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Fishing methods, use of indigenous knowledge and traditional practices in fisheries management of Lake Kolleru

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Abstract
A survey was conducted aimed at assessing the indigenous fishing methods adopted by the fishermen in Lake Kolleru, a wet land of International importance and the only Ramsar site from Andhra Pradesh. Information was collected by participatory rapid appraisal covering fifteen fishermen villages in around the lake and field visits. Study indicated that a diverse range of fishing gears and methods have been evolved over a long period of time by the fishermen of Lake Kolleru to capture a wide range of fish species and commercial exploitation of the lake. Indigenous fishing gears comprising gill nets, cast nets, traps, etc., have been discussed recorded during the study. It is evident that Dugout canoe, plank built boats are the most extensively used craft and cast net, traps are commonly used implements in fish capture. Among all indigenous fishing devices Kampagudu and Gaya are the unique and assured method of capturing fishes in the lake. No destructive methods are used in lake for fish capture.

Keywords: Indigenous fishing methods, Craft, Gear, Kampagudu, Gaya

1. Introduction
A knowledge of fishing gear, crafts and fishing methods is very essential for scientific and judicious exploitation and management of fishery resources. Fishing nets and gears are refers to those devices having different shapes and sizes and used in the aquatic bodies to capture different sizes of fish species [1]. Fishing techniques employed in a geographical area generally depend on various behavioural characteristics and microhabitat type of the fish fauna available in that area. Fishing crafts and gears used in India are mostly primitive and non-mechanized [2]. Fishing gear is any form of equipment, implement, tool or mechanical device used to catch, collect or harvest fish on the other hand crafts are used to carry the fishermen and gears to fishing grounds. Various types of materials are used to make these fishing gears include netting, twine, plastic structural and fasteners, clips and swivels, ropes, steel wire ropes, combination wire ropes, purse rings, polyester, polyethylene, nylon, cotton, polypropylene, mixed fibers, floats and sinkers, bamboo, wood etc [3]. Seasonal changes, physiography of the water body, types of fish available, efficiency of the gear, characteristics of the material used for the preparation of gear are the important factors determine the selectivity of the gear used. A thorough understanding of fishing craft and gear is crucial for understanding the present exploitation mechanism of natural fishery reserves and conservation and also for making suitable improvements of valuable fish resources. Several researchers documented various indigenous fishing methods used in various parts of India [4-23].
The Kolleru Lake (N 16º 32'& 16º 51'; E 81º 05' & 81º 20') is the largest fresh water lake in India, situated between two major rivers, the Godavari and the Krishna, in Andhra Pradesh with a catchment area extends up to 6121 km^2, of which 4763 km^2 comprise of upland, and 1358 km2 deltaic [24]. The only out let of the lake to Bay of Bengal, the Upputeru channel, an intricately meandering tidal channel playing crucial role in the maintenance of wetland's hydrological regime. At its maximum, the lake is 39km long and 22km broad. Its mean depth reportedly varies from 0.5 to 2.0m, while the maximum depth is about 10m. For most part of the year the water depth varies between 1 and 1.5m. During flood season it reaches 3 to 4m. Primary occupation of people living in the bed villages are fishing; agriculture being only the Second priority. Capture fishery is an important means of livelihood for large proportion of the people residing in the area.

The lake functions as a natural flood-balancing reservoir for both the rivers. In November 2002, lake was declared as a wetland of international importance by the RAMSAR convention for the conservation and sustainable utilization of wetlands [25]. It is the sole Ramsar designated wetland in Andhra Pradesh [26]. According to Raju *et al*. [27], it is a source of water for domestic use and irrigation and also traditionally supports a substantial fishery. It is a highly productive lake and provides habitat and good breeding and feeding ground for about 188 species of migratory and resident birds belonging to 46 families**.** The imperial Gazette described Kolleru as "a peerless fishermen's paradise" and "bird heaven". There are number of studies mainly focused on ichthyofaunal observations in the lake [27-35]. Unfortunately, the fishing methods used in Lake Kolleru were not documented ever. The present paper is an attempt to document various indigenous fishing methods used in the Lake.

2. Material and Methods:

The present investigation was conducted for one year from December, 2014 to November, 2015. Data regarding various indigenous fishing craft, gear and fishing methods was obtained from both primary sources (Direct observations from extensive field works, personal interviews) and secondary sources (Literature and Reports). Fishing gear available in this area is described under various groups as per the revised classification of Brandt [36].

3. Results

Fishing craft and gears adopted by fishermen community of Lake Kolleru were simple, mostly old-fashioned and indigenous. Use of various craft and gear and fishing methods depend on the physiography of the lake area, season, financial status of the fishermen, etc. Three varieties of craft (Dhoni, Plank built boat and thermocol raft), ten varieties of gear (Galamu, Dadikattu, Mavu, Gampagari, Sanchi vala, Ettudu vala, Visuru vala, Odhe, Lagudu vala and Moppa vala) falling under 6 categories and four fishing methods.

3.1 Fishing Craft

3.1.1 Dhoni: It is a long dug-out canoe made from carved out basal part of the trunk of a palmyra tree and is locally called as "Thati Dhoni". It is around 3 - 4 m length and with internal diameter of 0.5m. Major portion of the trunk is longitudinally scooped out for sitting and keep the captured fish. Wooden bar is sometimes fixed in the mid region of the scooped out part for sitting and to avoid collapse of the canoe. Margins of the scooped out part is framed by circular iron frames in some canoes to prevent from splitting. Generally it is operated by a single person due to its small size. Narrow width of this gear also facilitates rolling movements and hence skilled persons operate these canoes to maneuver it effectively (Figure 1A).

3.1.2 Plank built boats

These are spindle shaped constructed by joining together quality wooden planks with iron nails. Joints are leak proofed by applying coal tar. Small and large sized plank built rowing boats are commonly used in the lake. The smaller boats are 5 - 6m long with 80 - 90cm beam width and used for transport of harvested fish and also passengers from village to village within the lake. They are non-mechanized and manually operated. Bigger boats are about 15 - 20m long and are mechanized. They are used to transport fish to landing centers (Figure 1B).

3.1.3 Thermocol raft

It is an improvised country made fishing craft made of used thermocol boxes and slices (for fish preservation and transport). Required number of thermocol boxes and slices were tied together with the help of nylon ropes to make a platform of length 4 - 5m length with 1m width. It is commonly operated by children of 10 - 15 years of age for setting and collection of traps, transport of catch and fish capture near the lake shore (Figure 1C).

3.2 Fishing Gear

3.2.1 Galamu (Hook and line)

It is one of the oldest and widely used fishing methods which is not commercially used and fish caught is consumed by fishermen family itself. Catching of fish in which fishes are caught individually is based on feeding and hunting behaviour of fish species. In this technique, fish are caught with the help of baits tied to a metal hook tied with one end of a strong nylon thread and the other end of nylon thread is tied with a bamboo pole of different lengths to dip the metal hook supplied with bait in water. Earthworms, Grasshoppers, small sized fish and trash fish pieces are commonly used as baits. Attracted to the bait, fish swallow and gets entrapped by the hooks are caught by pulling up the threads. Catfishes and murrells are caught with this technique (Figure 1D).

3.2.2 Dadikattu (Fish screens)

Dadikattu is practiced during October to February when water level is high in the lake. Bamboo screen is constructed across the lake over a length about 100m. Traps are set in single rows on both sides of the screen. Traps are kept firmly in position by packing weeds and mud at their bases. Additional traps are piled above the two bottom rows along the entire length of the screen. Number of traps used in each pile is based on the depth of the lake. Tops of the upper most traps are weighted with weeds and mud so that they do not get displaced. Entrapped fish are collected once a day early in the morning and the traps are reset (Figure 1E).

3.2.3 Mavu (Box trap)

Trap, locally called "Mavu" is a fishing device in which fish are enticed by enclosures where they are guided to enter the trap. It is the chief gear used for fishing in the lake to catch different species and sizes of fish. Mavus are made of split bamboo sticks woven with the long pliable stems of a creeper called Good apala Theega. Catching fish through traps is a passive process. Baits are kept inside the traps sometimes to attract fish. In Lake Kolleru, rectangular shaped basket trap locally called "Pandirimavu". It is the most extensively operated gear and accounts for major part of the catches. It has two vertical openings, one on each long side. Each vertical opening is fixed with a series of inwardly directed, short, pointed bamboo sticks interwoven in such a way that the tips of the two series of splints cross each other. This type of arrangement only permits easy entry of the fish but not their exit. Three types of basket traps are regularly used in this area (Figure 1F).

3.2.3.1 Moora bethe mavu

This is the largest type basket trap used in this area. Vertical openings are opposite each other in the middle of each long side and along the entire height. Along one long side the edge of the base is not interwoven with the bottom edge of the corresponding vertical wall to clear the entrapped fish from the trap.

3.2.3.2 Moora mavu
This type of trap is used caught medium sized fish. This is similar in structure to Moora bethe mavu except for differences in dimension and is operated at depths of 1.5 - 2.5m.

3.2.3.3 Ingilayi mavu
Small and medium sized fish are caught with this trap. Width is same but show difference in dimension with moora mavu. Vertical openings on the long sides are situated towards either end, and not opposite each other.

3.2.4 Gampagari (Tubular trap)
It is funnel like (Gampa) seasonal (October to January) trap made of split bamboo slivers used to catch small and medium size fish. It is about 1 - 2m long with a wide mouth (85cm diameter) at one end and with a narrow opening at another end. Narrow end is attached to a large basket (Gari), narrow and longer than gampa and provided with valve-like arrangement which allow entry of fish but not exit (Figure 1G).

3.2.5 Sanchi vala (Bag net)
It a bag like net with framed mouth. It is more or less circular made up of nylon with a mesh size of 2 - 3 mm and depth of a bag is about 0.5 - 1m provided with a circular iron frame and a long handle made with bamboo pole. This net can be horizontally extended when scooping it through water column. Fishes entering the bag net are caught due to water filtering. Net is operated in shallow water regions of the lake either from the banks or from the dugout canoes by inserting the net inside water below the aquatic weeds or in the weed infested area. This net is also used as a passive gear while fish catching through 'gaya' method. This net can also be used to collect mollusks (Duck feed & fish bait) by dragging or scooping over the bottom of the lake bed (Figure 1H).

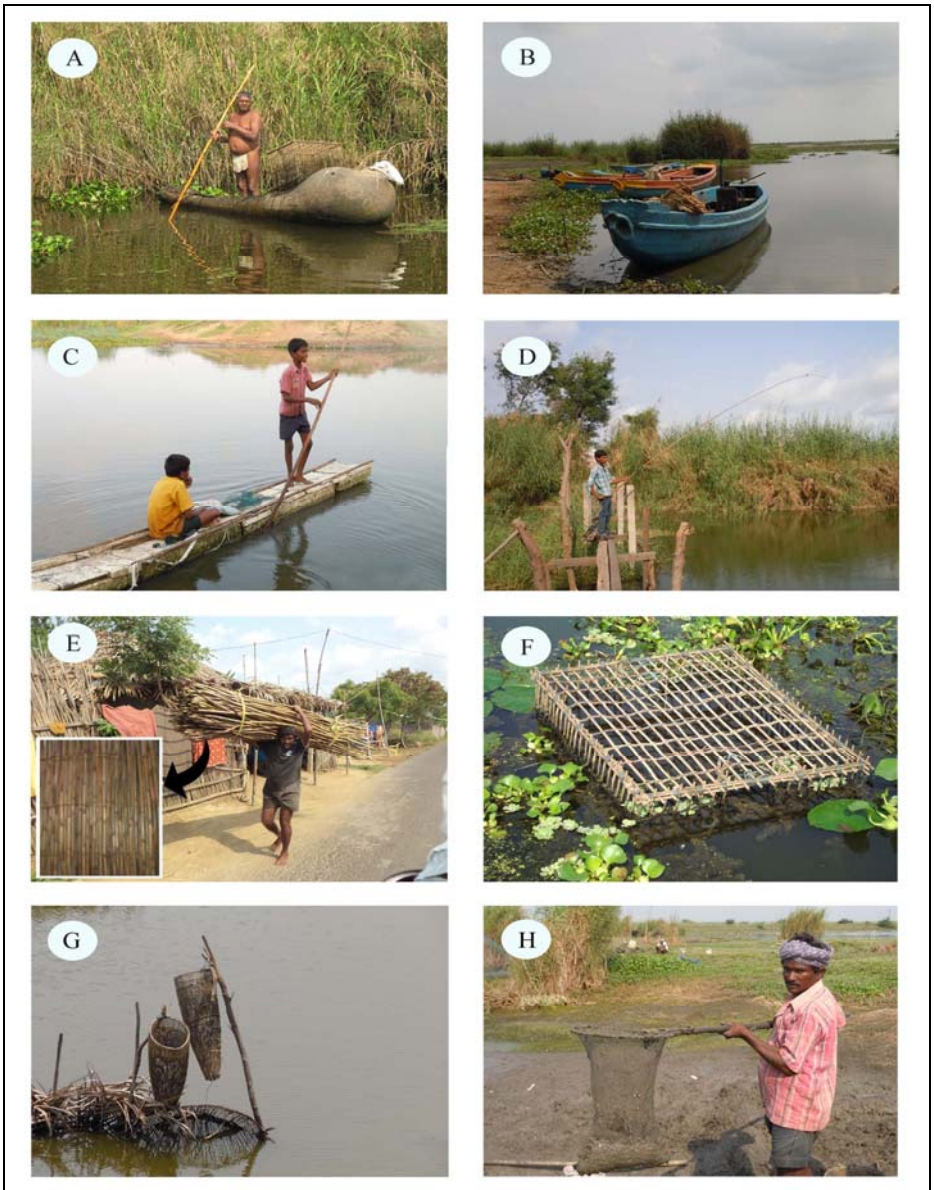

Figure 1: Fishing crafts and gear used in Lake Kolleru - A. Dhoni, B. Plank built boat, C. Thermacol raft, D. Hook and line, E. Fish screen, F. Trap, G. Gampagari, H. Bag net

3.2.6 Ettudu vala (Hand lift net)
Ettudu vala is a small, portable hand operated net generally used in the shallow region of the river to catch small sized fish. It is a rectangular shaped dip lift net supported by X-shaped

bamboo frame. Frame is made by two flexible bamboo poles of equal lengths. Four corners of the net are tied into four corners of the bamboo frame. This mobile scooping gear is dipped in shallow waters for some time and then lifted up rapidly from water so as to catch the entrapped fish which happen to be over the net by hand picking (Figure 2A).

3.2.7 Visuru vala (Cast net)

Cast net is locally called "Visuru vala" which is operated in shallow waters of the lake where depth is about 2 - 3m. It is circular net having umbrella shape made of nylon fibers. Cast net is a falling gear and operation of cast net is an active fish catching process. Iron or lead sinkers are fixed along the margin and a strong rope of 5 - 6m is attached to the apex of the net to haul the net during its operation. Size of the mesh ranges from 20 - 45mm and perimeter ranges from 10 - 18m based the size of the fishes to be caught. These nets can be operated single handedly in which fishermen throws the net conveniently and skillfully over the water either from a boat or from the banks of the lake in such a way that it spreads on the water surface fully expanded at its perimeter and cord is held in hand at its apex. Net sinks to the bottom of the lake with closed circumference due to the weight provided by sinkers provided. Small fishes such as carps and catfishes caught with these nets then pulled with the help of the cord (Figure 2B).

3.2.8 Odhe (Cover basket)

"Odhe" is a falling gear which is operated by a single fisher man in shallow waters and during dry seasons, when the water the water level is reduced to a minimal level. It is a conical cover basket made of bamboo sticks woven together by nylon threads and open at both the ends. Circumference of the upper opening is about 20 - 30cm and the diameter of the bottom opening is around 60 - 80cm. Height of the gear is generally 0.5 - 1m and there is gap of 0.75 - 1cm gap between adjacent sticks. Fisher man plunge the gear into the water with broad opening faces downward at the area with the presence of fishes by guessing by water movements. Then gear will be against the mud to prevent the escape of fish and are caught by hand picking (Figure 2C).

3.2.9 Lagudu vala (Drag net)

Drag net is locally called "lagudu vala or pedda vala or pattu vala" which encircle certain region of the lake to catch a detected fish school by dragging the net or scooped out with other gears. It is very effective gear to catch the wild fish populations and is more suitable for huge water bodies such lake Kolleru. During its operation one end is fixed at the bank of the lake and the other end is to be towed in an arc around the fish shoal to surround them and a boat or dhoni is used to pull the net into a large area before its hauling to the bank of the lake (Figure 2D).

3.2.10 (Moppa vala) Gill net

Gill net is a passive rectangular gear locally called "Moppa vala". These nets are erected in water column vertically perpendicular to the movement of fish with the help of head and foot ropes provided with sinkers and floats respectively. As fish attempt to swim through the mesh of the net, they become snagged by their gill operculum, fins or by their scales. Small undersized fish usually are able to swim through the mesh unharmed, whereas excessively large fish are unable to penetrate the mesh sufficiently to become trapped. Characteristics such as simplicity in its operation, design and construction, low investments attracted the fishermen to use it extensively. Nets of smaller size are operated in the shallow regions of the lake depth ranging from 1 - 2m where as large sized ones are relatively in the deeper areas of the lake at 2 to 4m depth (Figure 2E).

III. Indigenous fishing methods used for fishing in lake Kolleru

3.3.1 Grouping (Hand picking)

This method is the oldest among various fishing methods and is practiced in summer season. With considerable amount of skill and practice, fishermen caught fishes from the shallow waters of the lake simply with their hands without any device where the depth of the lake does not exceed 0.5m (Figure 2F).

3.3.2 Doddi fishing (Dewatering)

This type of fishing is practiced especially in dry season. "Doddis" are relatively deeper areas in the lake, where more fish tend to congregate. From February onwards, depth of the water in the lake is getting decreased and major part of the marginal areas get dried due to summer. These areas surrounding the villages in the lake bed are leased out for fishermen. When the lake water recedes, fishermen raise bunds enclosing 1 or 2 hectare area and start removing the fish by dragnets. Later the area is dewatered by natural or motor pumps and the remaining fish are captured by hand picking (Figure 2G).

3.3.3 Kampagudu: **Fish Aggregating Device (FAD)**

Fish Aggregating Device is a method used for the purpose of facilitating the harvesting of fish by attracting and aggregating them which can increases the rate of catch and reduces the cost of production. Kampagudu technique is regularly practiced in this lake especially at circar channel and Upputeru when the water flow is minimal. This method is very simple, needs low investment but requires long duration between installation and harvesting. Kampagudu reduce scouting time for fish, thereby decreasing operational costs of fishing craft. This also improves fishing efficiency as a result of increased time available for fishing. Further, due to concentration of fish around FADs, catching becomes comparatively easier. It is very useful to harvest fish from lightly exploited stocks, by aggregating them. Kampagudu is a surface FAD and can be made of simple, comparatively less expensive and locally available material. Another advantage of kampagudu is that it helps in market-oriented fish harvest that could be done when the market demands it. Thus, it will be useful in resource enhancement and proper management of resources (Figure 2H).

The installation period of kampagudu is mostly monsoon (September-October). Site selection for installation of kampagudu is based on their availability of fish aggregation and water depth varying from 1.5 - 3.0m. Most of these structures are confined to relatively shallow calm waters. Kampagudu is arranged to entice fish in accumulated mass of tree branches, where they form their abode and are finally caught by enclosing the area. The circumstances of the inner periphery, water hyacinth, bushes and tree branches such as seema chinta *(Pithecellobium dulce),* mulla tumma (*Prosopis juliflora*) and gum arabic tree (*Acacia nilotica*) are dumped together. To avoid the scattering, a circle is made by fixing tree stumps around this vegetation. The outer periphery about 4 - 6m is not disturbed during the period. Sometimes artificial feed like rice bran and oil cakes are also added in order to enhance the production. These are then left as such up to 2 - 3 months. After checking the availability of fish in this area, a

few days prior to the harvest kampagudu is encircled by net. When the actual fishing starts, a group of 5 to 10 fishermen enter the encirclement. The circle is gradually reduced, vegetation is removed. Fishermen churn the whole water to make the fishes come out of suffocation. Fishes are then caught by using the dragnets.

Figure 2: Fishing gear and methods used in Lake Kolleru - A. Hand lift net, B. Cast net, C. Basket trap, D. Drag net, E. Gill net, F. Grouping, G. Doddi fishing, H. Kampagudu.

3.3.4 Gaya

This indigenous technique (Figure 3 A - F) is practiced in lake proper in summer when the water level is decreasing. Harvesting lasts for 30 - 45 days. In this method, larger areas of the lake which are relatively deeper are dewatered with motor pumps and fishes are caught. Simultaneously, Freshwater is pumped into this dewatered area at a point where fish are congregated in large number. As number of fishes congregate in large number, the area the water body becomes muddy very soon. Fishes start gasping for air and come to water surface. Opposite to the area where fish congregated, a deep trench is excavated in such a way that fish attracted towards the freshwater when jump will be trapped in it. A bag net is also placed at the freshwater sprinkling point to collect the fish. This technique is recently developed by the fisher folk taking advantage of fish behavior, migrating towards freshwater.

FIGURE 3. Gaya - an Indigenous fishing technique. A. Drying of shallow area of the lake, B. Freshwater inlet, C. Deep trench opposite to the freshwater inlet, D. Net fixed opposite to the freshwater inlet, E & F. Collection of fish.

4. Discussion

Fishing is a profitable and effective way of getting food, since artisanal fishermen only harvest what they need. Most traditional fishing methods and management patterns are still applicable at the present time. Fishing gear is conveniently divided into two broad categories based on the method of capture: active gear that is propelled or towed in pursuit of the target species, or passive gear, which target species move into or towards [37]. Indigenous traditional fishing knowledge and methods of fishing community of Lake Kolleru is diverse, rich and some of them are unique. Common gears such as cast nets, gill nets, dip nets and traps are in vogue. Selectivity of craft and gear for fishing in Lake Kolleru is influenced by several factors such as economic viability of fisher man, availability of the material, seasonal changes, hydrological parameters of the lake, etc. The success of the fishing techniques depends on various factors like selection of site, time, efficiency of materials used and availability of fish, etc. Cost of craft and gear construction is less as they are made up of locally available material. Since no technical skill is required fishermen are easily adapted to the operation of this indigenous craft and gear. Among various crafts, plank built boats are most commonly used by all fisher men community. Using dug-out canoes is decreasing year by year due to increased prices of tree logs. Cast net is used almost throughout the year but the catch is maximum during rainy season, when the lake is flooded and fishes show horizontal migration to breeding sites. Cast nets are selective for lower size ranges, and larger, faster-moving fish can escape the falling net but may become entangled in the process [38]. Gill nets are among the most selective fishing gear with respect to the size range of target species captured. They can be highly selective for size classes of the target species provided the net is well serviced and tended regularly.

Kampagudu or bush Park fishing method is widely employed in the lake aiming at harvesting fish that find shelter in these structures for the purpose of feeding and breeding. These structures make fishing operations more efficient which could be used as an effective tool in the development of co-operative spirit in fishing communities. Among the all indigenous fishing methods “kampagudu” is the unique and assured method of capturing maximum quantity of fish fauna with less inputs. This method has resemblances with the “Byana fishing” of West Bengal, “Katal fishing” in Assam and “Padal fishing” in Kerala. They are of paramount importance in the fishery scenario, where over-exploitation and low incomes are

the obstacles in the fisheries development. Biological, environmental and socio-economical benefits derived from FADs (kampagudu) should be considered and information in this regard has to be dealt with from grass root level. Destruction of a sizeable quantity of juveniles and sub-adults of the commercially important fishes during kampagudu harvesting should also be prevented.

5. Conclusion

Present study concludes that the ichthyofaunal resources of the Lake Kolleru are an important component of Lake's biodiversity and are an important source of food and income source for fishermen communities. From the present study it is evident that, there is no destructive fishing in this area, fishermen in Lake Kolleru are using indigenous methods for fishing which is greatly contributing to the sustainability of the lake fishery. It is important to mention here is fishermen are releasing smaller fishes back to the lake if they captured them, which is a welcoming step for fish biodiversity conservation of this wetland. All the fishing gear are designed in such way to sustain fishery resources of the lake avoiding capture of small fish, fry and eggs by enabling them to grow well until they contribute to the lake fishery potential. Decreased fishery potential of the lake caused by various anthropogenic stressors is threatening the livelihood of local fishing community. Further research investigations should be focused on developing more suitable fishing gear aiming at exploitation of the fishery resources of the lake in a scientific and substantial way.

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