA macro-environment extends over the Union Councils (UC): Ibrahim Haidery, Rehri, Gulshan-i-Hadeed and Ghaggar. Geographical area of the macro-environment extends from the Korangi Creek on the west and along UC Ibrahim Haidery, Rehri, Chashma Goth (Korangi

Fish Harbour), the deep sea fish harbour, Laat Basti, Juma Goth in the north; the FOTCO Jetty and Port Qasim Industrial Area in the northeast; the Steel Mills in the far east, and the large mudflat covered by mangroves forest in addition to the navigation channel of Port Qasim in the south. The Karachi coastline between Korangi creek inlet and Kadiro Creek encompasses coastline of three islands; Bundal Island, Buddo Island and Khiprianwala Island and two large and deep openings towards the sea viz. Phitti Creek Mouth (Approach channel of Port Qasim) and the Kadiro Creek Mouth. The eastern coast has tidal creeks with mangrove and mudflats which are linked with a network of creeks of Indus Delta. The sea bed at the eastern and south eastern coast is generally smooth and regular as depicted by the bed contours. Phitti creek is the largest amongst the group of creeks developed on the western parts of the Indus delta formerly the delta of the Indus River. Phitti Creek is connected to a system of creeks including Jhari, Kadiro, Korangi and Gharo Creeks. Some smaller creeks branch of these major creeks forming a big network of the Indus delta. This network of creeks is a very sensitive ecological area of the delta and has all the characteristics of the deltaic behavior. A chain of small Islands such as Bundal, Buddo, and Khiprianwala are off shoots of Indus Delta formation system and are either sand banks or swamps partially submerged at high tide. Extensive vegetation of mangrove also exists. The islands are mostly flat and swampy having an elevation that is close to the astronomical high tide level of over +4.0 m.

4.1 Mangrove Ecosystem Services

Avicenna marina is the most dominant species. Other mangrove species in the deltaic region such as the *Ceriops tagal* occur in localized patches and there are a few plants of *Rhizophora mucronata*. A total of eight species of mangroves has been reported from the coastal areas of Pakistan. However, only four species survive in the Indus Delta. All other species are rare and have disappeared from most part of the Delta due to adverse environmental conditions. The mangrove trees growing 200-300 m away from the creek (seawater) in the land ward direction show an overall decline in the height of the mangrove plantations.

The mangrove forests which covered 263,000 ha in 1977 recessed to about 160,000 ha in 1990 (Qureshi, 2005), threatening the survival of the natural resources and thereby the livelihood of a large number of fisherman. The current mangrove cover in the Indus delta and the PQA shows an increase in mangrove forest by 3.17% from 94.18% (2005) to 97.35% in 2015 (2015 SPOTXS) - Table 1.

Region	Area in Hectares	Area in Acres	%
Karachi Harbour Area	985.5	2434.18	0.51

Indus Deltaic Region & PQA	186000	459420	97.35
Miani Hor	3431.36	8475.45	1.79
Kalmat Hor	194	497.18	0.10
Jiwani	433	1069.51	0.22
Total	191043.86	471896.33	100

Table 1. The area summary of Mangrove forests along the coast of Pakistan based on SPOT XS data 2015 (Qureshi 2015).

4.2 Mangroves: The Ecological Capital.

Mangroves in the Indus Deltaic area provide immense benefits, products and unrecognized regulatory services. Products of Direct Economic Value: Fish, Minerals and food. There are Products of Natural System (intangible) supplies of rich nutrients to support productivity. Coastal communities benefits in a multitude of ways from Mangrove ecosystems. Collectively, these ecological functions are known as ecosystem services. Ecosystem services are regularly involved in the provisioning of food and services and the decomposition of organic wastes. (Figure 1). Degradation of mangrove would destabilize the economic potential and the livelihood of communities' which include services and benefits offered by the mangrove ecosystem of the Indus deltaic area. The problem with valuing environmental assets is that many of them have a zero price because no market place exists in which their true values can be evaluated through buying and selling. They are therefore provided 'free'. Examples may be of Coastline Stabilization, Aquifer Recharge, Sediment and Nutrient Retention, Habitat Protection, Biodiversity, Biomass and Productivity, Recreation and Tourism the storm protection etc. Since environmental goods and services are often available to consumers at a zero price they do not 'appear' to affect markets, and cannot be measured as easily as marketed goods. This is a serious issue because typically environmental goods and services have a positive value (not a zero price) and many people are willing to pay to insure their continued availability (Pearce et al 1989).

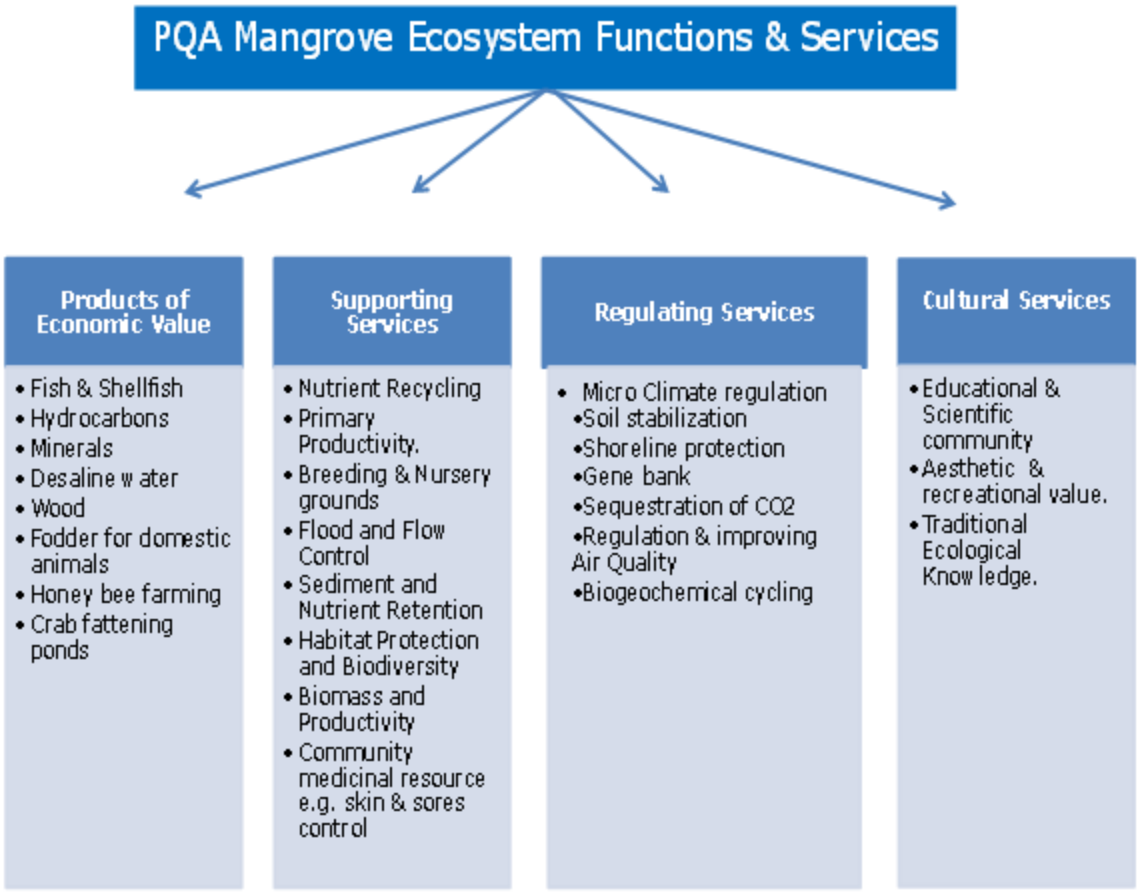


Figure 1: Ecosystem function and services (MA 2005, Q.T. Vo et.,al. 2012).

5. Study Area

The Karachi coastline between Korangi creek inlet and Kadiro Creek encompasses three islands; Bundal Island, Buddo Island and Khiprianwala Island and two large and deep openings towards the sea viz. Phitti Creek Mouth (Approach channel of Port Qasim) and the Kadiro Creek Mouth. The geographical location is given in figure 2. The eastern coast has tidal creeks with mangrove and mudflats which are linked with a network of creeks of Indus Delta. The Port Qasim Authority area consists of three major creeks systems, the Gharo Phitti Creek System: Gharo Creek, Kadiro Creek and Phitti Creek. All three are connected in a series starting from Gharo Creek at the north-eastern end to the Phitti Creek at the south-western end and located at 22.3 km from Karachi. This creek system is about 28 km long and its width ranges from 250 to 2,500 m. The Korangi Creek and Kadiro Creeks are connected with it at the north-eastern end while it acts as main waterway connected with the open sea at the south-western end. The qualitative and quantitative component of the study comprising of the mangrove related fishery resources, and the socio-economic aspects were carried out

in households (members sharing a kitchen) of four villages of Bin Qasim Area of Ibrahim Hyderi, Reheri KhalifaJat Paro, Laat Basti and Chasma Goth.

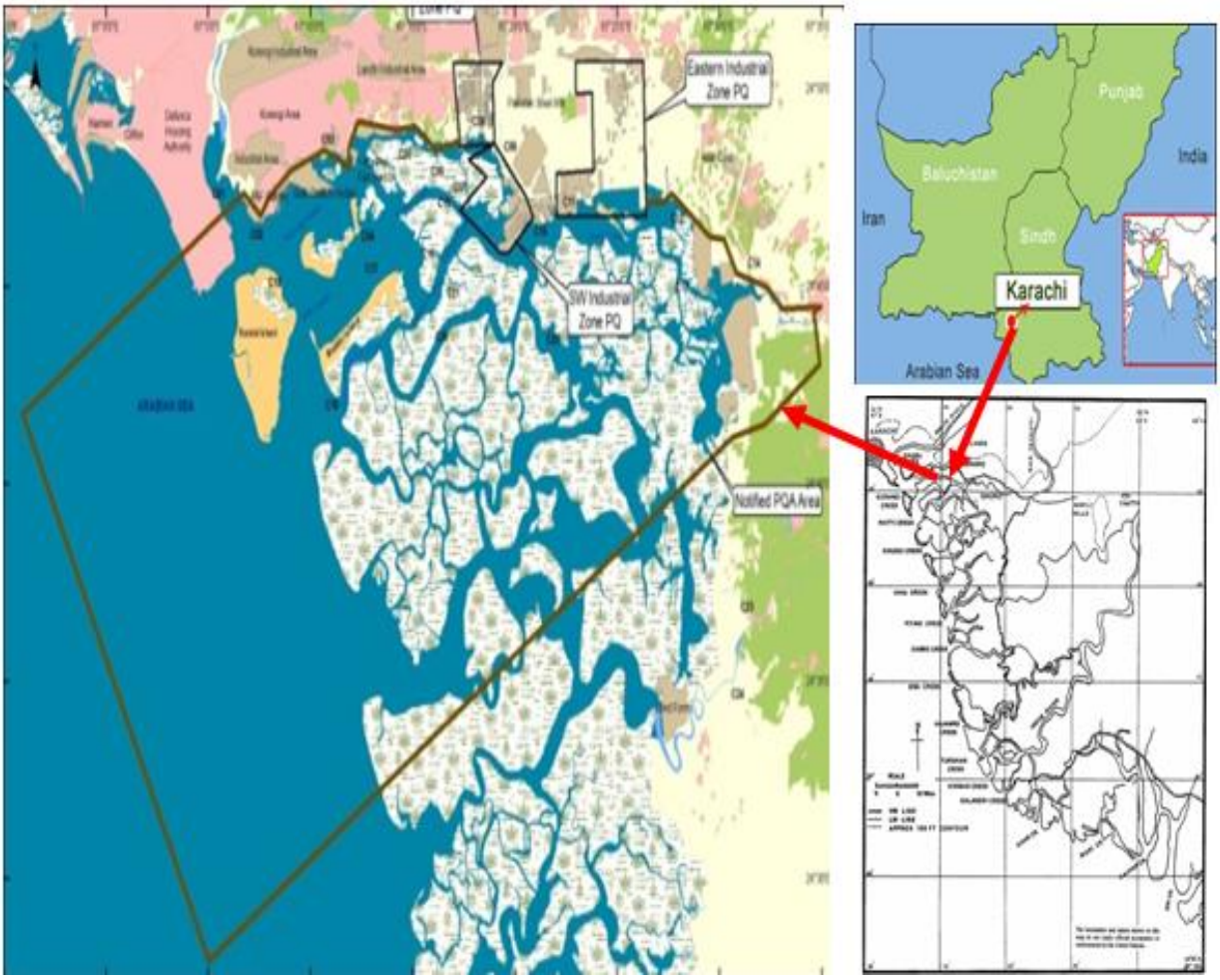


Figure 2. Geographical location and Study Area, South of Karachi Port Qasim Area, part of the Indus Delta, Sindh

The sampling location and coordinates in the PQA area for the observing the mangrove tree heights, densities, biodiversity and study on carbon sequestration are given in table 2 and figure 3

Station No	Latitude N	Longitude E
EC 1	24 48 37.8	67 14 57.2
EC 2	24 48 14.7	67 16 45.5
EC 3	24 46 12.6	67 25 19.4
EC 4	24 43 53.1	67 14 50.3
EC 5	24 43 45.9	67 21 13.2
EC 6	24 37 51.8	67 17 9.0

EC 7	24 46 23.9	67 12 50.7

Table 2 PQA Sampling stations and coordinates

Figure 3 Sampling station in PQA study area

6. Sampling Methodology

The total economic value of mangrove forests can be sub categorized into its use values and non-use values. The use values can be derived from how people obtain benefits directly or indirectly from the goods and services available in the study area. The direct use could be performed in both commercial and non-commercial ways for instance fishing, fuel wood collection, the use of mangrove forests for the purpose of recreation. The indirect use reflects the indirect benefit provided by mangrove forest in the form of water quality and flow maintenance, protection from floods and storms and all the consumption and production activities that are supported by mangrove forests. In addition to all the categories of use values there is a special category, namely, the option use. It is a premium placed on maintaining the resources of the coast for any possible use in the future. Non-use

values include biodiversity, bequest value and cultural heritage, which are associated with the benefits that are derived from knowing that the resource is maintained. Use values reflect the association of humans with the resource, whereas non-use values do not.

A qualitative questioner was designed Annex 1 with the inputs of IUCN and WWF-P. The study focused on direct as well as indirect benefits of mangrove ecosystems. Direct uses of mangrove are fisheries, timber, fuel-wood, fodder, construction and tourism.

6.1 Approaches and Methods

We have focused on direct as well as indirect benefits of mangrove ecosystems. Direct uses of mangrove are fisheries, timber, fuel-wood, fodder, construction and tourism situated in study area of the Indus delta (PQA). In this regard, this study employs the market price method which is the most obvious way of measuring economic value of nature if one has only information about how much fish, crop, livestock, wood etc available and used by the local inhabitants. These quantitative values can be obtained by the use of natural habitat. This method requires mainly two types of information i.e. the production quantities of the marketable goods and the per unit local market price of those goods. Once this information is collected, the total value of direct use for a certain category can be estimated.

The steps involved in estimating economic value by market prices approach may be summarized as:

- Finding out the quantity of the product collected;
- Evaluating the market price of the product;
- The values quoted by the local fisherman were also taken used considered.
- The values were extrapolated for the PQA study area.

The collection and analysis of such data is fairly easy, however, it is important to ensure that the sample of households is of adequate size when applying this technique. Furthermore, factors such as different seasons, different socio economic groups and different locations should also be kept in mind as they take in the possibility that prices and quantities may vary across these factors. This method relies on the actual market behavior which makes it relatively easy to use and which becomes the greatest advantage of this technique. Applying this technique requires only simple statistical analysis, simple modeling and few assumptions. This technique however also has disadvantages that it cannot be applied in isolation in some situations. For instance, it cannot be applied if households collect the products for the sake of their own consumption rather than for commercial purpose, as well as in a situation when prices are distorted by a variety of subsidies and market interventions.

The Objectives of the study was addressed through a mix of qualitative and quantitative survey techniques and by using secondary and primary data sources.

6.1.1 Primary Survey:

We have first surveyed 52 households using questionnaire based on qualitative questions. To get an additional insight, we conducted a survey of 55 households based on quantitative survey given in annex 1 of the four locations mentioned above. Community conducted profile was surveyed for each of the 4 locations. We also conduct few focus group discussion surveys on Coastal tourism and Mangrove as fuel wood consumption etc (annex 2).

6.1.2 Secondary data

Secondary data collection entailed review of existing information regarding mangroves in general and Port Qasim area mangroves in particular. A number of studies regarding fisheries and mangroves were reviewed to understand the general situation in Pakistan, Indus Delta region and in particular Port Qasim area.

Primary and secondary data and information was collected on carbon sequestration, epipelagic mangrove faunal community.

6.1.3 Sample Sizes and Groups

The study was carried out in four villages of Bin Qasim Town; the intention was to conduct random sampling, however due to inaccessibility of some localities, convenience sampling was conducted in the following localities.

- Ibrahim Hyderi,
- UC Reheri (Khalifa Jat Paro)
- Laat Basti
- Chasma Goth. (Korangi Fish Harbor)

The Coastal village community that fall partly or are under the jurisdiction of PQA viz a viz Ibrahim Hydri, Laat Baasti, KhalifaJat Paro etc were approached randomly by the project enumerators. (Figure 4) The project enumerators were trained by WWF-P. Vehicles and boat were hired for field trips to collect information and data from the creeks. Secondary data and information were collected through primary sources such as EIA assessment of ongoing projects in the PQA.

Figure 4. Qualitative data collection through community interviews with the local inhabitants.

6.2 Field Sampling in the study Area (PQA)

Field sampling and data collection was carried out from August 2015 to October 2015, in the PQA industrial area and the PQA administrative control areas including some of the adjoining industry and port areas of PQA. Figure 5 shows series of pictures of mangrove seedlings and saplings as in natural and replanted activities. Primary and secondary data and information was collected on carbon sequestration, epipelagic mangrove faunal community, replantation efforts of mangroves by the community and the industry, biological diversity. Direct and indirect economic values of products and services were derived using an econometric approach.

Broadcast Seedling of *Avicenna marina* and natural growth in PQA

Established mangrove nursery in PQA study area

Seedlings of *Rhizophora mucronata*, and planting of saplings.

Healthy growth of planted *Rhizophora mucronata* in PQA study area

Rhizophora mucronata nursery PQA study area.


More than 30 year old chopped mangrove tree (annular tree rings).

Figure 5 Mangrove activities in the study area and collecting information on mature mangrove trees *A. Avicenna marina*

6.3 Mangrove Carbon Sequestration.

Mangroves constitute a unique tropical ecosystem, occurring most extensively along the protected coasts, either on muddy to sandy bottoms covered by tidal fluxes. Mangroves differ from forest ecosystems in that they receive large inputs of organic matter and energy from both land and the sea. Mangrove ecosystems are large and dynamic reservoir of carbon, which is an important part of global carbon cycle and a potential sink of atmospheric carbon dioxide (Matsui, et. al., 2010). Mangroves store large quantities of organic carbon.

Very few studies have been conducted on the biomass carbon content of mangroves species Avicenna marina (Pandey & Pandey 2013).Carbon Cycling and Storage in Mangrove Forests (Alongi 2014)

6.3.1 Method for determining Carbon Sequestration Mangrove

The amount of CO2 sequestered by trees can roughly be estimated if we divide by the tree's age, get a yearly sequestration rate. (Scott DeWald, Scott Josiah, and Becky Erdkamp, 2005 Worldagroforestrycentre.org) The process involves

- Determine the total (green) weight of the tree.
- Determine the dry weight of the tree.
- Determine the weight of carbon in the tree.
- Determine the weight of carbon dioxide sequestered in the tree
- Determine the weight of CO2 sequestered in the tree per year.

The root system weighs about 20% as much as the above-ground weight of the tree. Therefore, to determine the total green weight of the tree, multiply the above-ground weight of the tree by 120%.

Determine the dry weight of the tree

Taking all species into account, the average tree is 72.5% dry matter and 27.5% moisture.
Therefore, to determine the dry weight of the tree, multiply the weight of the tree by 72.5%

Determine the weight of carbon in the tree

The average carbon content is generally 50% of the tree's total volume. Therefore, to determine the weight of carbon in the tree, multiply the dry weight of the tree by 50%.

Determine the weight of carbon dioxide sequestered in the tree

CO2 is composed of one molecule of Carbon and 2 molecules of Oxygen.
The atomic weight of Carbon is 12.001115.
The atomic weight of Oxygen is 15.9994.
The weight of CO2 is C+2*O=43.999915.

The ratio of CO_2 to C is 43.999915/12.001115=3.6663.
Therefore, to determine the weight of carbon dioxide sequestered in the tree, multiply the weight of carbon in the tree by 3.6663

Determine the weight of CO2 sequestered in the tree per year

Divide the weight of carbon dioxide sequestered in the tree by the age of the tree.

6.4 Fish production biomass

The Primary Productivity values from literature for the months of February, March, and June show relatively higher productivity rates for PQA area. The nutrients including Phosphate, Nitrate, Nitrite and Ammonia play a vital role in the food chain of marine ecosystem in primary production of coastal and oceanic waters. The Gharo/ Phitti creek in PQA receive large quantities of nutrients as part of the sewage effluent and garbage that is disposed off in these creeks. Nutrients in the PQA do not appear to be limiting to primary productivity in the channels. The phytoplankton biomass, primary production or zooplankton biomass and fish production was calculated as per Ryder (1965).

6.5 Shannon- Weaver biodiversity index

Shannon- Weaver index measures species richness and proportion of each species within the local aquatic community (Shannon & Weaver 1949). The index was calculated for evaluating the Marine Benthic Invertebrates (MBI) in the PQA by using the formulae:

Shannon Index (H) = $-\sum_{i=1}^{S} P_i \log(P_i)$

In the Shannon index, p is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), log is the decimal log, Σ is the sum of the calculations, and s is the number of species.

7. Results and Economic Valuation

7.1 Population of local inhabitants in the Study Area

Using population estimates of IUCN study by Samina Khalil (1999) the estimated population of Ibrahim Hydri, Laat Baasti, Jaat Paryo are given in figure. We have used 4% population growth rate for our estimates. According to our estimates, Ibrahim Hyderi is the most populous area and Laat Basti has the least population. The total population estimates of our study area are 244,168 (Table 3). The average household size is 12, which shows that joint family system is a norm in these less developed areas. (Figure 6 & 7)

Location	Population 2016	Households 2016	HH Size Survey

Ibrahim Hydari	157,495	15,197	10
Chasma Goth	18,720	1,370	14
Khalifa Jat Paro	60,525	6,171	10
Lat Basti	7,428	511	15
TOTAL	244,168	23,249	

Table 3 Total population estimates in the locations of the study area.

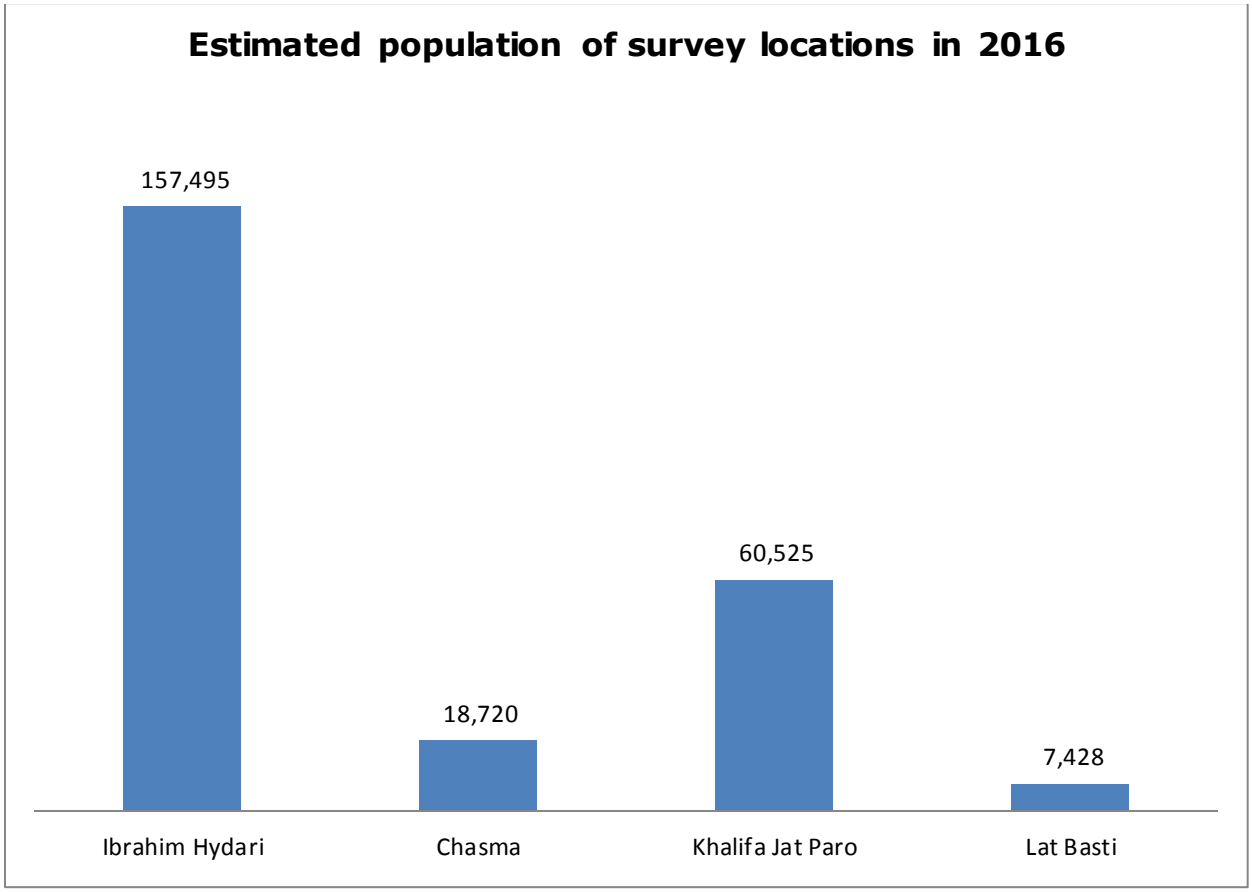


Figure 6 Estimated populations of the locations surveyed 2016 in the study area

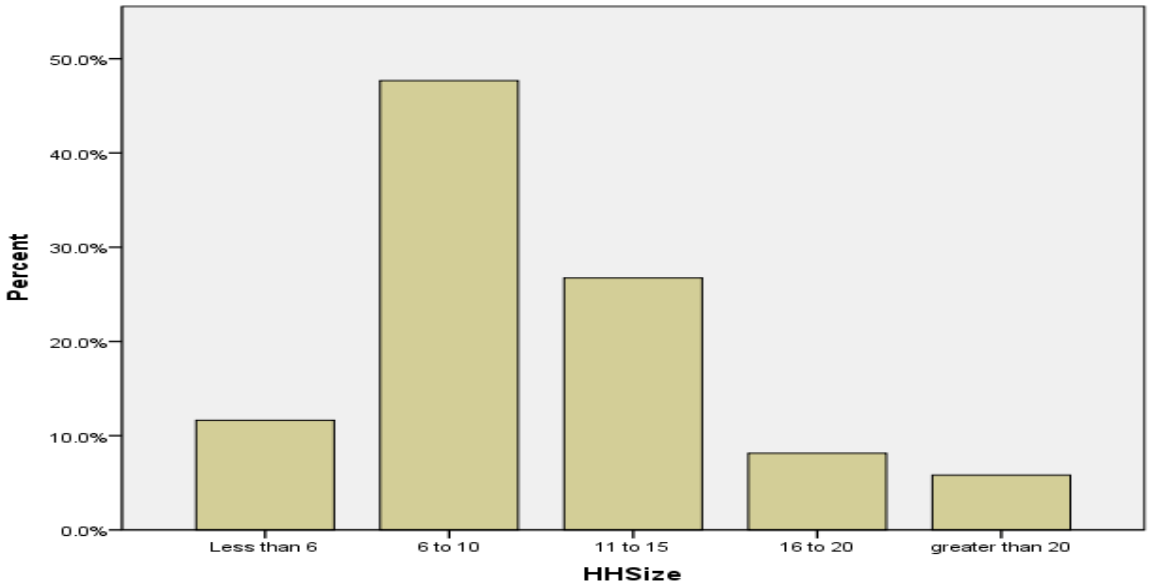


Figure 7 Number of individuals per household (people sharing a kitchen) in the study area.

7.2 Source of Drinking Water

The main sources of drinking water in the localities were evaluated. Piped tap water was the main source for water supply in most areas. (>80%). Figure 8.

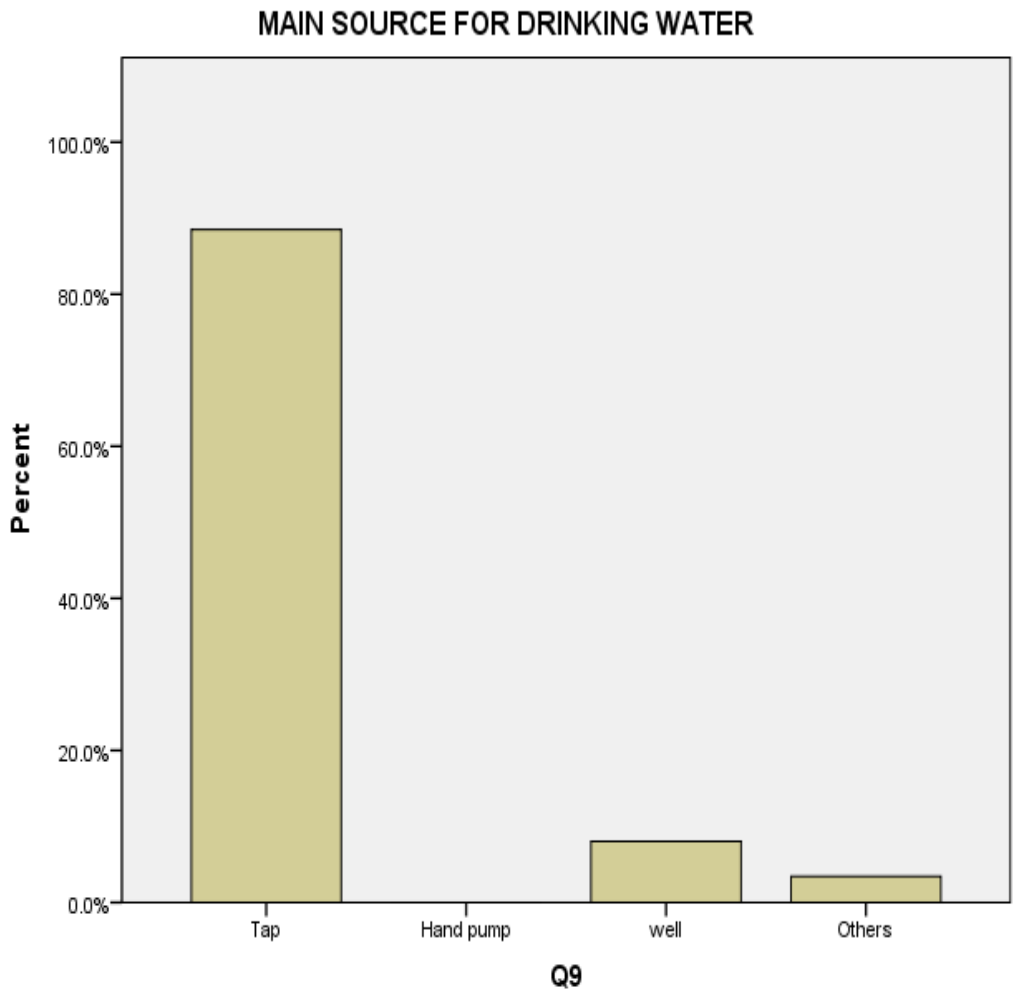


Figure 8 Sources of drinking water in the surveyed area

More than 80% respondents had the facility of tap water, while the remaining use well or other sources.

7.3 Household Income level

Ibrahim Hyderi enjoys the highest average household income of PKR 46109. In fact it is an outlier as in all other areas average household income is equal to or less than PKR 13000. A significant proportion of Korangi Creek dwellers is living below poverty line (Figure 9). This is also evident from descriptive statistics table 4. The multiple comparisons in table 5 shows there is significant difference between Ibrahim Hyderi and other three locations.

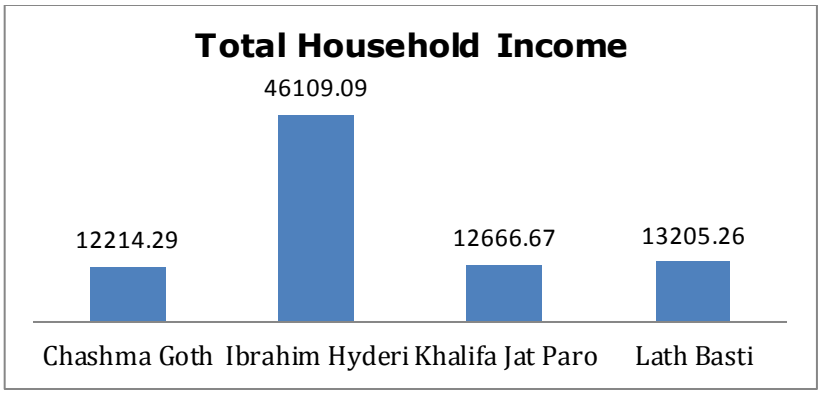


Figure 9 Household income level in PKR

Total Household Income

Location	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Ibrahim Hyderi	11	46,109	43,099	12,995	17,155	75,063	1,200	125,000
Khalifa Jat Paro	18	12,667	8,139	1,918	8,619	16,714	1,000	30,000
Laat Basti	19	13,205	12,126	2,782	7,361	19,050	300	50,000
Chashma Goth	7	12,214	6,939	2,623	5,796	18,632	4,000	22,500
Total	55	19,484	24,491	3,302	12,863	26,104	300	125,000

Table 4 Descriptive statistics of household income levels in surveyed locations

Multiple comparison test was performed to compare the HH average level of income at four locations; the result shows that there is significant difference in the Ibrahim Hyderi and other locations. P<0.05, While there is no significant difference in other three locations.

Multiple Comparisons

Total Household Income
LSD

(I) Area Code	(J) Area Code	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Ibrahim Hyderi	Khalifa Jat Paro	33,442*	8,063	.000	17,256	49,629
	Laat Basti	32,903*	7,982	.000	16,880	48,928
	Chashma Goth	33,894*	10,186	.002	13,445	54,344
Khalifa Jat Paro	Ibrahim Hyderi	-33,442*	8,063	.000	(49,629)	(17,256)
	Laat Basti	-538	6,930	.938	(14,450)	13,373
	Chashma Goth	452	9,384	.962	(18,387)	19,292
Laat Basti	Ibrahim Hyderi	-32,903*	7,982	.000	(48,928)	(16,880)
	Khalifa Jat Paro	538	6,930	.938	(13,373)	14,450
	Chashma Goth	990	9,315	.916	(17,710)	19,691
Chashma Goth	Ibrahim Hyderi	-33,894*	10,186	.002	(54,344)	(13,445)
	Khalifa Jat Paro	-452	9,384	.962	(19,292)	18,387
	Laat Basti	-990	9,315	.916	(19,691)	17,710

*. The mean difference is significant at the 0.05 level.

Table 5. Multiple comparison of income between inhabitants of Ibrahim Hyderi and other locations.

7.4 Educational Level of Respondents

Almost half 47% of respondents were illeterate without any school education and 33% had only primary education. A very small proportion (7%) was matriculated (Figure 10). Very few got the opportunity to study further (3%). Due to extreme poverty and large family size local youth have to work at a tender age. These areas need attention of concerend authorities to provide school education at the doorsteps of local inhabitants.

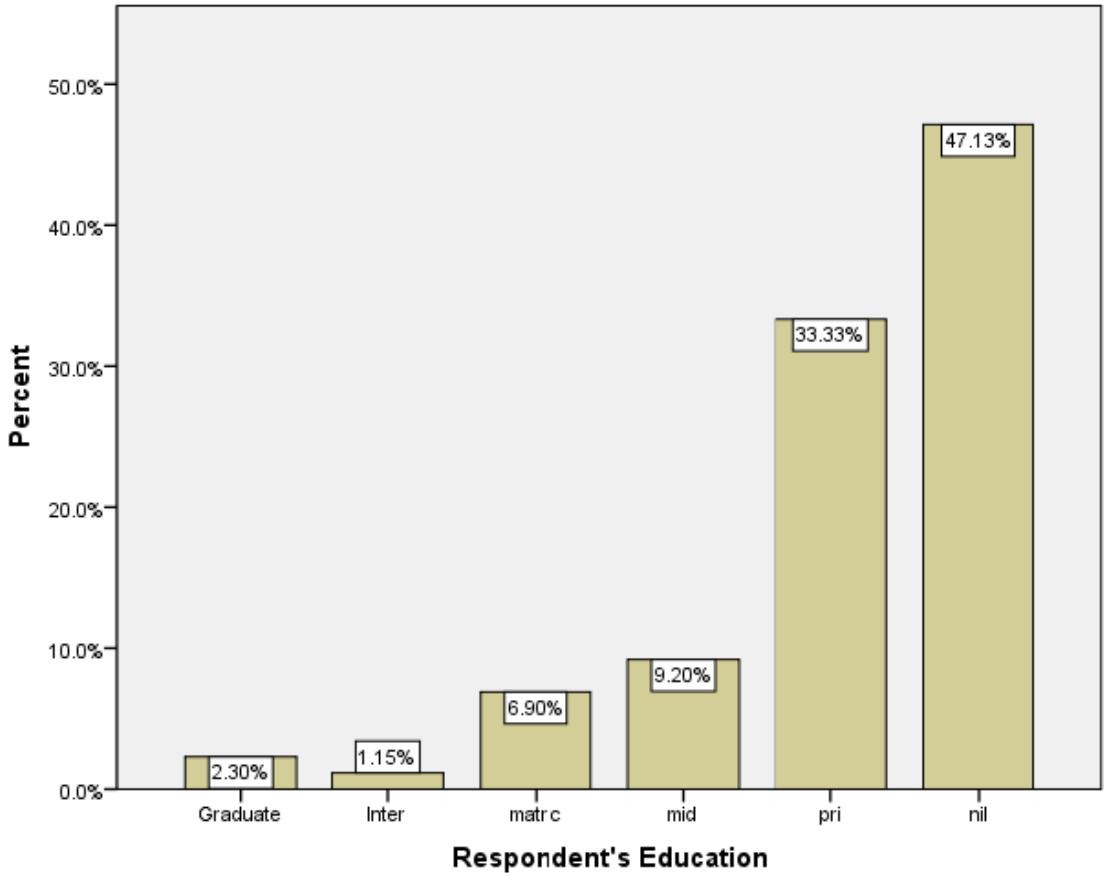


Figure 10. Percentage Level of education in the area

7.5 Statistical relationship between income and education

Our sample revealed that a large part population of Korangi Creek is living below extreme poverty line as except for Ibrahim Hyderi all areas have per capita income equal to or less than PKR 13000, even less than minimum legal wage rate of Pakistan. Simultaneously there is high rate of illiteracy as almost half of the population is illiterate and only 10% are matriculated or above. In the literature, there is strong linkage between level of education and income. It is widely believed that education is the key to success, it not only broadens people's mind, enables to face challenges, builds confidence to make critical decisions but it also helps them to earn higher income. The hypothesis that low education leads to low income seems to be functional in Korangi Creek area. The important task was to estimate the extent of relationship between income and education in our targeted area; this was done by using Ordinary least square (OLS) method (Table 6). OLS method is the easiest and most

commonly used technique to estimate the extent of relationship between two or more variables. This technique has been designed to minimize the margin of error that is bound to occur during the process of estimation of parameters for huge population on the basis limited sample. Due to cross section nature of our data we expect hetroscedasticity. Hence White hetroscedasticity- consistent standard error & amp; covariance method was used. Regression results show significant relationship between income and education at 5% level of significance. The extent of relationship between income and education is provided by the coefficient 9399.40 in the table. It shows that, with one additional level of educational qualification the local dweller's income increases by PKR. 9399. This is evident that efforts are required to provide college and above level education to the people of this area. This should help them in developing required skills to exploit the potential of fishing and related professions in the area. R-square of this regression is 18% which is relatively low but it is expected using cross sectional data. F-value is significant at 1% level of significance showing that our regression model is statistically valid.

Income and Education relationship				
Dependent Variable: Income				
Method: Least Squares				
Sample (adjusted): 1 85				
Included observations: 55 after adjustments				
White Heteroskedasticity-Consistent Standard Errors & Covariance				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11280.53	3404.21	3.313692	0.0017
EDUC	9399.39	3874.96	2.42567	0.0187
R-squared	0.180324	Mean dependent var		19483.64
Adjusted R-squared	0.164858	S.D. dependent var		24491.02
S.E. of regression	2.24E+04	Akaike info criterion		22.90553
Sum squared resid	2.65E+10	Schwarz criterion		22.97853
Log likelihood	-627.902	Hannan-Quinn criter.		22.93376
F-statistic	11.65969	Durbin-Watson stat		1.412572
Prob(F-statistic)	0.001232			

Table 6 statistical relationship between income and education in Korangi Creek area

7.6 Mangroves Tree Heights and Densities.

The survey data indicates that about 68% of household respondents classified the health (Thickness, Height & Density) of mangroves as good while another 28% household worried about the health of mangrove ecosystem in the PQA area and think that it is deteriorating.

About managing the mangroves area in PQA, about 60% of household were satisfied that mangroves were adequately managed, around 40% responded that the mangroves could be managed better (Figure 6). This contradiction in people's perception about better mangrove health and consistently decreasing amount of fish catch was statistically addressed by applying chi-square test. the objective was to test for the significance of relationships between the two question asked in the survey i.e. How will you classify health (Thickness, Height & Density) of mangroves in this region in last five years? And the question 'Has the fishing/shrimp/crabs yield changed in the last five years in this area?' The resulting table 7 shows the cross tabulation of the two questions; 58 out of 85 respondents (68%) respondents thought the mangroves are healthy, while 71 out of 85 (83.5%) considered that there has been a significant change (decrease) in fish related catch during the same period. The p-value of Pearson's chi square obtained 0.453 which is larger than any suggested value of significance i.e. (0.1, 0.05 or 0.01) therefore chi-square test of independence was not rejected which means that the two variables are independent to each other. This may be attributed towards better mangrove management. But simultaneous adverse developments for example; chemical and organic waste plus ever increasing environmental degradation are posing threat to mangroves in the area and has the potential to pose serious problems in future.

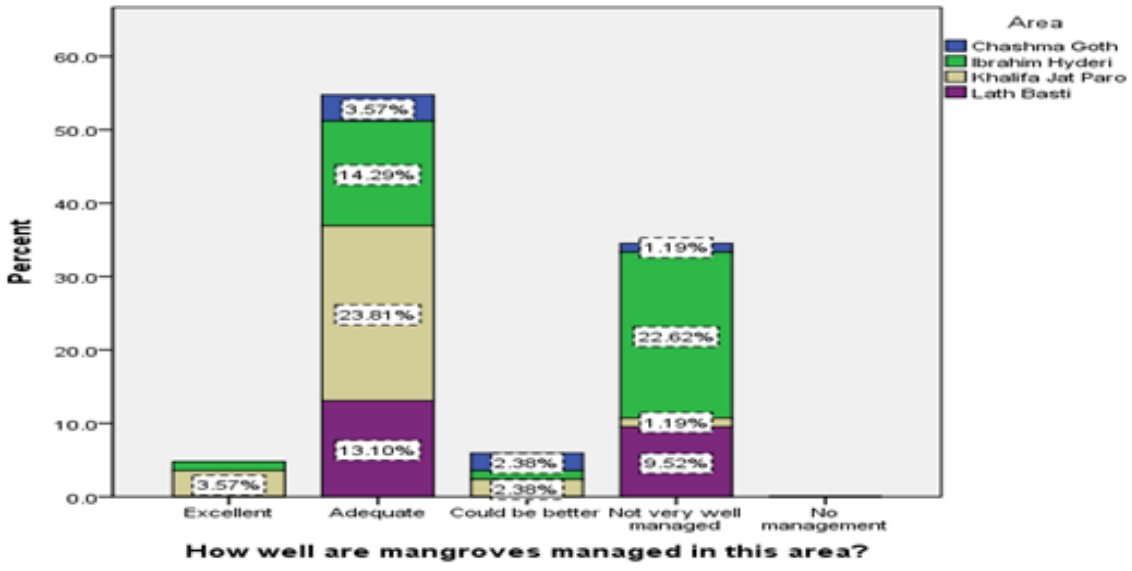


Figure 6. Response of respondent how well are mangroves managed in this area

How will you classify health (Thickness, Height & Density) of mangroves in this region in last five years? * Has the fishing/shrimp/crabs yield changed in the last five years in this area? Cross tabulation

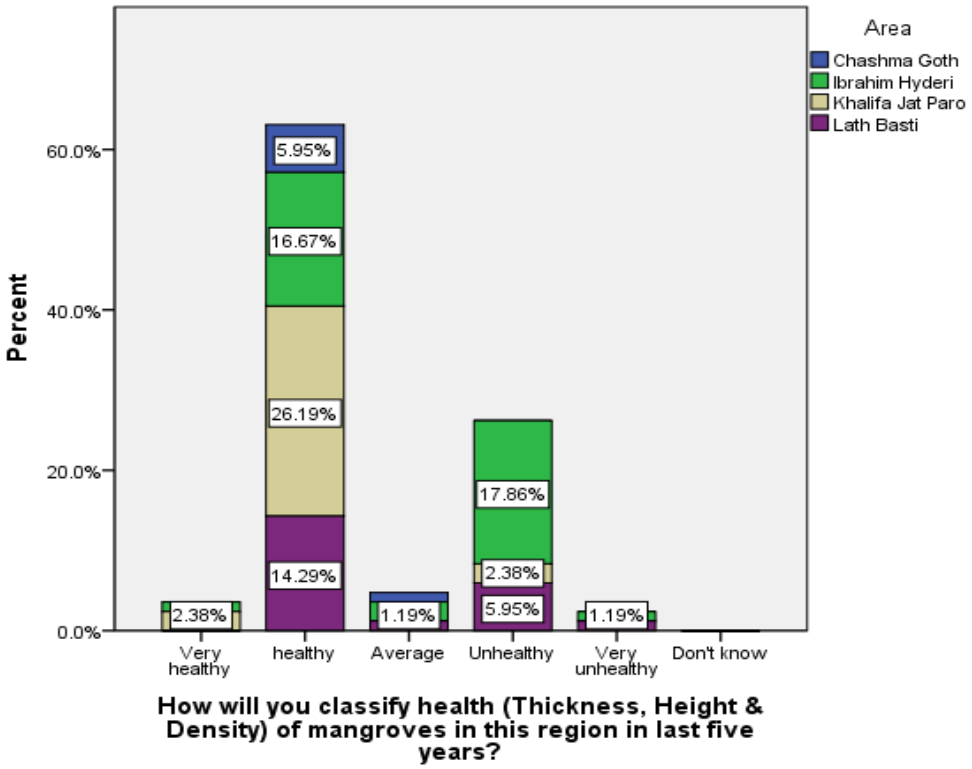
Count

How will you classify health of mangroves in this region in last five years?	Has the fishing/shrimp/crabs yield changed in the last five years in this area?					
	1	2	3	4	5	**Total**
Very healthy	2	2	0	0	0	**4**
healthy	33	10	2	1	8	**54**
Average	1	1	0	0	2	**4**
Unhealthy	16	5	1	0	0	**22**
Very unhealthy	0	1	0	0	0	**1**
Total	**52**	**19**	**3**	**1**	**10**	**85**

Table 7: Rank 1-5; Highest (very significant) to lowest (No change)

The perception of the local inhabitants about the health of Mangroves the area is given in figure 7. The actual observations from several locations show patchiness in the density of Mangroves in the study area (Figure 8 series of picture showing patchiness). Mean tree heights of *Avicenna marina* in PQA at seven randomly selected locations in PQA were evaluated (table 4, figure 8), falling in the range of greater than 2 meters to 6 meters and over. The mangroves density ranges 4-9 trees/$10m^2$ (Figure 9). Data of mangrove tree height (Figure 10) from seven locations was subject to ANOVA (table 8). The results indicate significant difference ($p<0.05$), between mangrove (*Avicenna marina*) tree heights. Regression between mangrove tree heights and density is given in figure 11.

Figure 7 The perception of locals about the health of Mangroves the area.



Avicenna marina measurement of diameter (BHD) for carbon biomass assessment, mature growth in less dense area

Growth and density of replanted *Rhizophora mucronata* seen amongst *Avicenna marina* introduced by Sindh Forest Dept off Rehri village PQA

Figure 8 Actual observations from several locations show patchiness in the growth and density of Mangroves in the study area

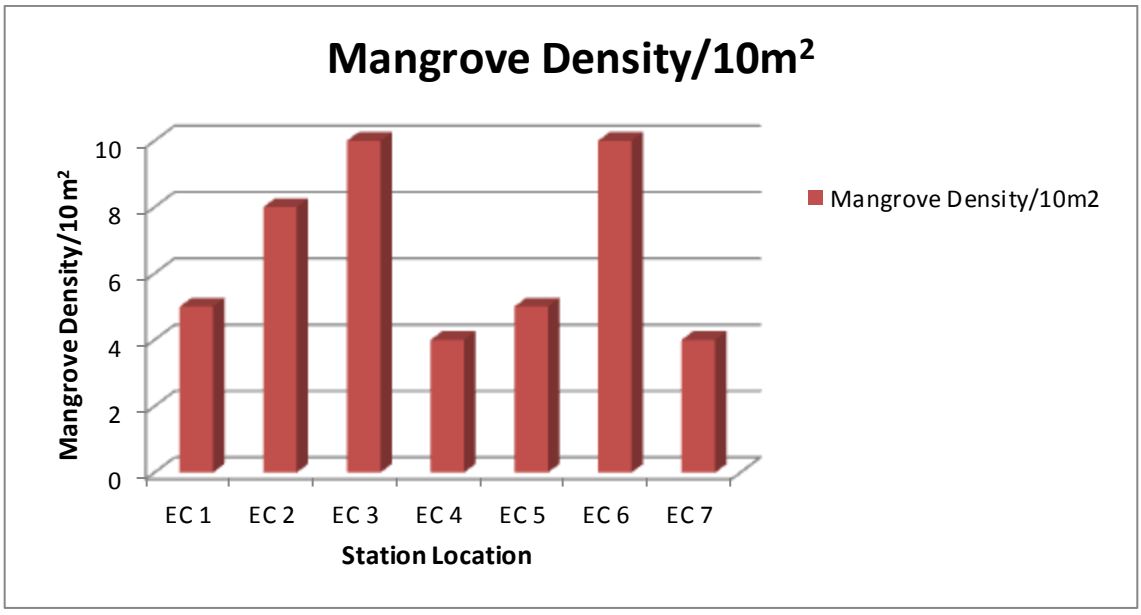


Figure 9. Graph showing mangroves density of *Avicenna marina* trees in approx.. $10m^2$ PQA study area

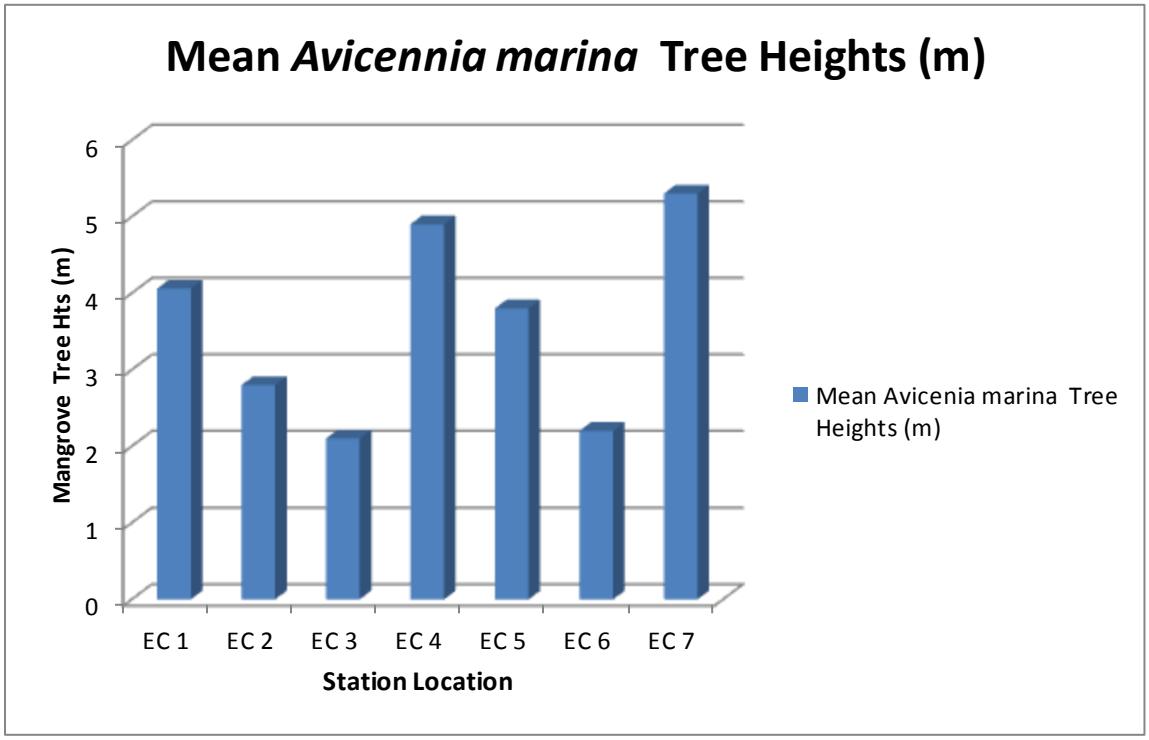


Figure 10 Graph of mangrove tree *Avicenna marina* height in meters in the study area.

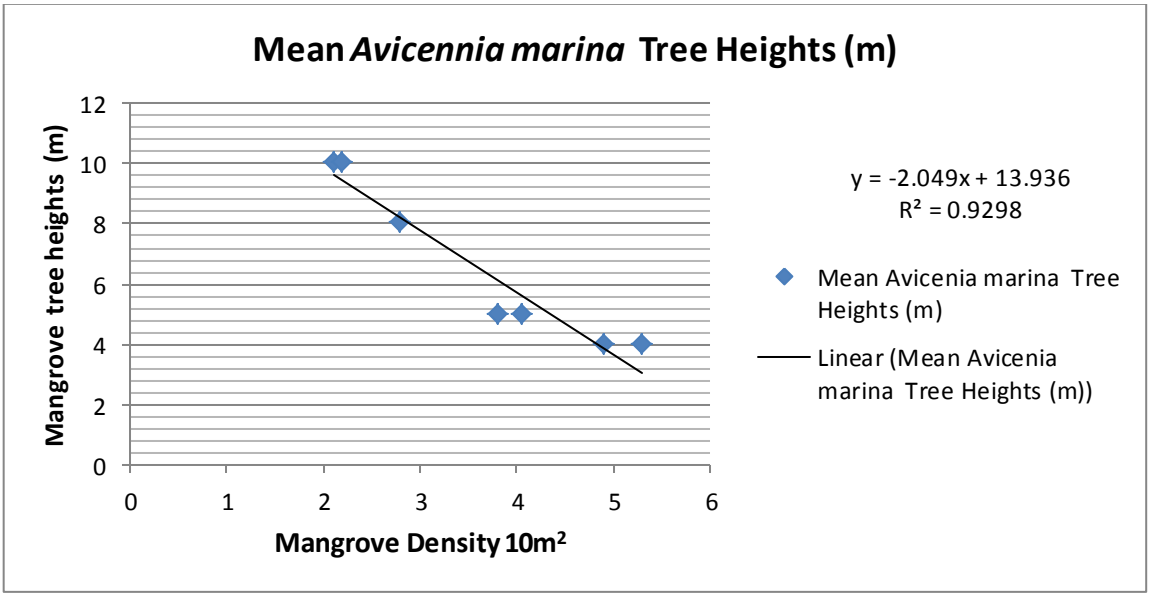


Figure 11 Regression between mangrove tree heights and density.

There is a strong positive (r^2 =0.929) goodness of fit between mangrove *Avicenna marina* tree height and their densities. Mangrove of >2.0 meters were evaluated for estimated Carbon biomass.

ANOVA

Avicenna marina (Mangrove heights) in PQA

	Sum of Squares	Mean Square	F	Sig.
Between Groups	48.407	8.068	8.566	.000
Within Groups	26.372	.942		
Total	74.779			

Table 8. Results of ANOVA on *Avicenna marina* (Mangrove heights) in PQA

The mangroves plants have a high biological productivity and are important to the nutrient budget of coastal waters. They export organic matter, mainly in detritus form (i.e. leaf litter) to the marine environment, thus providing a highly nutritious food source for marine fauna. Mangroves provide a habitat and breeding ground for a variety of marine life, particularly fish, shrimps and crabs. Since they act as nurseries and shelters for many species of commercially important finfish and crustaceans they are important for maintaining offshore fishery, as well as habitat for wildlife, such a loss would reduce available habitat for birds and juvenile fish, and the biodiversity of the local plants and benthic marine invertebrates.

7.7 Mangroves as Fuel Wood, Construction and fodder.

Household fuel consumption patterns in types of houses (Figure 12) show that nearly 22 percent of the resident communities do not use mangroves at all only 24 percent reported they use fire wood for cooking. This indicates that pressure on mangroves for fuel is slowed down. Most of the household (78 percent) uses gas as primary fuel for cooking. They use mangroves as fuel wood when gas pressure is too low and cooking is not possible or for domestic celebrations/functions. The mangroves mostly used as fuel (in cooking) in KATCHA house (mud and grass), few PACCA house uses mangroves as alternate fuel. On average 260 Kg/ Month (3,120 Kg/year/ HH). The total value of fuel wood consumption per year in these four locations is PKR 274 million (estimated).

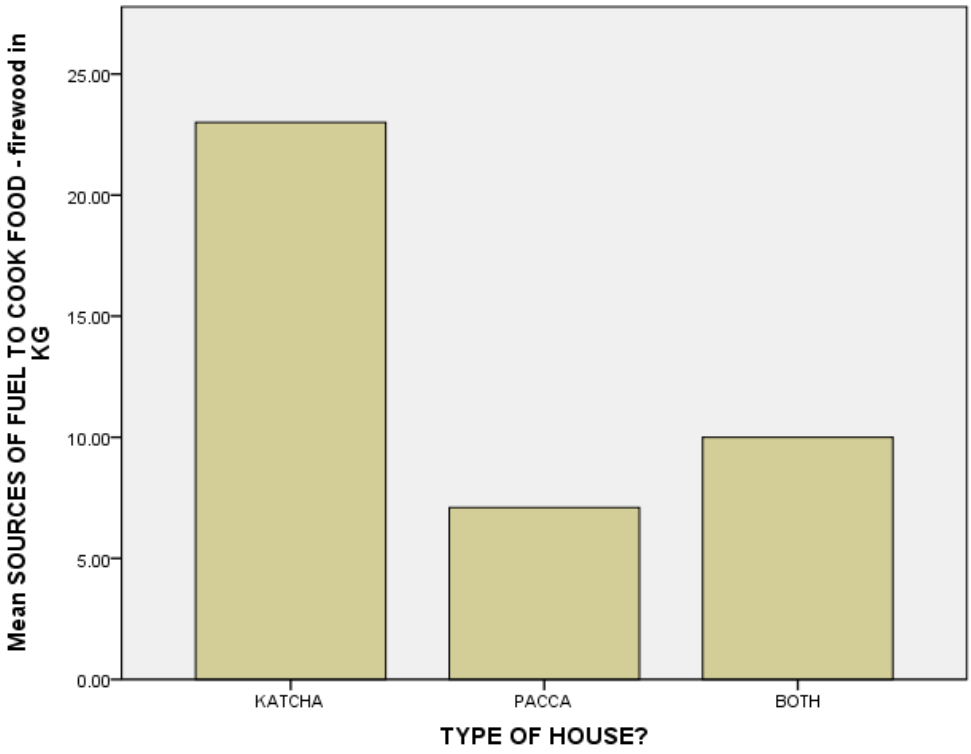


Figure 12. The mangroves mostly used as fuel (in cooking) in KATCHA house

Mangroves are a valuable resource for many of the coastal villages. They are primarily used as a source of fuel. A small percentage of Local inhabitants from Ibrahim Hyderi and Reheri village are in the business of cutting and selling mangrove wood as fuel wood. The type of wood they cut are dry, they termed it as dead wood. The wood is used as a fuel by the locals and the fishermen for preparing meals. Mangrove wood is also used as fuel wood for preparation of elaborate meals during festivities (wedding ceremonies, etc). The respondents' conveyed that the mangrove wood selling business has been severely affected due to the availability of gas (cheaper option) which has replaced mangrove wood as a fuel. After supply of natural gas mangrove wood is no more a primary source of fuel in the four villages. But some household are still using it as firewood. According to survey estimates a total of 134,853 mounds are used per month valued at PKR 26.97 million per month and PKR 323.65 million per year. Location wise consumption of mangroves by households as firewood is shown below (table 9). Mangrove fuelwood stalls located in the study area is given in figure 13. Continued availability of cheaper option (gas) would continue to curtail the mangrove fuel wood business for the coastal villages. Mangrove fuelwood consumption in different location values in Figure 14.

Village	Total Fuelwood Consumption in Mound (40Kg) per Month	Value in PKR Per month	Value in PKR Per Year
Ibrahim Hydari	83,813	16,762,576	201,150,914
Chasma Goth	18,263	3,652,646	43,831,751
Khalifa Jat Paro	22,459	4,491,885	53,902,620
Lat Basti	10,317	2,063,460	24,761,518
TOTAL	134,853	26,970,567	323,646,803

Table 9 Location wise consumption (Mds) of mangroves by households as firewood

The mangrove species *Avicennia marina* that is found in abundance in this region has a curving bark that is not suitable as scaffolding or for use as the skeleton. So only those who cannot afford good quality timber opt to use it. The survey team saw these curvy barks are used in KACHA houses for roof and fencing.

Figure 13 Mangrove fuelwood stalls in the study area

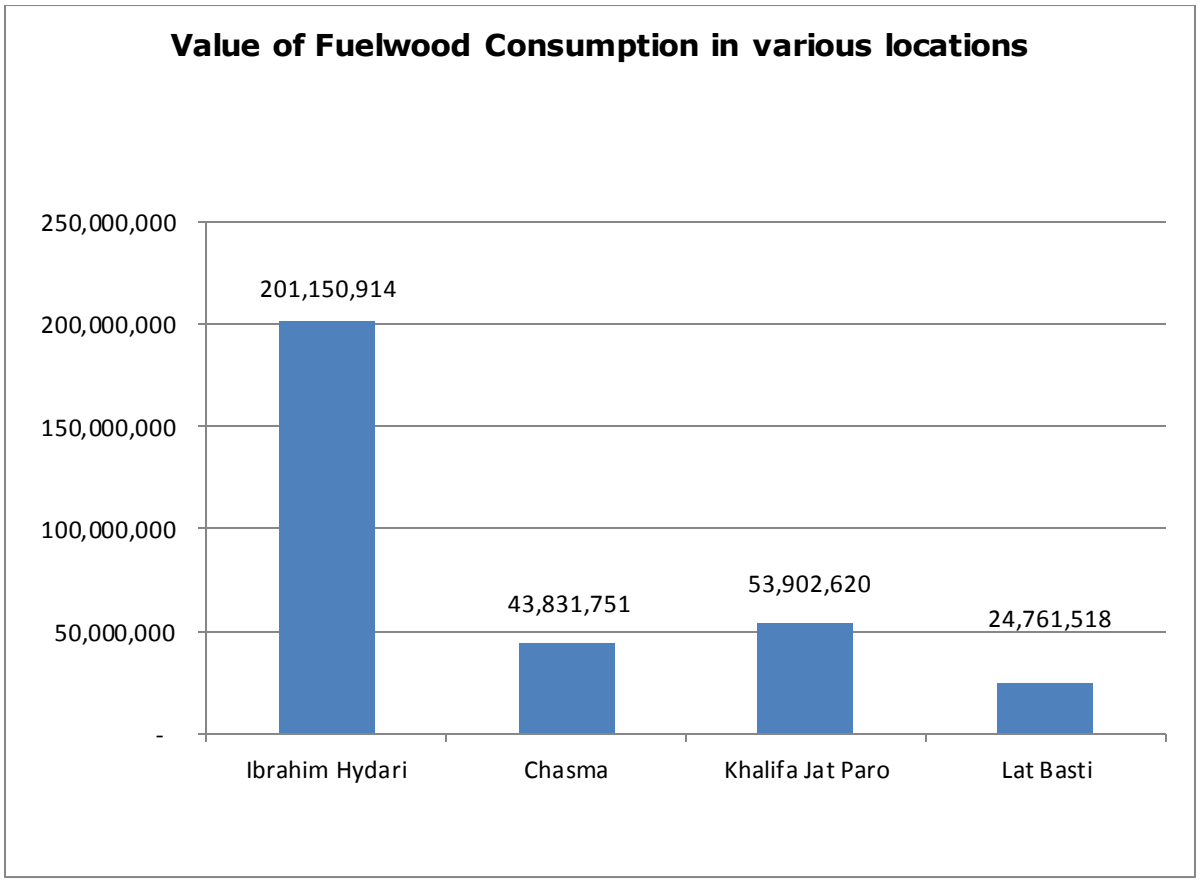


Figure 14 Mangrove fuelwood consumption in different location value in 000' PKR

The survey team was informed that the mangrove wood was also used for making crates for use by the fruit packaging industry. Ice cream sticks were also made from mangrove wood.

Though after supply of natural gas mangrove firewood is no more a primary source of fuel in Korangi creek area yet it is used by poor people. The type of house and size of household are crucial in using mangroves as firewood. But again the extent of relationship is important In order to determine the economic significance of mangrove as firewood. The relationship among use of mangroves as fuel wood and household size and type of house, ordinary least square (OLS) regression was run. White heteroskedasticity-consistent standard errors & covariance method was used to control any adverse effect of hetroscdasticity. Following table shows that although relatively few household use mangroves as fuel wood yet there is significant relationship between fuel wood and household size (HHSIZE). According to the results obtained, when as household size increase proportionately firewood consumption is increases more than that of. There is negative relationship between PACCA house and the banchmark categary that is KATCHA house. This shows PACCA houses dwellers' consumption of fuelwool was 36% lower, but it is statistically insignificant same is the case with BOTH category of houses. Hence only household size(HHSIZE) is statistically significantly related to firewood. The R-square of this regression is 0.46 showing that 46% variation in the amount of firewood is explained by our model. This is a good explanatory power of the model keeping in mind that we are dealing with cross section data. The overall model is also statistically significant at 10 % level.. (Table 10)

Relationship of Fuelwood use with HH size and type of house (PACCA)				
Dependent Variable: LOG(Fuel wood)				
Method: Least Squares				
Sample (adjusted): 11 84				
Included observations: 15 after adjustments				
White Heteroskedasticity-Consistent Standard Errors & Covariance				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.36142	1.829212	-1.29095	0.2232
LOG(HHSIZE)	1.872259	0.741098	2.526332	0.0282
Q6=2 (PACCA)	-0.36308	0.540106	-0.67223	0.5153
Q6=3 (BOTH)	0.770752	0.458569	1.680776	0.1209
R-squared	0.467727	Mean dependent var		2.15421

Adjusted R-squared	0.322561	S.D. dependent var	1.201098
S.E. of regression	0.988584	Akaike info criterion	3.038092
Sum squared resid	10.75028	Schwarz criterion	3.226905
Log likelihood	-18.7857	Hannan-Quinn criter.	3.03608
F-statistic	3.222027	Durbin-Watson stat	1.327182
Prob(F-statistic)	0.065089		

Table 10 Relationship of Fuelwood use with HH size and type of house (PACCA)

7.8 Fodder for Domestic Animals

Mangrove leaves are a source of food for cattle and camels and are considered to be very nutritious. On the basis of our survey, we have calculated domestic animal grazing of mangroves equal to 2 million kg per year and at PKR 15 per Kg the economic value of it, is estimated a little above PKR 31 million. Location wise consumption of mangroves by cattle is shown below (Figure 15). Figure 16 provides estimated livestock consumption of Mangrove in 000' PKR The food for domestic animals (Figure 17 & 18) freshly cuts Mangroves leaves and seeding as fodder are supplied for domestic animals on a daily basis.

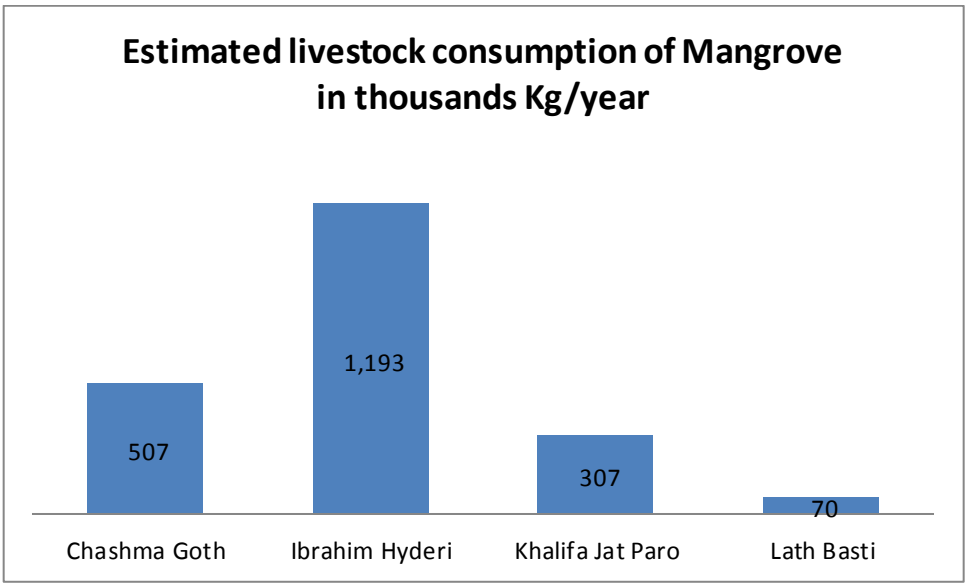


Figure 15 Estimated quantity of livestock consumption of mangroves

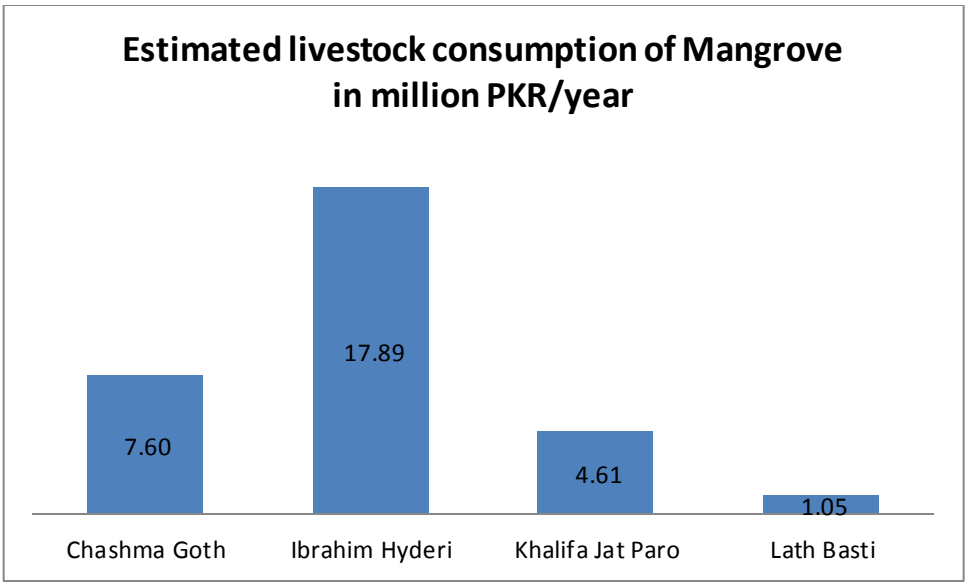


Figure 16. Estimated livestock consumption of Mangrove in million PKR/year

Figure 17. Freshly cuts Mangroves leaves as fodder are supplied for domestic animals on a daily basis.

Figure 18. Mangrove seedlings are collected and dried and used as food for domestic animals in Rehri Goth.

7.9 Shannon Weaver Biodiversity Index

Shannon Weaver diversity index is a tool for measuring the health of the ecosystem. Epipelagic Fauna from the observed station locations of EC 4 (1.146) and EC 6 (1.0) show a relatively higher biodiversity of MBI in PQA (Diversity ranges from 0.1-3.0). The epipelegic species show a relatively even distribution at sampling stations EC 1 (0.841), EC 3 (0.898). The normal range for evenness (J') is from 0.1 to 1.0. PQA is a designated industrial area, creeks system are a disturbed due to industrial activity, and therefore both species diversity and species richness are relatively low (Table 11). Figure 19 show the species observed in at the sampled locations.

Index	EC 1	EC 2	EC 3	EC 4	EC 5	EC 6	EC 7
Shannon H' Log Base 10.	0.802	0.161	0.628	0.274	0.577	0.418	0.201
Shannon Hmax Log Base 10	0.954	0.778	0.699	1.146	0.903	1	0.699

Shannon J'	0.841	0.207	0.898	0.239	0.639	0.418	0.288

Table11. Shannon Weaver Diversity Index in for marine benthic invertebrates PQA

Crab and mud skipper

Crabs and mud skippers are the first to re-colonize degraded mangrove areas


Epifauna observed in the mangrove ecosystem at low tide in PQA


Bivalve, barnicles and Uca crab.


Figure 19 Diversity of fauna bivalves, gastropods, crustaceans etc. observed at the study area

7.10 Primary Productivity and Fish Biomass

The overall Productivity in the mangrove areas is reported to be high (365-780gC/m^2/year, IOC 1994), compared to coastal waters (50-200gC/m^2/year), which accounts for greater potential for fisheries yield in the PQA (64,000ha) mangrove area. Table 12.

Mean Primary Production	PQA Area (m^2)	Transfer efficiency (across two trophic levels)	Fish Production Biomass (mtC/year)
572.5 gC/m^2/year	$6.4x10^8$	0.1 x 0.1 = 0.01	36,640mtC/yr

Table 12. Primary productivity and Potential fish productivity in the PQA area

The standing stock of plant biomass represents the 'natural capital' of the PQA ecosystem that is combined with nutrients, water, and abiotic components to maintain the existing biomass, and create new biomass essential for the well being of the Indus delta. They support the growth of phytoplankton which serve as the food for zooplankton as well as larval stages and juveniles of fish and crustaceans, they also serve as food for filter feeders and benthic marine invertebrate (MBI). If there is any limitation, it is due to water turbidity that restricted the photic zone. Higher concentrations of nutrients result in overproduction and subsequently leading towards exhaustion of dissolved oxygen in the seawater.

7.11 Fishery Resources in PQA

The local inhabitants of coastal communities surveyed were related to fishing or fishery related professions. The table 13 shows the fishing effort, number of times a typical boat undertakes fishing activity and the number of days spent out at sea fishing

Locations Surveyed	Average number of days spent in one trip	Number of times (trips) in last month	Fish Catch in Kg. per trip	Shrimp Catch in Kg. per trip	Crab Catch in Kg. per trip
Chashma Goth	30.00	1.00	24333	816.67	.
Ibrahim Hyderi	5.00	9.27	1250	950.00	1050
KhalifaJat Paro	7.67	2.71	162	273.00	.

Laat Basti	8.84	2.00	.	176.59	.

Table 13 Fishing effort, number of boat undertaking fishing activity

The survey data indicate reductions in the catch of different fish species from the survey locations over the last five years, as reported by the locals. 52 households out of 85 responded a very significant reduction in fish catch, similarly another 19 out of 85 responded to a significant reduction in fish catch, this shows 83% percent responded to a reduction in catch had occurred. Only one household reported insignificant (no) change in fish catch.

		Average Total Expenditure (Boat)	Average Total Income from (Boat fishing)	Average Total Value – Fish	Average Total Value - Shrimp	Average Total Value - Crab	Fish Catch	Shrimp Catch	Crab Catch
		PKR	PKR	PKR	PKR	PKR	Kg	Kg	Kg
How many times (trips) you went on fishing in last month?	1.00	821,963	4,733,983	4,339,167	473,780	.	16,677	1,790	.
	2.00	86,566	177,420	816,250	56,163	.	200	204	.
	3.00	171,214	499,550	280,500	97,333	336,933	870	370	512
	4.00	52,000	100,000	.	.	100,000	.	.	.
	5.00	165,000	307,333	161,000	300,000	.	1,375	1,000	.
	8.00	20,000	.	.	.	.	.	.	.
	12.00	87,300	53,750	27,750	16,000	20,000	1,500	900	1,200
	15.00	359,500	60,000	20,000	20,000	20,000	1,500	1,500	1,500
	19.00	79,800	397,100	199,500	190,000	7,600	950	475	380
	26.00	117,000	468,000	260,000	.	208,000	.	.	.
	30.00	171,000	.	.	.	.	-	-	.

Table 14 Average values -per trip

Table 15 shows number of days in out at sea.

		Average Total Expenditure (Boat)	Average Total Income from (Boat fishing)	Average Total Value - Fish	Average Total Value - Shrimp	Average Total Value - Crab	How much you produce from - Fish	How much you produce from - Shrimp	How much you produce from - Crab
		PKR	PKR	PKR	PKR	PKR	PKR	PKR	PKR
Number of days in one trip	1	79,829	246,275	124,875	76,667	63,900	920	730	1,027
	2- 5	243,700	205,900	119,167	204,000	.	1,517	867	.
	6-10	60,257	134,175	156,313	64,604	366,667	514	239	750
	11-15	348,850	896,700	1,725,000	42,000	10,800	900	160	36
	16 and above	936,571	5,674,180	5,200,400	473,780	.	20,000	1,790	.

Using market price approach total market value of fish products is estimated at PKR 4.47 billion/year[4]. Fish products include Fish, Shrimp and Crab. Annual market value estimates of total fish shrimp and crab catch are PKR 2.824 billion/year, PKR 1.179 billion/year and PKR 0.46 billion/year. Location wise total market value of fish products is shown below in Figure 20, table 16. The total value of fisheries products catches per year in these four locations is PKR 6.4 billion/year (estimated at the value reported by fisherman). On the other hand if we use average market value (fish=PKR 150/Kg, shrimp = Rs 250/Kg and crab at PKR 300/=) our estimated value is at PKR 4.47 billion /year.

Location	Total Value by type (PKR Million/Year)			Yearly Total Value (PKR Million/Year)	Total Value by type (PKR Million/Year)			Total Value (PKR Million/Year)
	Fish	Shrimp	Crab	(As reported)	Fish	Shrimp	Crab	(using mkt value)
Chashma Goth	1,217	57	-	1,273	821	46	-	867
Ibrahim Hyderi	3,739	953	342	5,034	1,992	1,103	462	3,557
Khalifa Jat Paro	34	51	-	85	11	30	-	41
Laat Basti	-	4	-	4	-	7	-	7
		-	-	6,396	-	-	-	4,472

Table 16 Estimated values of fish catch using market price approach

[4] Market value calculated at the fish landing site.

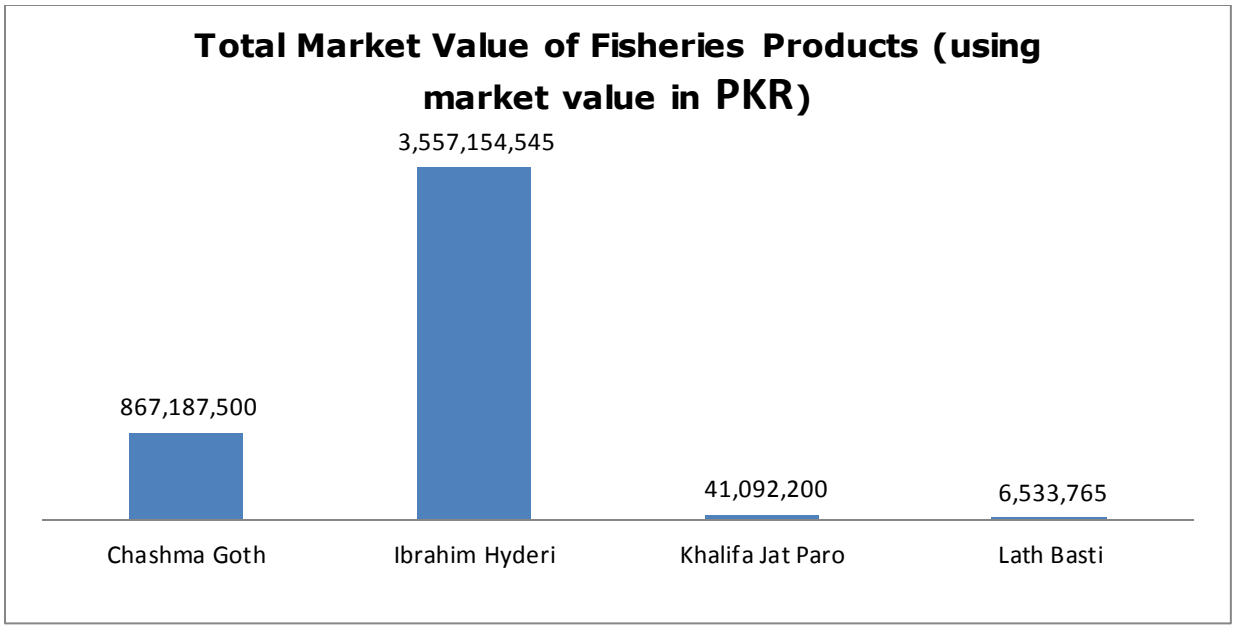


Figure 20. Total market value of fishery products from the study area in PKR.

Fishery resources (Figure 21) particularly exports of shrimps, have been the main source of foreign exchange in marine fisheries over the past four decades. From less than USD 15 million/year in the early seventies, official exports have risen twenty-fold to around USD 320 million/year in the 2014. But exports have stagnated in recent years.

Figure 21. Fish landing at fish landing locations in the study area

Around 150,000 men and women are engaged as fisherfolk. In use are around 25,000 craft of various types and sizes, ranging from small sail boats to medium sized and large mechanized launches. Principal fishing crafts used by the community are Horas, which are mostly sailboats with outboard engines (figure 22). Gillnetters and trawlers used inboard engines. Trawlers are specially designed craft for catching shrimps but gillnetters are frequently used also for trawling. Both gillnetters and trawlers are owned by the community as well as outside commercial interests. Most community fishing is done in creeks and the sea within the 12 miles of coastal waters under provincial jurisdiction. Depending upon the season, the fishing activity can keep the crew for a few days to fortnight in the North East Monsoon period, winter months.

Figure 22 fishing crafts used for catching fish in PQA creeks

7.12 Recreation and Tourisms

Out of four locations surveyed in PQA area, only at one location (KhalifaJat Paro) the community reported that they use their boats for tourism purpose. (Figure 23) Out of 18 boats (Hora type with outboard engine), 11 were engaged in tourism activity, which is around 61% of boats station at the village. The average earning from of individuals from tourism was reported to be PKR 10455/= per month per boat. The NGO "HANDS" built a concrete jetty on this location for the purpose of promoting tourism. The total value of tourism income generated per year is estimated at PKR 4.6 million.

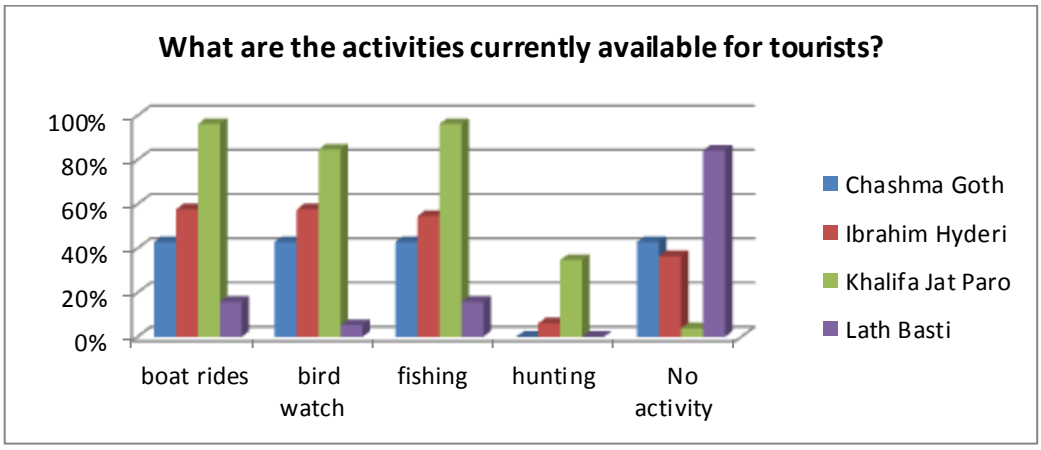


Figure 23 Tourist activities in the study area

Other three locations catered for tourist activity on the availability of the boat, and as and when need arises which can be termed as occasionally (figure 24). Some tourism activity was also witnessed at the near the Mazar in PQA (figure 25). During weekends local tourist flock this location and also enjoy a boat ride Rs 2000/trip to the mangroves lasting for about an hour.

Figure 24 Recreation location at Khalifa Jat Paro in surveyed area

Figure 25 Picnickers at the PQA mazar site

7.13 Carbon Sequestration Mangrove Tree Height verses Diameter in PQA

Figures 26 and 27 shows a positive linear regression between Mangroves tree and CO2 Sequestered and Mangrove diameter and CO2 Sequestered

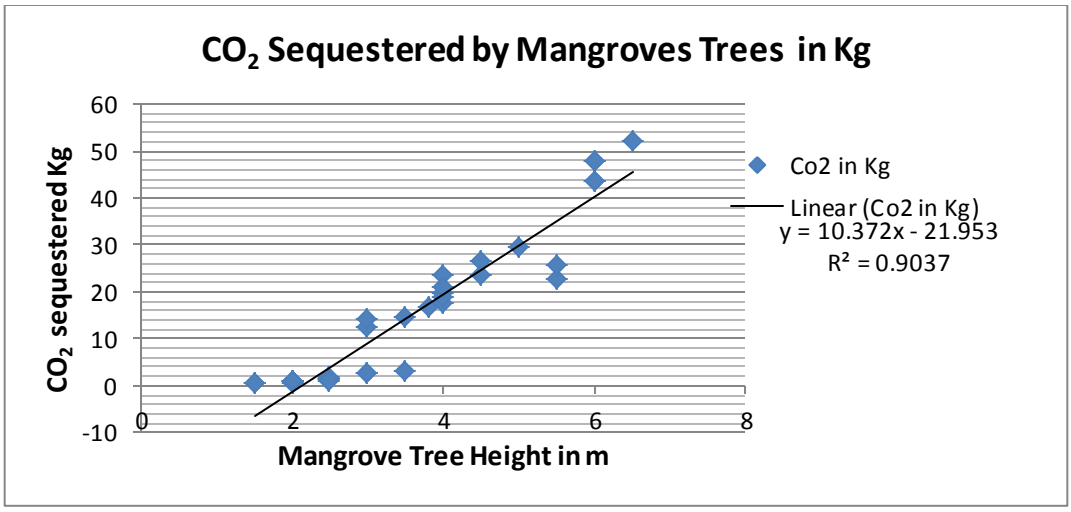


Figure 26 shows a positive linear regression between Mangroves tree and CO2 Sequestered

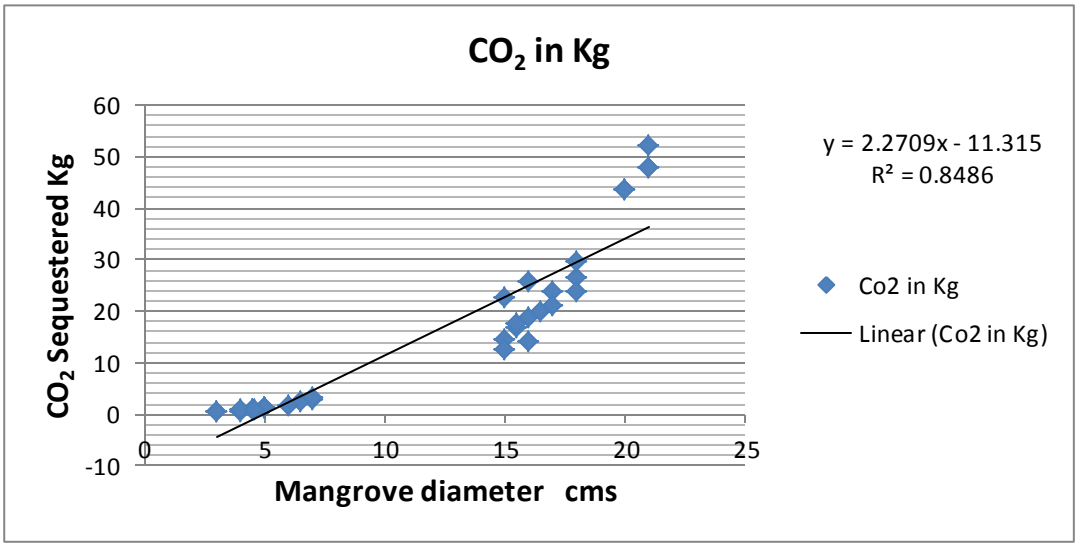


Figure 27 Mangrove tree diameter and CO2 Sequestered

Table 17 shows the result of regression analysis, carbon dioxide sequestered per year is dependent and diameter and height of mangroves are independent variables. We have total 35 observations 5 observations for each location. Coefficient of diameter (β) and height (λ) shows the impact of diameter and height on carbon dioxide sequestered per year in kg; t-value shows the significance of coefficients, R-square is goodness of fit and P-value shows the significance of model.

Carbon dioxide sequestered kg per year = $\alpha + \beta$ Diameter + λ Height + μ

β= Coeff. Of Diameter which shows the increase in one cm diameter of mangroves tree leads to β kg increase or decrease in carbon dioxide in Kg $^{-1}$on average per year.

λ = Coeff. Of Height Which shows the increase in one feet height of mangroves tree leads to λ kg increase or decrease in carbon dioxide in Kg $^{-1}$on average per year

Dependent Variable is Carbon dioxide sequestered per year

Observation Area	Coefficient of Diameter		Coefficient of Height		R-Square	P-Value
	β	t-value	λ	t-value		
Total Area	0.84	3	6.99	5.77	0.92	0.00
EC1	1.19	4.3	6.97	3.98	0.99	0.00
EC2	0.62	4	0.45	1.58	0.99	0.00
EC3	0.52	11	0.17	2.2	0.99	0.00
EC4	2.27	1.03	2.81	0.34	0.99	0.00
EC5	1.4	11	5.78	3.1	0.99	0.00
EC6	0.68	1.4	7.58	3.8	0.95	0.00
EC7	3.97	47	4.58	29	0.99	0.00

5% significance Level

Table 17 Result of regression analysis, carbon dioxide sequestered per year is dependent and diameter and height

According to our results one cm increase in diameter of mangroves tree leads to increase of approx. 0.84 kg carbon sequestered on average and one meter increase in mangroves height leads to increase 6.99 kg carbon sequestered on average within the PQA study area of Indus delta.

The biomass carbon content values from the predominant *Avicenna marina* mangroves trees (above soil) of PQA area, is estimated at 33.795 tons/ha. The biomass carbon content values of mangroves from other parts of the world range from 25 t CO_2 /ha to 2,254 t CO_2 /ha (Pandey & Pandey 2013, Samantha, et. al., 2011, Matsui, et. al., 2010). The carbon dioxide sequestered by mangrove plants for the dense, moderate and sparse mangroves of Gujarat (India) is 95.3 t /ha, 39.1 t/ ha and 19.3 t/ ha respectively (Pandey & Pandey 2013).

7.14 Replanting of mangroves in PQA

The local communities have been overexploiting mangrove forest wood resource for many years. IUCN has, in association with Sindh Forestry Department, initiated a program of mangrove conservation, replanting and sustainable management along the coastline of Rehri village. Clearing of mangroves can rapidly result in significantly reduced carbon stores the present work has reiterated the importance of mangrove vegetation and its planting

efforts for sequestering carbon and as a counter-measure of mitigating the climate change in the tropical coastal domain.

Engro Elengy Terminal (Pvt) Limited (EETPL) is constructing a Liquefied Natural Gas Terminal in Port Qasim Area (PQA), inclusive of ship berthing and import facilities, floating storage tanks and regasification equipments. The construction phase has resulted in the conversion of 50 ha of coastal mangrove ecosystem into reclaimed industrial land (Figure 28).

Figure 28 Mangrove Rhizophora mucronata seeding planted by Engro Elengy in PQA designated areas

In order to mitigate the impact of the construction on natural mangrove ecosystem and to compensate for the loss of mangrove cover, IUCN under it's Business and Biodiversity Program is working with Engro Elengy Terminal Limited to enable it to implement a project titled "Restoration of Mangroves Ecosystem in Port Qasim Area" with the objective "To restore the mangrove plantation on 500 ha over two years at the selected locations of Port Qasim Area."

- The likely benefits of this initiative will be
- Establishment of 500 ha of mangroves within the PQA, resulting in a net gain of 450 ha of mangrove habitat over pre Elengy project conditions;
- Improved air and water quality and carbon sequestration;
- Enhanced coastal protection from erosion and storm surge;
- Increased abundance and diversity of indicator species;
- Increased availability of mangrove ecosystem services in nearby communities;
- Increased awareness of the value of mangrove ecosystems and more sustainable use; and improved land use decisions.

PIBT is taking a step towards fulfilling its corporate social and environmental responsibility by partnering with the International Union for Conservation of Nature (IUCN) for the conservation and plantation of coastal mangroves. PIBT and IUCN Pakistan have signed an agreement to undertake the restoration of the mangrove plantations in PQA Indus delta. PIBT recognizes the importance of mangroves forest and is contributing towards greening and protecting the coasts by planting mangroves species of *Avicenna marina* and *Rhizophora mucronata* inover 1200 acres in the Port Qasim area. PIBT is also raising awareness among the coastal communities for promoting sustainable use of mangrove forest with the help of IUCN PIBT (Figure 29).

Figure 29 Mangroves nursery of *Rhizophora mucronata* at PIBT site in PQA

Pakistan Navy in line with the prime minister's vision of 'Green Pakistan' launched mangroves plantation campaign in the coastal areas of Sindh and Balochistan. Being a major stakeholder of the maritime domain and realizing the importance of mangroves for marine life, Pakistan Navy has taken a major initiative to revive mangrove forests all along the coast.

8. Society and Economy

Mangrove ecosystems do not exist in isolation but are linked through material, hydrological and nutrient cycling and energy flows with neighboring ecosystems. Improper management of one component of the resource, such as mangrove forestry, can therefore result in significant economic losses elsewhere, such as the coastal and offshore fisheries.

A problem, apparent for most ecosystems but particularly acute for mangroves, is establishing the ecological linkages between the various resource components. These ecological linkages are considered to be very significant but poorly understood, making it difficult to accurately measure the impact on using the resource for productive uses or the impact of a change in environmental quality.

For example, mangroves may serve as an important habitat for part of the life cycle of commercially valuable fish species (e.g., shrimps, mullet, and coastal fish). Part of the value of coastal or inland fisheries outside of the mangrove area may be attributable to this vital mangrove support. Ideally, it would be useful to know the net loss in productivity of these fisheries if the mangrove area is no longer able to support them. The value of this change in productivity would thus approximate this support service's contribution. In practice, however, it is extremely difficult to estimate the 'value added' provided by the mangrove to external fisheries or any other economic activity that it may be supporting due to the uncertainties surrounding the ecological linkages.

The largest concentration of marine fishermen fish harvesters and workers are within Karachi division. Much of the population in Ibrahim Hyderi and Rehri coastal villages can be traced to the migration forced upon coastal communities by upstream dams and barrages. The remaining Sindh population of marine fisherfolk is found largely within Thatta district. Almost all of the economical fishing (including shrimp trawling) is concentrated around the sea port of Karachi, which also buys much of the commercial catch from Balochistan because of its poor infrastructure for exports.

Principal fishing crafts used by the community are Horas, which are mostly sailboats with outboard engines. Gillnetters and trawlers used inboard engines. Trawlers are specially designed craft for catching shrimps but gillnetters are frequently used also for trawling. Both gillnetters and trawlers are owned by the community as well as outside commercial interests.Smaller wooden fishing crafts locally known as *Yakdar* or *Horra* account for about 64% of the total fishing craft. These fishing crafts operate in shallow waters closer to the coast and on a typical fishing trip may last from one to several days. The larger fishing vessels known as mechanized launches remain at sea from four weeks to three months period.

The total market value of mangrove area in Korangi/phitti Creek. It includes Ibrahim Hydri, Laat Basti, Khalifa Jat Paro, Chashma Goth etc. is given in table 18 and figure 30 shows that total market value of mangrove in our targeted area is Rs 6.75 billion per year in which fish products(Fish, Shrimp and Crab) are the main source of income with a market value of Rs 6.39 billion, Fuel wood contributes 0.323 billion, fodder's annual market value is Rs 3.11 million. Though this area has great tourism potential but only Khalifa Jat Paro reported tourism worth mentioning with Rs 4.6 million

Location	Fisheries products	Fuel Wood	Fodder	Tourism	Total
Chashma Goth	1,273,230,000	43,831,751	7,602,069.00		1,324,663,820
Ibrahim Hyderi	5,033,773,687	201,150,914	17,890,826.00		5,252,815,427
Khalifa Jat Paro	84,648,600	53,902,620	4,610,560.00	4,591,836	143,161,780
Laat Basti	4,492,787	24,761,518	1,045,635.00		30,299,940
Total	6,396,145,074	323,646,803	31,149,090	4,591,836	**6,750,940,967**

Table18. Total Economic Value in PKR Derived from the Mangrove Products

Location wise total market value of mangroves is shown below in Graph

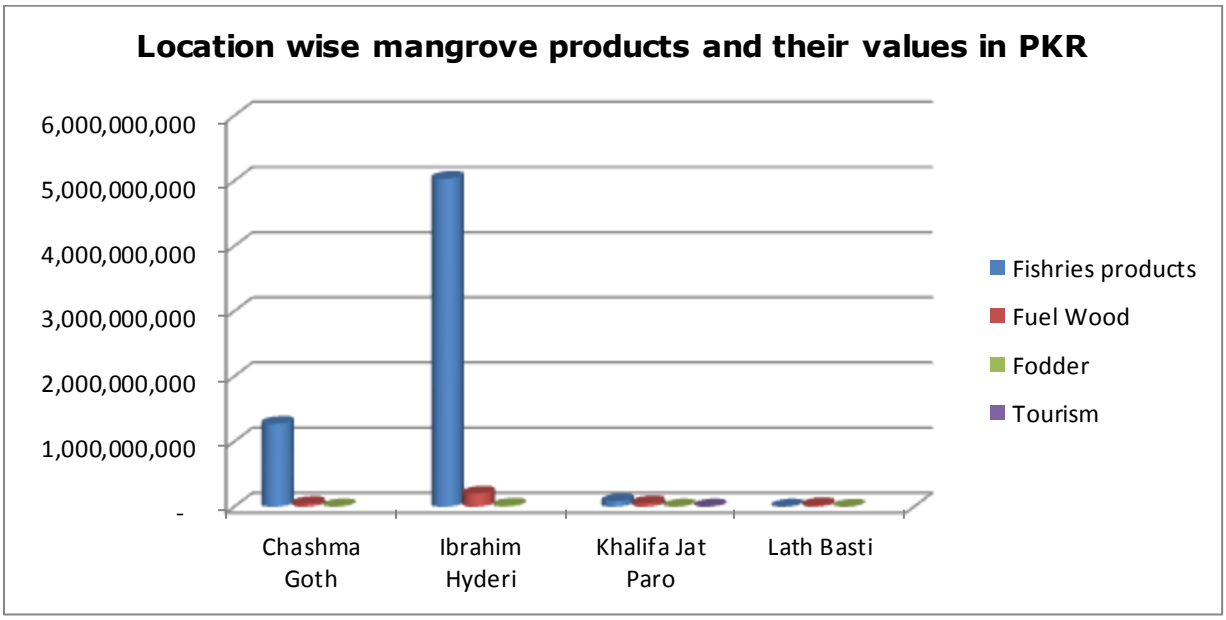


Figure 30 Location wise mangrove products and their values in PKR

9. Discussion

The total market value of mangrove in our targeted area is estimated at PKR 9.24 billion/year (table ….) in which fish products (Fish, Shrimp and Crab) are the main source of income with a market value of PKR 6.39 billion/year, Fuel wood contributes PKR 0.323

billion/year, fodder's annual market value is PKR 3.11 million/year. Though this area has great tourism potential but only Khalifa Jat Paro reported tourism worth mentioning with PKR 4.6 million/year. Carbon dioxide sequestered per year in our targeted area is estimated at PKR 2.52 billion/year.

Total Economic Value (EV)		
Source	**PKR (millions)**	**USD (millions)**
Fishries products	6,396.15	60.34
Fuel Wood	323.65	3.05
Fodder	2.08	0.02
Tourism	4.59	0.04
Carbon Sequestration	2,521.92	23.79
Total EV in PQA area	9,248.38	87.25
	PKR	**USD**
Total EV per hactre	144,506	1,363

Tuan and Tinh (2013) mentioned some use and non-use values associated with mangrove forests which they took from Barbier (1997) which are given as follows.

Use values			**Non-Use values**
Direct use value	**Indirect use value**	**Option value**	
■ **Fishing**	■ Nutrient retention	■ Potential future uses (as per direct and indirect uses)	■ Biodiversity
■ **Agriculture**	■ Flood control	■ Future value of information	■ Cultural heritage
■ **Fuel wood collection**	■ Storm protection		■ Bequest values
■ **Recreation**	■ Groundwater recharging		
■ **Transport**	■ External ecosystem support		
■ **Harvesting wildlife**	■ Microclimatic stabilization		
■ **Peat/energy**	■ Shoreline stabilization		

Source: Tuan and Tinh (2013)

Tuan and Tinh (2013) used the Contingent Valuation Method (CVM) which is known as the non-market valuation method in order to perform economic valuation of conservation and restoration of mangrove forests in Thi Nai lagoon. CVM is a survey based approach that develops a hypothetical market which can be used by an individual to state his/her willingness to pay in a particular location for the conservation of an environmental service. Findings of the study suggest that in Thi Nai lagoon, most of the households, involved in this study, are willing to pay for mangroves' non-use value and for mangrove restoration. Their willingness to pay differs across household's level of income, employment, education, gender and age. They found that over four years about VN$ 17.7 billion of investment in restoring 150ha of mangroves will lead to generate about VN$32 million in return.

Hema and Devi (2015) used CVM in an attempt to carry out the economic valuation of ecological benefits of mangroves using both primary and secondary data in the case of Kerala, India. They found that the average willingness to pay by the respondents was IRS 2308/year (Indian rupees/year), thus the total economic value of the mangrove ecosystem of the state was 117, 947 million in Indian rupees.

Do and Bennett (2005) used the Contingent Valuation method to find out the total economic value of goods and services available at wetland in Mekong River Delta, Vietnam using both primary and secondary data. They mainly focused upon the direct use value of the wetland resource. Their findings suggest that the wetlands under study for aquaculture, fuel wood, captured fisheries, timber, medical plants and Nypa fruticans have the direct uses, whose estimated average value is around VND 7, 549, 824 or AUD 982 per ha per year. They found that among all the direct uses, aquaculture occupies the highest value which is about 48 percent of the total.

Gunawardena and Rowan (2005) presented an economic assessment for a proposal about a 42 ha large shrimp culture development in Rekawa Lagoon system, Sri Lanka. The assessment involved two types of analyses (i) an extended cost and benefit analysis of the proposal and (ii) the total economic valuation of a mangrove ecosystem. Their results indicated that the internal benefits of shrimp farm development outweigh the internal costs by the ratio of 1.5:1. On the other hand, they found that the external costs are much larger than the external benefits for which the ratio ranges between 1:6 and 1:11. For total economic valuation they took into consideration the direct use value, indirect use value, option value and bequest value. The direct use value involved the net benefits of forestry, net benefit of lagoon fishery and net benefit of coastal fishery. For the indirect use value they considered erosion control and buffer against storm damage. For bequest and option value they used they wiliness of individuals to contribute into a hypothetical fund for mangrove protection. For data they used both primary and secondary sources. They found the direct use value to be USD 758/ha/year, the indirect use value to be USD 300/ha/year

and the bequest and option value to be USD 2.6/ha/year. The total economic value therefore was estimated to be USD 1088/ha/year.

Baig and Iftikhar (2006) by using both primary and secondary data estimated the total economic value of mangrove ecosystem in the case of Miani Hor Village, Pakistan. For direct use value (Products of the ecosystem) they applied the market price method whereas for indirect use value (Services of the ecosystem) they used the does-response method. They found that the value of the direct benefits of mangrove ecosystem in Miani Hor was USD 1, 287 per hectare per year and for the whole village it was USD 4, 419, 935 per year. They found the value the indirect use of mangrove ecosystem to be USD 873 per hectare per year and for the whole village it turned out to be USD 2, 996, 976. Finally, they undertook a cost and benefit analysis in order to find out the rationale behind investing in the conservation of mangrove ecosystem. In doing so they compared the cost and benefit of transforming a hectare of mangroves into a shrimp form with a hectare of well managed mangrove ecosystem. They found the benefit of the shrimp form to be USD 10, 930, while that of the managed mangrove ecosystem was USD 11, 196. They concluded that investing in the conservation of mangrove ecosystem does make sense. They also concluded that the economic value of the habitat provided by mangrove ecosystem is substantially high which indeed is beneficial not only for the local economy but also for the national economy.

Our findings do not differ in terms of mangrove ecosystem services derived values obtained from other parts of the world. The total values calculated for our study area in (PQA) shows mangrove products and service is estimated at USD 1,363 /ha/year. Gunawardena and Rowan (2005) calculated the total economic value for Rekawa Lagoon system Sri lanka to be USD 1088/ha/year. Baig and Iftikhar (2006) found that the value of direct benefits of mangrove ecosystem in Miani Hor (Balochistan) was estimated at USD1, 287 per hectare per year.

10. Conclusion

The Avicennia *marina* is the dominant species of the mangroves in the Indus Delta. All other species are rare and have disappeared from most part of the Delta due to adverse environmental/ecological conditions Mangroves are an integral part of the coastal ecosystem and hence are crucial to the livelihoods of fisherfolk. They provide nurseries for fish and generally afford protection to and supply food for various species of fish. Most community fishing is done in creeks and the sea within the 12 miles of coastal waters under provincial jurisdiction. Few of the locally owned vessels venture into deeper waters of the

"Exclusive Economic Zone" under federal jurisdiction. Depending upon the season, fishing can keep crews gone for as little as few deep to as such as fortnight in the winter months.

Creeks around healthy mangroves become fishing grounds easily accessible to small fishermen. Coastal communities depend upon mangroves as a cheap source of fodder and fuel wood, as well as for other timber needs. By acting as a barrier, mangroves forests check intrusion and erosion of sea and natural disasters, thereby protecting both coastal crop land and homes. Sindh has suffered a substantial loss of mangroves acreage over the past fifty years. Some estimates place destruction between just the late 70s and mid 90s at nearly half of all mangroves. Much of the remaining mangroves Sindh coast, suffer from being stunted. Clearing of mangroves can rapidly result in significantly reduction of carbon stores. The current study emphasizes the importance of mangrove vegetation and its planting efforts for sequestration of carbon dioxide as a counter measure of mitigating the impacts climate change in the tropical coastal domain. Balochistan have been almost completely destroyed over the century because of scarcity of freshwater and lack of scientific management.

Livelihood of Coastal and Wetland Communities: Coastal and Aquatic areas are diverse and include productive habitats, ecosystems and natural resources which are important for coastal and wetland communities and settlements. They include mangroves, variety of fish, wildlife, agriculture and livestock resources. Fishing has been the mainstay of economic survival of coastal and aquatic communities. Mangrove forests have an international status. The wildlife in the coastal and wetland areas consists of both marine and terrestrial species and migratory birds visiting coastal and wetland areas every year. The total values calculated for our study area in (PQA) shows mangrove products and service is estimated at USD 1,363 /ha/year, these values do not differ from values calculated by other researcher.

Changing condition in coastal and terrestrial environments associated with degradation of environmental quality and the health of coastal ecosystems would threaten the survival of certain species and communities. The coastal domain is dramatically affected by changes in sea level, ground water level, salinity, wave pattern, current regimes. Sediment budgets, storm events and erosion patterns Physical changes themselves result in a wide variety of biological changes at the population, community and ecosystem level, which in turn affect the suitability of the coastal zone and its resource for use by human population. Coastal and Marine areas are fragile ecosystems and therefore any attempt to deplete them for alternative uses may result in irreparable loss of natural systems with serious consequences to the productive potential and economic uses and services provided by the associated natural systems.

11. Recommendations

- Initiate an integrated management approach for conservation and management of Mangrove ecosystem in the PQA and adjoining area; introduce integrated coastal zone management (ICZM) programs.
- Foster greater Cooperate Social Responsibility for the betterment of mangrove ecosystem.
- Using the ecosystem management approach, the Government of Sindh/PQA/SEPA/CDA should prepare a mangrove Utilization / management plan illustrated with maps and statistics of the mangrove areas to be allocated for. Sustained yield production, Preservation and Conversion to other land uses.
- Industries in PQA to facilitate creation of funds for the betterment of Mangrove Ecosystem in PQA as part of their CSER.
- Cost, benefits assessment should be ascertained, resulting from the management of mangrove ecosystem.
- Assessment of short term and long term direct and indirect benefits and cost should be assessed if Mangroves areas are converted for other uses.
- Institutional strengthening and capacity building of relevant government, NGOs and local communities of the coastal areas a time bound mangroves rehabilitation plan along the coast of Pakistan.
- At the planning level, multi-disciplinary teams of experts / planners should be tapped to properly integrate all ecologic / environmental and socio-economic components of alternative schemes for mangrove development.
- Create coastal and marine protected areas to conserve rare and endangered species of plants and animals.
- Empower coastal communities as custodians of coastal resource.
- Encourage creation of a fund through coastal industry to rehabilitate and conserve degraded mangrove forest.
- Use traditional ecological knowledge with conventional scientific information.
- Encourage level of education and skills of amongst youth in these areas.
- Attract educated young entrepreneurs towards the fishing industry.

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Annex 1

Questionnaire

AN ECONOMIC VALUATION OF MANGROVES IN PQA INDUS DELTA

DATE/TIME: _____

ENUMERATOR NAME: _____

SUPERVISOR NAME: _____

SECTION A: SETTLEMENT

SETTLEMENT NAME: _____

NAME OF INFORMER: _____

NO. OF HOUSES: _____

POPULATION:_____

APPROX. AREA OF SETTLEMENT _____ MANGROVE/SEAGRASS/COREL REEF AREA_____

MAIN SOURCE OF INCOME/OCCUPATION: _____

ARE MANGROVES PROTECT COASTLINE FROM STORMS AND STORM SURGES: _____

ARE MANGROVES PROTECT LOCALITY-HOME AND FAMILY FROM COASTAL EROSION: _____

ARE MANGROVES IMPORTANT AS BREEDING GROUNDS FOR FISH, SHRIMPS AND CRABS?

DO YOU THINK THAT INCOME CAN BE GENERATED THROUGH LIMITED ECOTOURISM (SHORT BOAT RIDES IN MANGROVES, RECREATIONAL FISHING ETC)?

CAN YOU FACILITATE ECOTOURISM THROUGH BIRD WATCH ACTIVITY FOR LOCAL/FOREIGN TOURISTS?

WOULD YOU BE WILLING TO SUPPORT SETTING UP OF A MUSEUM OF MANGROVE AND MANGROVE PRODUCTS TO CREATE GREATER AWARENESS IN THE AREA?

WOULD YOU BE WILLING TO DOCUMENTARY FILM ON MANGROVES TO PROTECT MANGROVES?

WOULD YOU ASSIST IN ORGANIZE EVENTS IN THE AREA TO CREATE AWARENESS ABOUT MANGROVES

CAN YOU FACILITATE RECREATIONAL AND EDUCATIONAL FACILITIES FOR RESIDENTS AND TOURISTS?

ARE MANGROVES IN THIS AREA VULNERABLE TO ILLEGAL ENCROACHMENT AND DEFORESTATION?

DOES SETTLEMENT HAS

- EDUCATIONAL FACILITY: INFORMAL _____ FORMAL _____
- HEALTH FACILITY: INFORMAL _____ FORMAL _____
- CLEAN WATER _____
- ELECTRICITY _____
- CONNECTED WITH METALIC ROAD (PAKKA ROAD) _____
- HOW IS THE MANGROVE USED IN THE AREA? _____
- IS THERE ANY FISHING OR CRAB COLLECTING AT THE MANGROVE?
- HAS THE FISHING YIELD CHANGED OVER THE TIME, AND IF SO WHAT ARE FACTORS RESPONSIBLE?
- DO YOU MANAGE THE MANGROVES IN ANY WAY?
- HAVE ANY AREAS OF MANGROVE BEEN REPLANTED?
- WHO OWNS THE MANGROVES? IS THIS PRIVATE PROPERTY OR PUBLIC.
- HAVE THERE BEEN CHANGES IN MANGROVE WILDLIFE AND SIZE OF MANGROVES HERE?
- IF SO WHAT ARE FACTORS RESPONSIBLE? _____
- DO YOU THINK THE MANGROVE IS IMPORTANT?
- HAVE ANY AREAS BEEN DEFORESTED?
- DO YOU THINK THE MANGROVE DESTROYED FOR LOCAL DEVELOPMENT ACTIVITIES?
- IS THERE ANY FISH MARKET NEARER TO THE AREA?
- IS THERE ANY TIMBER MARKET NEARER TO THE AREA?

SECTION B: RESPONDENT (HOUSEHOLD)

RESPONDENTS' NAME & ADDRESS:

_____

TIME INTERVIEW STARTS: _____, TIME ENDS: _____

GENDER _____ EDUCATION _____ AGE _____

LANGUAGES KNOWS _____

HOW MANY PERSONS USUALLY LIVE IN THIS HOUSEHOLD? (EXCLUDE GUESTS AND THOSE CURRENTLY RESIDING ELSEWHERE EVEN FOR 2-3 MONTHS OF THE YEAR): _____

TYPE OF HOUSE? KATCHA (1) PACCA (2) KATCHA PACCA (BOTH) (3): _____

WHAT IS THE MAIN SOURCE OF FUEL TO COOK FOOD[5] _____

MAIN SOURCE OF LIGHTING[6] _____

WHAT IS MAIN SOURCE FOR DRINKING WATER[7] _____

DO YOU HAVE ANIMALS[8]? _____

DO YOU USE MANGROVES FOR MEDICINAL PURPOSES? _____

WHAT ARE THE MANGROVE SPECIES USED LOCALLY FOR MEDICINAL PURPOSES?

DO YOU EARN AN INCOME (OR LIVELIHOOD) FROM SERVICES PROVIDED BY THE MANGROVES? _____

- FISH CATCH 2. ANIMAL FEED 3. BIRD CATCH 4. FIRE WOOD 5. Others (Specify)

DO YOU PURCHASE SERVICES PROVIDED BY THE MANGROVES? _____

- FISH CATCH 2. ANIMAL FEED 3. BIRD CATCH 4. FIRE WOOD 5. Others (Specify)

DO YOU USE MANGROVES FOR EDIBLE PURPOSE? _____

WHAT ARE THE MANGROVE SPECIES USED LOCALLY FOR EDIBLE PURPOSE, AND WHY?

SECTION C: PERSON INFORMATION

ID	Relation	Sex	Age	Current	Level of	What is the	How	Do

[5] Fire-wood, Gas, Sticks, Kerosene oil , Coal, Cow-dung cakes, other.
[6] Electricity, Candle, Gas, Kerosene oil, Fire-wood, Other.
[7] Tap, Handpump, well others
[8] Buffalos, Cows, goats, others

CODE	to head[9]	M,F		Residential Status (Present, temporary Absent, out of settlement)	Education (No formal education, Primary, Secondary, College, others)	nature of work (Occupation)	many hours you have worked in the last week.	you earn money (Yes, No)
1								
2								
3								
4								
5								
6								
7								

ID CODE	What is the secondary nature of work (Second Occupation)	How many hours you devoted for this secondary occupation.	Do you earn money (Yes, No)	What activity are you willing to get involved into as a source of income generation from Mangrove?	Are you aware about impacts of climate change on Mangroves?	Would you assist in Organize events in the area to create awareness about mangroves

Last of all, what do you think of this questionnaire?

	YES	NO
1. Interesting		
2. Too long		

[9]Head, Spouse, Son/Daughter, Grandchild, Father/Mother, Brother/Sister, Other

3. Difficult to understand		
4. Educational		
5. Unrealistic / not credible		
6. Others, please specify		

Annex 2

MANGROVE WOOD – Focused Group Discussion

SECTION – 1. Questions

1. House hold information of the respondent?
2. Work nature attached to the Mangrove wood?
3. Is it your primary or secondary work?
4. How much is the total mangrove wood collected in a single trip? (average)
5. How much is paid to buy the mangrove wood?
6. How much is earned per maund from mangrove wood sellings?
7. How much is paid to the labor (Khalasi) engaged in wood business?
8. What type of people at large are interested in buying mangrove wood?
9. Purpose of buying and selling wood?
10. Particular season attached to booming this wood business?
11. Cost incurred in transportation of mangrove wood?

SECTION – 2. Responses
Respondent # 1:

GHANI PATHAN: **location: Ibrahim Hyderi**

1. 14 people live in a single house with the access of gas and electricity.
2. **Wood selling** is the work nature attached to the mangrove wood business.
3. Wood selling is **the primary work.**
4. (Blank)
5. **PKR 40** is paid to the wood cutters/transporters per maund. **1 maund = 40kg**
6. **PKR 150/maund** is paid by the customer buying the mangrove wood.
7. (Blank)
8. **Fishermen** on long trips in the sea are main customers interested in mangrove wood.
9. Purpose of buying and selling the mangrove wood is to use it as a fuel. **(Fuelwood)**
10. fishermen don't want to return empty, they come with Mangrove wood. **(off - season)**
11. (blank)

Respondent # 2:

KHUDA BAKSH JATT **location: Ibrahim Hyderi**

1. Kacha house with 10 people living in it.
2. Wood Collector is the work nature attached to the mangrove wood business.
3. Wood collection is the secondary work.
4. Total of **10 – 15 maunds** collected in a single trip.
5. Wood collected is sold in PKR 40 per maund to the wood sellers.
6. (blank)
7. In sharing system (Patti) each labor (Khalasi) gets 300/week.
8. Fishermen on long trips in the sea are main customers interested in mangrove wood.
9. Purpose of buying and selling the mangrove wood is to use it as a fuel. **(Fuelwood)**
10. fishermen don't want to return empty, they come with Mangrove wood. **(off - season)**
11. Cost incurred is **PKR 600/trip** that covers fuel cost for transportation.

Respondent # 3

Asif Solanri (Baloch) **location: Ibrahim Hyderi**

1. Pakka House with 10 people living in it with facilities of gas and electricity.
2. Wood seller is the work nature attached to the mangrove wood business.
3. Wood selling is the secondary work nature.
4. (Blank)
5. PKR 150/maund paid to Wood Transporters/collectors
6. Wood collected is sold in PKR 180/maund to the customers.
7. (Blank).
8. Fishermen on long trips in the sea are main customers interested in mangrove wood.
9. Purpose of buying and selling the mangrove wood is to use it as a fuel. **(Fuelwood)**
10. (Blank)

11. (blank)

Respondent # 4

ISMAIL **location: Ibrahim Hyderi**

1. Kacha House with 15 people living in it with no gas fascility.
2. Wood seller is the work nature attached to the mangrove wood business.
3. Wood selling is the primary work nature.
4. (Blank)
5. In PKR 40/maund mangrove wood is bought from wood transporters/collectors.
6. In PKR 80/maund mangrove wood is sold to the customers.
7. (Blank)
8. **Fishermen** on long trips in the sea are main customers interested in mangrove wood.
9. Purpose of buying and selling the mangrove wood is to use it as a fuel. **(Fuelwood)**
10. The stock of wood is sold within a month. Amount of wood sold is 50/maund per month.
11. (Blank)

Respondent # 5

KHALID DAD/ NAJEEBULLAH PATHAN **location: Rehri**

1. Marbled bunglow with 16 people living at home. Gas and electricity facility available.
2. Mangrove wood seller.
3. It was the little part of their business complex (fishing business and fuel selling business)
4. 9 maund mangrove wood is collected in a single boat (Hor)
5. PKR 120/maund is paid to buy wood from wood transporters.
6. PKR 300/maund is charged to customers buying the mangrove wood.
7. (blank)
8. (blank)

9. (blank)

10. (blank)

11. (blank)

Local Words,

1. Boat: Hor
2. Labor: Khalasi (people joining captain in fishing trips)
3. Share: Patti

SUMMARY OF FOCUSED GROUP DISCUSSION

Most people involved also admitted that they are engaged in the wood cutting. The type of wood they cut are dry, they termed it as dead wood. The business has been severely affected since gas used as a fuel has replaced mangrove wood. The average of 10 mangrove trees covers one meter of area according to most respondents in Ibrahim Hyderi. As mentioned earlier the wood is used as a fuel by the fishermen, besides some part of it is also used as a fuel in events (wedding ceremonies , etc.) Despite the above mentioned fact, the Mangrove wood business is on the decline. The respondents also mentioned that all the mangrove wood stocked collected for the business was sold within a month.