Socio-economic importance of Kokkilai Lagoon

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Abstract

This paper reviews the socio-economic aspects and economic importance of lagoon fishery for the livelihood of Kokkilai fishing community. Data were collected using semi structured questionnaire from 89 fishing units. Among the demographic attributes of the fisher community collected were religious and ethnic diversity, age structure and education level. The economic indicators such as profitability, rate of return on investment (ROI) and production per hectare of the lagoon surface were calculated. Fishers of three major ethnicities, Sinhalese, Tamil and Muslim were involved in fishing in the lagoon.Age distribution of fishers indicates that a few of younger generation are entering into lagoon fishery. No one below 21 years of age was engaged in the lagoon fishery. Education level is satisfactory among fishers although 2% of them never attended schooling. Major gear types operated in the lagoon was fyke net, cast net, gill net, trammel net, crab net and the scoop net. Other than fyke and crab nets all the gear are operated year-round. Fyke nets targeted for shrimp but accidental by catch of fish and crabs are common. The average catch per trip was about 7 kg per craft irrespective of craft category. However, craft wise catch for Fiber Reinforced Plastic Boats (OFRP), Mechanized Traditional Boats (MTRB), Non-mechanized Traditional Boats (NTRB) and manually operated gear was 8.4, 4.9, 7.9 and 2.4 kg per craft per trip respectively. In terms of gross income, NTRB was the highest and the lowest was for manually operated gear category. Due to higher variable costs OFRP craft's gross income was comparatively lower despite the highest catch among the all craft. The ROI depicts the economic viability of the fishing operation. All fishing units show economically viability of which NTRB is the most profitable craft category. The estimated total production of the lagoon per year was 219kg/ha. This indicates that the rich fish and shellfish resource availability in the Kokkilai Lagoon.

Key words: Socio-economic importance, Kokkilai Lagoon, fishing gear, production

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Introduction

Kokkilai was known in ancient times as "Kukulava" or "Kokilava" according to Sinhalese chronicles which is a place with historical importance (Somasiri, 1982). Kokkilai Lagoon is an estuarine lagoon bordering Mullaitivu and Trincomalee Districts, in the north-east region of Sri Lanka. The lagoon is fed by a number of small rivers and spill water from the Padaviya Tank which drains through to the Mee Oya and the Ma Oya (Adithiya, 1969). It is also linked to the sea by a narrow opening that is very often blocked by the sand bar. The lagoon is surrounded by a densely populated region containing human settlements, cultivated lands, scrubland and open forest. The lagoon has extensive sea grass beds and small areas of mangrove swamps and mudflats (Krishanthan *et. al.*, 2015). The lagoon was declared a wildlife sanctuary in 1951 and the shallow waters of the lagoon attract a wide variety of water birds.

Figure 1. Kokkilai Lagoon showing provincial boundaries

The studies on faunal and floral diversity of the lagoon is meager, however available studies for reference shows an abundance of economically important fish and shellfish resources (Katupotha, 2016, Krishanthan *et. al.*, 2015, Silva *et. al.*, 2013, Jayamanne, 1992, Jayasuriya, 1991). In additions to extractive resources, the lagoon is blessed with unlimited potential for non-extractive uses such as recreational and scholarly values (Silva *et.al*, 2013). The paucity of the socio-economic studies on Kokkilai Lagoon limits our understanding of fishery communities.

Due to this inherent nature as a rich resource base, the lagoon gradually increased the dependent fisher population during the last 6 decades. It was recorded that since the 1940s migrant fishers from Chilaw and Negombo seasonally migrated to Kokkilai for beach seine fishery which was the dominant fishery at that time (Wimalasena *et. al.*, 2012). The native fishers had primarily confined to lagoon fishing. However, during the period of the civil war, fishing activities of both lagoon and sea going were severely affected and slow down the development of the fishing industry. After ending of civil war, the security situation relaxed and gradually increased the fishing activities with the resettlement of fisher population around the lagoon. According to Wimalasena *et.al.* (2012) there are 03 types of craft operated in the Kokkilai Lagoon. They are Fiber Reinforced Plastic Boats (OFRP), Mechanized Traditional Boats (MTRB) and Non-Mechanized Traditional Boats (NTRB). In addition to above craft categories some of the fishing gears operated by fishers manually without using a craft.

Materials and methods

Socio-economic survey methodology was adopted for the field survey. The total number of sample comprised of 89 fishing units. The sample by craft categories was 42, 35, 6 and 6 of OFRP, NTRB, MTRB and manually operated gears. Data collection was carried out using semi-structured questionnaire from January to November 2016. Data coding, entering and analysis are performed by SPSS version 22. Data is presented using descriptive statistics and cost, revenue and profit models.

Figure 2. Scenic beauty of Kokkilai Lagoon

Results and discussion

Demographic attributes of fishers

The main demographic attribute of the Kokkilai Lagoon fishing community is ethnic and religious diversity. Muslim and Tamil fishing communities are native to the area while Sinhalese fishing community had been settled in Kokkilai after their ancestral migratory fishers in 1940s who had introduced the beach seine fishery to Kokkilai. According to former Government Agent of the Mullativu district, other than migrated Sinhalese fishers no one has engaged in fishing activities in the area at that time (Jayawardene, 2010). The total fishers around lagoon is about 1531 and of them 76% falls under Trincomalee fisheries administration while 24% belong to the Mullativu fisheries administration.

Average number of persons of a household was 3.8. The highest number of persons of a household was 6 and that was 8% of total sampled families. Generally, 32%, 24%, and 21% of households had 4, 3 and 5 persons per family respectively. There were no fishers whose age is less than 21 years. Ninety one percent (91%) of fishers represents the economically active population and only 1% fishers whose age was more than 81 years. Age groups 26-30, 31-35 and 36-40 were among the highest percentages of fishers. The mean age in years of fishers of OFRP, MTRB, NTRB and No craft -gear only categories were 41, 47, 38 and 48

years respectively. Compared to the other craft categories NTRB fishers mean age is the lowest.

The average number of years in fishing for OFRP, MTRB, NTRB and manually operated gear categories were 25, 17, 13 and 11 years respectively. The motorized craft operators had more fishing experience than that of non-motorized operators. This is an indication of fishing career progression takes considerable time span for low income fishing communities.

More than two thirds of them attained secondary level education while 2% never had any kind of formal education. The dropout rates from primary education were comparatively higher in the Kokkilai fisher community with national level figures. However, according to UNICEF report (2013), enrollment of children for primary education in Mullativu district was 100%.

There are some distinct characteristics of the education level by types of craft categories. OFRP and NTRB fishers show similar education levels in percentages. However, MTRB fishers accounted for 100% within the grade 6-11 category. Moreover, all MTRB and No craft- gear only fishers had some kind of formal education.

Irrespective of craft category 89% of fishers were members of any kind of community organization in their respective area. However, considering craft wise membership, OFRP, MTRB, NTRB and No craft- gear only category were 88.5%, 66.7%, 93.5% and 75% respectively. Thus, NTRB fishers were among the highest percentage of membership in community organizations.

Occupational categories

The occupational categories of the respondents are given in table 1. Among the fishers, 60% engaged in both sea and lagoon fishing while 38% of fishers solely carried out lagoon fishing. Only about 2% of the sample identified their full-time occupation as farming but their part time occupation as lagoon fishing.

The farmers whose part time occupation was fishing in lagoon (2%) indicates the possibility of occupational transition from farming to fishing as an alternative livelihood.

Table 1. Occupational categories of fishers

Occupational category		Frequency	Percent	Valid Percent	Cumulative Percent
	Fishing in lagoon	33	37.1	36.4	37.5
	Fishing in sea and lagoon	53	59.6	60.2	97.7
	Farmer	2	2.2	2.3	100.0
	Total	88	98.9	100.0	
Missing	System	1	1.1		
Total		89	100.0		

Source: SED, NARA 2016

Craft and fishing gear

Three types of craft are operated in Kokkilai Lagoon. Out board fiber reinforced plastic boats (OFRP), Mechanized traditional boats (MTRB) and Non-motorized traditional boats (NTRB) are the three types of craft operated in the Kokkilai Lagoon. These craft are operated from 6 landing centers located around the lagoon. Of them, Mohottuwaram, Pattikudha, Kuruththumaulai, Karayaweli has a prominent Muslim ethnicity while Sinhapura and Thennamaramvadi has a prominent presence of Sinhalese and Tamil ethnicities by the landing sites respectively.

Table 2. Number of craft by landing sites

Landing site	Number of OFRP boat	Number of NTRB boat
Mohottuwaram	300	100
Pattikuda	60	30
Kuruththumulai	20	30
Karayaweili	60	25
Sinhapura	15	20
Thennamaramvadi	23	40
Total	**478**	**245**

Source: SED, NARA 2016

Although fishing operation is basically carried out using craft but at times some fishing gears are operated manually without using a craft. The motorized craft are powered by outboard engines. The percentage composition of respondents by type of craft operated is given in table 8. OFRP and NTRB craft are the dominant types of craft operated in lagoon and only a 7% were MTRB craft. There were 7% fishers engaged in fishing without a craft.

Mainly six types of fishing gear operated in the Kokkilai Lagoon. Gill net is the dominant gear type that constitutes 35% and next highest is the Fyke net (Poottu del/ Cootu valai)) which is having with 30% of craft. Crab net also operated by 20% of craft for Mud crab (mada kakuluwa/kalapu kakuluwa). Cast net and scoop net specially operated for catching shrimp in lagoon.

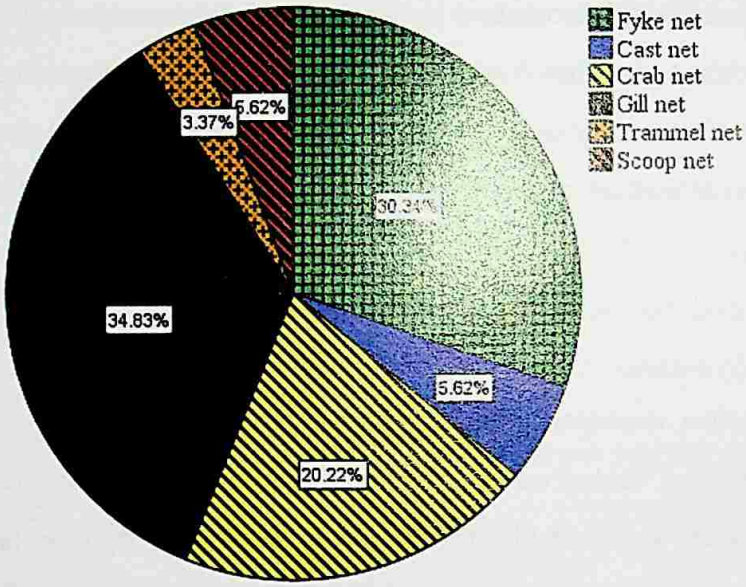

Figure 3. Composition of fishing gear in Kokkilai Lagoon

Most of the gear (59%) is operated in the lagoon were targeting shellfish varieties of shrimp and crabs. Fyke nets were mostly operated by OFRP craft (21%) and highest percentage of gill nets were operated by NTRB craft (21%). No craft-gear only category fishers at times gear operate without craft and generally craft are taken by NTRB craft on daily rental basis. The rental of NTRB craft was in the range of Rs. 150-300 per day. Scoop nets were used for the collection of fish from fyke nets.

Fishing operation and seasons

Fishing in lagoon is a year-round activity, especially for the NTRB fishers and for those who fish without using craft. On the other hand, OFRP fishers have a mix of fishing gear suitable for lagoon and coastal fishing on accidental rolling basis depending on seasonality of fishing operation and catch. They alternate shift from lagoon to sea and vice versa. Fishing for crabs in lagoon is a year-round fishery while fyke nets are operated from February to December

each year. Cast netting and gill netting required no specific season and operate according to the fish and shellfish availability. The season for trammel nets is November to March. Average fishing days per month was 20 and 208 days are operated a year.

Economic aspects of lagoon fishery

Lagoons and estuaries provide an array of ecosystem services from which surrounding communities directly or indirectly depend for their livelihood. Some of the services could be identified as economic activities at commercial or subsistence levels. Mainly, fishing is the widespread economic activity across almost all lagoons in Sri Lanka which is no exception for the Kokkilai Lagoon.

Investment capital

The fishing operation as a productive economic activity needs capital for inputs of the production process. The main inputs of fishing operation are craft and fishing gear. The following table 3 presents the amount incurred on craft and gear purchased by Kokkilai Lagoon fishers.

Table 3. Investment capital by type of craft/boat (Rs)

Type of craft	Hull	Engine	Fishing gear	Total
OFRP	74158	133400	44460	252018
NTRB	22125	0	32337	54462
MTRB	20000	124000	21850	165850
Manually operated gears	0	0	21875	21875

Source: SED, NARA 2016

The sources of funds for purchase capital inputs were borrowings, donation or own money. Most of the craft owners (47%) had purchased their craft by taking loans and 31% of them were able to get external donation and only 22% of fishers were able to use own money.

Repair and maintenance cost

The capital inputs are subject to wear and tear due to continuous usage. Therefore, repair and maintenance (R & M) is essential to keep inputs in workable condition. Comparatively engine incurs higher R &M cost for keeping in good condition of motorized craft. Fishing

gear also needs to be mending and repair periodically. OFRP and MTRB fishing units show higher R & M costs than that of NTRB. Increasing R& M costs decreases the annual net return to the owner.

Variable costs

Variable costs of fishing operation include all inputs that vary or change according to the nature of the fishing operation. For a motorized craft, fuel is the major cost item that determines the amount of variable cost. This was for OFRP and MTRB craft were Rs. 634 and 670 per fishing operation (trip) respectively. The fuel accounted for by 86 and 100 percent of variable cost respectively for OFRP and MTRB craft. Relatively variable cost for NTRB is negligible and that is for manually operated gears are zero. The divisible income from fishing operation is determined by the amount of total variable costs.

Table 4. Variable costs per fishing operation per trip per day (Rs)

Type of craft	Fuel & oil	Ice	Food	Other	Total operational cost
OFRP	634	20	51	21	738
NTRB	0	0	56	0	48
MTRB	670	0	0	0	670
Manually operated gears	0	0	0	0	0

Source: SED, NARA 2016

Catch and prices

Main catch varieties in the Kokkilai Lagoon are shrimp, crab and fishes. At times however, catch comprised of multi species regardless of targeted specific varieties. Following table 16 shows catch and prices of each variety for single fishing operation regardless of craft and gear used in fishing operation.

Gear wise catch

Shrimp and crabs are highly demanded varieties with under supply. Shrimp catch varies from 0.5 to 3 kg and depending on the size and price may vary from Rs. 300 to 750 per kg. The mean income from shrimp was about Rs. 1516 per trip. Compared with shrimp catch per fishing operation is more or less similar but income is fairly higher than that for shrimp. That is due to higher prices prevail in the market for crabs as there is a remarkable demand

coming from the export market. Generally, fishery for crabs brings Rs. 2043 income from days fishing.

Mean catch of fish using gill nets per operation was approximately 16 kg of which 2 kg brings home for consumption. The salable quantity of fish is 14 kg and the average income generates is Rs 2065 at the price per kg of Rs. 172. On average generates Rs. 2233 of income from a fishing unit per day regardless of craft and gear differences.

Table 5. Catch, price and revenue by variety per trip per day

Item	N	Minimum	Maximum	Mean	Std. Deviation
Shrimp catch(kg)	36	.50	8.00	3.0722	2.05977
Shrimp- bring home kg	1	.10	.10	.1000	.
Shrimp price per kg	36	300.00	750.00	486.5278	98.32584
Shrimp-income	37	250.00	4500.00	1516.2162	1004.73214
Crabs catch(kg)	42	.28	17.00	3.3757	3.15649
Crabs- bring home kg	4	.25	1.00	.5625	.31458
Crabs price per kg	42	100.00	3000.00	845.4126	718.88679
Crabs-income	42	200.00	9400.00	2042.6190	1637.03563
Fish catch(kg)	26	.50	60.00	14.8692	14.81906
Fish- bring home kg	4	.50	4.00	2.1250	1.43614
Fish price per kg	26	15.00	600.00	172.9231	116.22149
Fish-income	26	150.00	6750.00	2064.6154	1893.21363
Total catch per day	83	.00	60.00	7.5781	10.10161
Total income per day (Rs)	86	.00	9400.00	2233.3605	1791.49238
Valid N (listwise)	0				

Source: SED, NARA 2016

The share of fishing gears operated in Kokkilai Lagoon was 55% for shrimp, 35% for fish and 20% for crabs.

Craft wise catch

The mean catch per craft per fishing operation is given in table 6. OFRP shows highest catch followed by NTRB, MTRB and No craft-gear only category respectively. For revenue calculation purposes, craft with any combination of gear is taken as the fishing unit.

Table.6: Catch per trip per day by type of craft/boat

Type of craft	Catch per trip per day (kg)
OFRP	8.4
NTRB	7.9
MTRB	4.9
Manually operated gears	2.4

Source: SED, NARA 2016

Revenue and gross income

The highest revenue from lagoon fishing was earned by OFRP craft but in terms of gross revenue NTRB craft was significantly higher. This situation is explained by the operational cost factor of each craft category. Due to higher operational costs of OFRP and MTRB craft the overall impact on gross income or divisible income finally reflect by the owner's and the crew's share. There are two types of ownerships. The non-working owner does not participate in fishing and generally owns 50% of divisible income. While working owner actively participate in fishing operations and as per the practicing norm he/she gets 75% of divisible income. The fishing gear operated without craft (cast net) incur no operational or variable costs, the revenue fully becomes working owner's share.

Table 7.Gross income and share per trip per day (Rs)

Type of craft	Revenue	Operational cost	Gross income (divisible income)	Non-working owner share	Working owner share	Crew share
OFRP	2470	738	1732	866	1299	433
NTRB	2153	48	2105	1053	2105	1052
MTRB	2070	670	1400	700	1050	350
Manually operated gears	1265	0	1265	-	1265	-

Source: SED, NARA 2016

Economic indicators

The highest gross income from fishing unit per year is reported by NTRB craft and lowest is recorded by those who operate fishing gear without craft. The non-working owner's share is estimated on the assumption that the craft owner is not actively participating in fishing and

he employs 2 fishing crew. The share of income of the owner is the return for his investment. The rate of return on investment (ROI) indicates the profitability of the investment. All the fishing units indicate positive profits on investment at varying rates but NTRB craft shows nearly 5-fold yearly gross incomes than the capital investment. The lowest ROI is for OFRP craft, but it is also 60% of the investment. This implicitly indicates that Kokkilai Lagoon's fish and shellfish resources are economically at underutilized state.

Table 8. Economic indicators for lagoon fishing

Type of craft	Gross income of fishing unit per year (Rs)	Non-working owner share (Rs)	Capital investment (Rs)	Ratio of return on investment
OFRP	301042	150521	252018	1:0.6
NTRB	493940	246970	54462	1:4.5
MTRB	350750	175375	165850	1:1.06
Manually operated gears	215465	-	21875	1:10

Source: SED, NARA 2016

Estimated production of Kokkilai Lagoon

The productivity of lagoon is an indicator of the status and utilization of its resources. The following table 9 depicts the estimated yearly production of Kokkilai Lagoon. The estimated total fish and shellfish production of the lagoon was 1161616 kg (1162mt) per year. The extent of Kokkilai Lagoon is 53 km^2 or 5300 ha. Thus, the annual production per hectare of lagoon was 219 kg. This is comparatively higher figure with respect to other lagoons in Sri Lanka (2011, Joseph).

Table 9. Estimated total fish and shellfish production of Kokkilai Lagoon per year

Type of craft	Total catch per craft per year (kg)	Total number of craft operated	Fishing days per year	Total production per year (kg)
OFRP	1351	478	206	645778
NTRB	1902	245	208	465990
MTRB	911	22	218	20042
Manually operated gears	298	100	164	29800
Total production				1161616
Total production kg/ha				219

Source: SED, NARA 2016

Conclusion

Kokkilai Lagoon is unique ecosystem with diversity in biological, social, and economic spheres. Three major ethnicities, Sinhalese, Tamil and Muslim are involved in fishing in the lagoon. At present motorized craft are in operation in Kokkilai Lagoon where this type of craft are not permissible in many of the lagoons in Sri Lanka. OFRP, MTRB motorized craft and NTRB non-motorized craft are in operation in the lagoon. Some of the fishers operate cast and scoop nets without using craft.

Age distribution of fishers indicates that a few of younger generation are entering into lagoon fishery. No one below 21 years of age were engaged in the lagoon fishery and this situation may be result of the changing way of life after the socio-economic transition taking place in the area.

Education level is satisfactory among fishers although 2% of them never attended schooling. The dropouts from primary education show a high percentage but according to UNICEF report, enrollment of children for primary education is 100% in Mullativu district.

On average 89% percent were members of community organization and thus social capital formation in the Kokkilai Lagoon is a plus point for participatory management of lagoon resources.

Major gear types operated in lagoon were fyke net, cast net, gill net, trammel net, crab net and scoop net. Other than fyke and crab nets all the gear are operated year-round. Fyke nets targeted for shrimp but accidental by catch of fish and crabs are common. The average catch per trip was about 7 kg per craft irrespective of craft category. However, craft wise catch for OFRP, MTRB, NTRB and No-craft category was 8.4, 4.9, 7.9 and 2.4 kg per craft per trip respectively. In terms of gross income, NTRB was the highest and the lowest was for no craft- gear only category. Due to higher variable costs OFRP craft's gross income is decreased despite of the highest catch among the all craft. The ROI depicts the economic viability of fishing operation. All fishing units show economically viability of which NTRB is the most profitable craft category. The estimated total production of the lagoon per year is 219kg/ha. This indicates that the rich fish and shellfish resource availability in lagoon.

Policy implications

- Kokkilai Lagoon spread over two administrative as well as fisheries districts. The ethnic diversity, technological, social and economic differences of people around the lagoon may put varying levels of weightings for utilizing resources. This will inevitably rise to conflicting environment in respect to livelihoods. Thus, efficient monitoring and management regime with participatory approach is a must for sustainability of resources and undisputed harmony of the society.

- A considerable percentage of fishers are carrying out fishing both in lagoon and the sea. Therefore, the right to fishing should be clearly identified and legalized for those who doing fishing in the lagoon only.

- At present gross income of NTRB exceeds the same of OFRP craft. This indicates that the motorized craft operation inside the lagoon is economically not efficient. Moreover, this may be harmful to the lagoon environment as well as to the marginal fishers who fish without craft. Therefore, social and scientific assessment may be required to assess the suitability of motorized craft operating inside the lagoon.

- Markets are efficient when buyers and sellers are freely traded. Fish marketing in Kokkilai is wholesaler dominant. Freeing fishers from unwarranted bondages can be performed by economic empowerment. Educating and awareness of fisherwomen, government intervention and development of infrastructure are priority areas to address fish marketing issues.

- Some of the stated fisheries related issues are in sensitive nature. Implementation of existing regulations is not only enough to cure these issues. Improving socio-economic status of fishers within the broader framework of participatory management is also essential to enhance negotiation power of unequal resource users.

References

1. Adithiya, L.A. (1969). Archaeological remains at Deiyanne-kanda, Padaviya. The journal of the Ceylon branch of the Royal Asiatic Society of Great Britain & Ireland. 13: pp 64-82

2. Fernando, D.K. (1996). Resolution of conflicts in small scale fisheries in Sri Lanka. In: Proceedings of the Sri Lanka/FAO National Workshop on Development of Communiuty-based Fishery Management. ed., Morris, M.J., Hotta, M., and Atapattu, A.R. Bay of Bengal Programme, Madras, India, BOBP/REP 72. 228-237

3. Jayamanne, S. C. (1992). Mud crab fishery of Sri Lanka. In: Report of the seminar on mud crab culture and trade, ed., Angell, C.A. Bay of Bengal Programme, Madras, BOBP/REP. 51: 41-48

4. Jayasuriya, P.M.A. (1991). The species composition, abundance and the distribution of seagrass communities in Puttalam lagoon. Vidyodaya Journal of Science 3: 93-102.

5. Jayawardene, A. (2010). Paper article on Sunday Lankadeepa (Sinhala weekly) on 17/01/2010.

6. Joseph, L. (2011). Fisheries and environmental profile of Negombo lagoon, Sri Lanka: A literature review. Regional Fisheries Livelihoods Programme for South and Southeast Asia (GCP/RAS/237/SPA) Field Report Document 2011/LKA/CM/04. pp 15-18

7. Katupotha, K.N.J. (2016). Mangroves in lagoon ecosystems: A neglected habitat in Sri Lanka. WILDLANKA 4(3): pp 079-105.

8. Krishanthan, G., Thiruchchelvan, N. and Mikunthan, G. (2015). Pedestal study for diversity of fishes, crabs and shrimps in Kokkilai Lagoon in Sri Lanka. Advances in Biological Research 9(1): pp 49-52. doi: 10.5829/idiosi.abr.2015.9.1.924

9. Silva, E.I.L., Katupotha, J., Amarasinghe, O., Manthrithilake, H., Ariyaratna, R. (2013). Lagoons of Sri Lanka: from origins to the present. Colombo, Sri Lanka: International Water Management Institute (IWMI). 122p. doi: 10.5337/2013.215

10. Somasiri, D. (1982). Traditional Sinhala place names in Sri Lanka and their Tamilized forms, http://dh-web.org/place.names/barelist.htm. Date accessed 08/03/2017

11. UNICEF(2013). Out of school children in Sri Lanka, UNICEF country report. https://www.unicef.org/srilanka/2013_OSS.pdf. Date accessed 08/03/2017.

12. Wimalasena, H.D., Maheepala, M.M.A.S. and Amaralal, K.H.M.L. (2012). Socio-economic aspects of Kokkilai fishing community in the eastern coast of Sri Lanka. In: proceedings of the NARA Scientific Sessions, Colombo, Sri Lanka. p11.