Economics, visible turnover, and impacts

Joe K Kizhakudan, Shoba Joe Kizhakudan, Geetha R, Remya L and Narayanakumar R.

An assembly of 150-250 units of the various modules at one village site constitute one Artificial Reef and this provides a faunistic support area of 0.10 Ha and 0.17 ha in the latest versions per site on the sea bed. The area of Influence of fish was observed to extend up to 200-300 m from the epicentre of the reef for surface and midwater fauna and up to 100 m for bottom fauna. Primary Efficient Boundary and Secondary Efficient Boundary were found to be 200-400 m and 400-600 m for surface waters, and 40-200 m & 200-400 m for bottom waters. Fish fauna was found to be **10 to 15-fold higher in bottom waters** and **20 to 25-fold higher in surface waters as compared to the adjacent non-reef area**. Maximum catch in gill nets were observed from 40-60 m extending from the periphery of the reefs. Nearly **10-15-fold** increase is observed in the number of fish species occurring per unit area of the reef when compared to the non-reef area in the same zone. The resources (**rare and over-exploited resources)** like large sciaenids (*Protonibea diacanthus*), blue spotted rays, sharks, parrot fishes, black perch, serranids and many grouper species are remerging at the reef sites. Several sites have established as spiny lobster seed settlements and cuttlefish breeding (egg attachment) grounds. Similarly, galatheid lobsters, pistol shrimps, camel shrimps, marbled shrimps, pearl oysters, edible oysters, mussels, amphioxus, polychaetes, echinoderms, sedentary coelenterates-corals, soft and hard etc. breed and multiply on the substrates.

The zooplankton and phytoplankton productivity in the reef adjoining waters and suspension is 2-3 folds from a non-reef area in terms of volume and density and the species diversity is also very high when compared to open adjacent waters. The benthic sediment biota is nearly 5-10 folds higher per sqm in numbers and 2-3 folds high in species diversity. The AR sites thus serve as corridors for fish settlement, movement, feeding and nursing and breeding, and also act as shelter and refreshment habitats like hotels and canteens for migratory groups and rehabilitation centres for the vulnerable ones, thus improving resilience to environmental stress and extreme impacts.

The developed sites after an initial incubation period of nearly 1 year stabilise the population balance over the reef in the third and fourth year and subsequently, they sustain a stable life and community structure with seasonal movements, additions and desertions and forage and predation for another 10 years. If the sediment texture is coarse and the bottom dynamics is not disturbed for a great instance, the units sustain longer. The **Benefit Cost ratio** values observed at a series of stations studied indicate the values ranging from **1.4** to **1.8**, indicating positive turnover and efficient returns. The studies in 2020 undertaken indicate the presence of a standing stock biomass over each reef site at around Rs 25 lakhs and commercial fisheries from an efficient reef site to be Rs 100 lakhs per annum. The present model can sustain 15-25 FRP outboard engine boats, operating in shifts and a maximum of 10-15 at the same time

during currents and drifts. The present dimension and density can support 50 fishers directly engaged in small-scale fishing practices and another 50 who are indirectly involved.

The hook and line fishers have been able to improve the quality of fish catch, reduce their input costs by a reduction in fuel costs and scouting time and increased catch rates and thus the revenue to the tune of Rs 1200 to 4000 per trip. This has thus facilitated single fisher operations and reduced dependency and more independent savings. The trend of diversifying into smaller mesh-sized gill nets and using encircling nets and larger intensified efforts started to reverse when these reefs started to perform with traditional fishing methods and reduced input costs and manpower.

The artificial reef concept has thus reinstated the participatory role in marine fisheries management and the way forward to sustainability amongst the traditional sector. This has also helped in evolving strategies towards solutions towards conflicts arising out of sharing and use of unapproved gears or operating out of turns or seasons, thus bringing a feeling of self-discipline amongst the operators and getting serious behind such conservatory and long-term sustainable development goals.

The Artificial Reefs concept is developed fully to support the traditional artisanal fishermen, specifically the ones operating small-scale low investment crafts/gears and less energy dependent. The Artificial Reefs developed for coastal productivity are placed within the fishery jurisdiction of the traditional non-mechanised sector as per the state MFRA. This is to derive two distinct benefits for the resource and fisher stakeholders. (a) Promote productivity in the near coast and improve fish habitats. (b) Give better access to the traditional fishers, improve their economy and livelihood and reduce pressure on engines/fuel and manpower. And two indirect benefits: (a) Avoid bottom exploiting/habitat damaging gears and reduce conflicts and reduce soft sediment plain areas vulnerable to intensive mechanised exploitation. (b) Increase sustainable fishing practices by promoting of long lines, hooks & lines and drift gill nets.

With sustained efforts in this direction with relentless fisher participation and management efforts, the coastal productivity scenario can make a huge turn around in the coming years with sufficient efforts towards the fulfilment of the ecosystem restoration and conservation goals of the SDG.

The cost of one reef consisting of 250 reef modules creating approximately 1700 sq. m surface area ,400 cubic meters of volume can cost 35-40 lakhs depending on the site, distance from the nearest harbour, labour costs and transport charges. One good and well-deployed such site can ably support 25-30 fisher boats year-round and on an average income of Rs 25 lakhs and could go upto 100 lakhs if the sites are well managed into the fourth year onwards.

Table 6. Socio-Economic-Biological and Environmental benefits from Artificial reefs

1. Increase in Biomass	• **10-25 tones per reef site** • **10 fold increase in bottom fish biomass** • **25 times increase in pelagic & midwater fishes** • **300 time increase in Annual Biomass Flux over the reef area.**
2. Increase in Fish Catch	• 5-25 Kg/Sq.Mt • 2-3 times increase in Fish Catch • **25 lakhs worth fish catch per annum** • **Sea Ranching of Species** which have economic value and ecologically suitable
3. Increase in income	• Up to 70% increase in income is reported from hook & line fishing • Additional Livelihood opportunities like **Tourism like Scuba Diving, Snorkeling**
4. Savings in Fuel & Labor Costs	• 30% savings in Fuel Costs
5. Environmental Benefits	• Coral Restoration • **Attachment of natural coral recruits on ARs** • Enhancement of Biodiversity • Stabilization and Reconstruction of Islands • **reduction of wave energy and thereby coastal erosion**
6. Social Benefits	• **Participatory Approach and Co-Management** of the Reefs will promote ownership • Empower the Small & Artisanal Fishers by improving their income & livelihoods • Prevents Bottom Trawling in the Reef Sites

The overall impacts are in terms of reduced fuel consumption and costs and reduced gas emissions and therefor better carbon foot print advantages, reduced scouting time hence, time saved for social life. The togetherness in the management brings in more integration and social binding and equitable sharing creates a harmonious existence at village level.