

# Tuna Fisheries Sustainable Management: Assessing of Indonesia Fish Aggregating Devices (FADs) Fisheries

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**Abstract.** This paper aims to describe the Fish Aggregating Devices (FADs) fisheries in Indonesia and its relation to sustainable fisheries management. On tuna fishing, FADs are widely used as a tool to attract fish. FADs uncontrolled development is feared to have an impact on the sustainability of fish resources. We found that most of the fish caught around FADs are still juvenile. Deployment FADs can also interfere with the swimming pattern of tuna resources. This is negatively affecting the sustainability of tuna resources. However, from the social and economic aspects, FADs provide significant benefits for fishing communities. The Government has imposed regulations on FADs but not yet implemented. The objective of SDG's in the management of tuna fisheries associated with FADs can be implemented through the application of RFMO regulations. Findings from this paper can be used for policy recommendations for the management of sustainable FADs fisheries.

## 1 Introduction

Tuna is one of the important economic resources in the world, which are only found in marine ecosystems. The trend of global tuna fisheries production in the world increased in 1980 - 2008 but tends to decrease in the next 2 years [1]. FAO noted the tuna fishery production reached 7 million tons in 2012, which spread throughout the world except in the Arctic waters [2]. Tuna fishing industry in Indonesia began in 1962 and had evolved in the 2000s[3]. Tuna became one of an important source of foreign exchange through exports. In 2012, exports of tuna resources reached 201.159 tons with a value of US \$ 749.992 million or the third largest commodity after shrimp and other fish[4].

Tuna resources in Indonesia caught by both industrial and small-scale fishing using several fishing gears such as longline, purse seine, handline, pole and line, gillnet and troll line. For efficiency and effectiveness, fishers used the fishing equipment. One of the equipment used to attract fish is Fish Aggregating Devices (FADs) or commonly referred to as 'rumpon' [5]. FAD's density has ecologically impacted the marine

resources (tuna and like tuna species), so it needs good management. The world's tuna resources are managed by the Regional Fisheries Management Organization (RFMO) as mandated in the Code of Conduct for Responsible Fisheries (CCRF)[6].

Management of tuna resources is needed to maintain the sustainability of utilization. Also, one of the targets for Goal No. 14 in the Sustainable Development Goals (SDG's) by 2020 is to sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impact, including by strengthening their resilience and taking action for their restoration to reach a healthy and productive ocean. And that involves the productivity of tuna fisheries associated with FADs. The Indonesian government has issued regulations regarding the deployment of FADs as one of the efforts for the management of tuna fisheries associated with FADs. However, implementation of this regulation has not been effective. This is due to the limited knowledge of the social economic conditions of fishers. This paper aims to describe the condition of FADs relation to the development of ecologically sustainable fisheries, socio-economic and institutional.

## **2 Materials and Methods**

This paper is part of environmental science by looking at fish resources as an ecological entity with human resources as the main part of fishing activities. The basic principle in environmental science used in this paper is sustainability. It is the capacity of the earth's natural systems and human culture system to survive, thrive, and to adapt to changing of environmental conditions in the future [7]. Sustainability is intended as an effort to meet the needs of the present generation without limiting the ability of future generations to realize the fulfillment of their needs [8,9]. Sustainability in natural resources would occur if its use were not exceeding the specified limit or commonly called the Maximum Sustainable Yield (MSY)[10].

This paper uses the sustainable development as the main approach. This approach must overhaul the conventional development paradigm in order to provide sustainability of the economic, social and environmental issues simultaneously in the three-growth path that continues to move forward [11]. To do so, it has to meet the needs of the present without compromising the ability of future generation to meet their own needs [12]. Sustainability is directed at actions intended to improve or preserve the environment, such as a renewable resource like a fishery. Moreover, sustainable development should emphasize the optimal economic activities, yet still maintaining environmental sustainability as part of the efforts of keeping such development for a long period of time.

Sustainable fisheries management can be found in the Code of Conduct for Responsible Fisheries / CCRF [6]. Sustainable fishing activity can be achieved through proper and effective management that generally characterized by the increased quality of human life and it's well-being as well as the preservation of fish resources and ecosystem health. Sustainable fisheries development use existing fishery resources effectively and efficiently by considering the continuity of the fish stock. The goals of sustainable fisheries development as embodied in Sustainable Development Goals (SDG's) point 14th point published by the UN are: prevent and reduce marine pollution; manage and protect marine and coastal ecosystems; minimize the impact of

ocean acidification; regulate fishing efforts, prevent overfishing and combat IUU fishing; conserve at least 10% of coastal and marine areas; regulate fisheries subsidies; increase and equalize fisheries economy; develop research capacity; provide access to small scale fishers and apply international law.

The Government of Indonesia through The National Medium Term Development Plan (RPJMN 2015-2019) in accordance with the Goal of SDGs point 14 are: (i) Acceleration of marine economic development; (ii) Improving and maintaining the quality, carrying capacity and sustainability of marine environment functions; (iii) Improving marine insight and culture, as well as strengthening the role of HR and Marine Science and Technology; (iv) Improving the living standards of fishermen and coastal communities. It is also translated into the Strategic Plan or "RENSTRA" of the Ministry of Marine Affairs and Fisheries which has fisheries development goals in 3 (three) things: sovereignty, sustainability, and prosperity.

Carles [13] suggested the development of fisheries must be able to accommodate four main aspects: 1) Ecological sustainability: maintain the sustainability of the stock/biomass of fish resources so that utilization is not exceeding its carrying capacity, and to improve the capacity and quality of the ecosystem; 2) Socio-economic sustainability: pay attention to the sustainability of the welfare of the fisheries business to maintain or achieve a decent level of social welfare; 3) Community sustainability: maintaining the sustainability of fisheries community environment conducive and synergistic with enforcing rules or collective agreements firmly and effectively; 4) Institutional sustainability: ensuring the sustainability of good, fair, and clean governance through the efficient and effective institution in order to integrate other three major aspects (ecological sustainability, socio-economic sustainability, and sustainability of the community). So it can be formulated that sustainable fisheries development can be achieved, in the case of the fish resource sustainability, profitable economy, and accepted by the social community.

The management of tuna fisheries has the ultimate goal of establishing management measures in the utilization of tuna resources including the preservation of tuna ecosystems to ensure sustainability of resources and long-term livelihoods for fishers and tuna fisheries businesses. This objective is in line with Article 7 of CCRF 1995 which essentially states that fisheries management is aimed at ensuring the long-term sustainability of fish resources by promoting the optimum utilization of fisheries resources, maintaining the sustainability of these resources for present and future generations [6]. Based on the highly migratory tuna properties, tuna fisheries management is conducted by Regional Fisheries Management Organizations (RFMOs).

Sonoko & Huang [3] states that in the management of tuna resources fisheries must follow the rules of RFMO. The list of RFMO includes Indian Ocean Tuna Commission (IOTC); Commission for The Conservation of Southern Bluefin Tuna (CCSBT); Western and Central Pacific Fisheries Commission (WCPFC); Inter-American Tropical Tuna Commission (IATTC) and the International Commission for the Conservation of Atlantic Tuna (ICCAT). One focus of RFMO is the management of FADs as a tool for tuna fishing. The management of sustainable FAD is done with a local-based approach where there is a relationship between the social environment of society, the economy and the resources of tuna fish, but it often has little to do with localization, local identities and sedentary [14]. Thus, the government should be able to accommodate local interests in the management of FAD based tuna fisheries.

This research uses the desk study method. Research Desk is commonly referred to

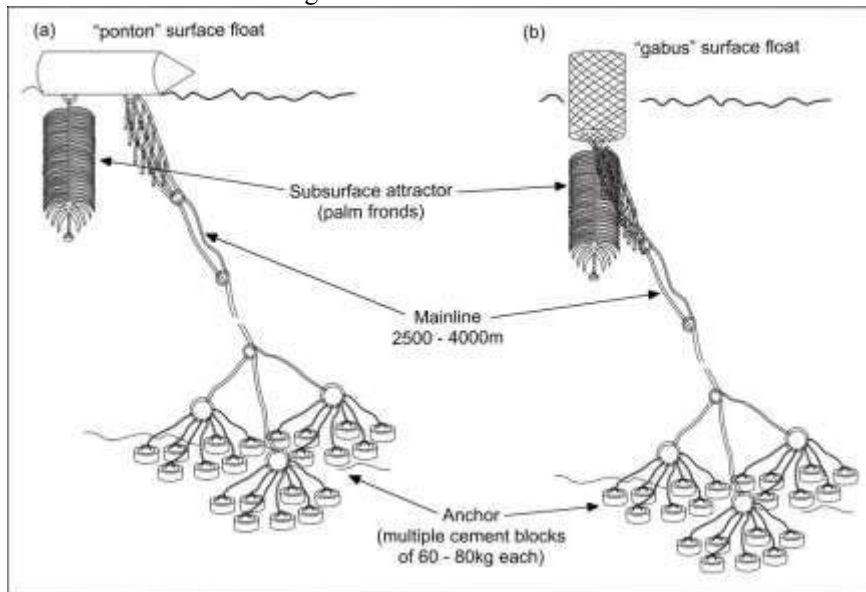
as secondary research; it refers to research where no such original data is collected but uses the existing source of data instead [15]. The data collected comes from scientific journals, government reports and other information sourced from the Internet. Data were analyzed by using descriptive analysis.

### 3 Results and Discussions

#### 3.1 Present Status of FADs Fisheries

Information about the FADs fisheries development needed to determine the current status of the FADs in Indonesia. FADs at sea have been developed since the 1940s and have evolved into a new form called "payaos" in 1978 which was introduced by the Philippines [5]. There are more than 2000 types of FADs in the World [16]. FADs are grouped into two types, anchor FADs and drifting FADs [17]. In Indonesian waters just deployment anchor FADs.

Itano et al. [18] also provided information on the design of an anchor and drifting FADs in the Western Central Pacific Ocean, including anchor FADs used in Indonesia. The FADs construction consists of a float, attractor, rope and sinker/weight. The float used usually made from iron pontoon or cork. Attractor used is made from leaves, usually from coconut leaves. The length of rope used depends on the seabed, up to 3000 m. The weights used in the form of stone or cement. FADs construction in Palabuhanratu can be seen in Figure 1.



**Fig 1.** Type and FADs construction installed in Indonesian waters

Now, there are 3858 FADs registered on Directorate General of Capture Fisheries [19]. But in reality, many more are not registered. This happens due to lack of supervision of the deployment of FADs. Installation of FADs carried out by industry and individuals are not registered. It is one of the factors in the development of tuna fishing. Fishing gear associated with FADs such as purse seine, handline, troll line, and

pole and line. Purse seine and pole and line change their fishing operations from looking for fish schools into traveling to the nearest FADs. This is an indication that the use of FADs, the fishing operation can be made more effective and efficient.

### **3.2 Ecological Sustainability**

Utilization of FADs has an impact on the ecological because they interfere with the movement of tuna as a highly migratory species [20]. Tuna belonging to the family of Scombridae and is one of the large pelagic fish and highly migratory [21]. The results of the study on tuna tagging conducted by the SPC-WCPFC- MMAF 2009-2010 has reinforced previous research results mentioned above [22]. There is movement on a reciprocal basis between tuna resources in the waters of the Banda Sea, Seram, Ambon, and Papua, with tuna outside the territory of Indonesia such as Papua New Guinea, Philippines and the Solomon Islands.

Tuna will move towards FADs so it will be out of the normal migratory track [23]. This will result in a higher density of fish in the FADs than in the free schooling. The density of fish around FADs is highest on the surface to a depth of 25 m for up to 16 fish / 1,000m<sup>2</sup> and decreases as the water gets deepens, where the highest density was found at noon [24,25]. The density of FADs, which are far away from the coast, is higher than that in areas near the coast [26].

In addition, the use of FADs will have an impact on the level of susceptibility of the fish to capture fisheries. Forget et al., [27] mentions the vulnerability of tuna resources related to the behavior of tuna resources on FADs that the spatial distribution and the distance to FADs, vertical distribution, time of capture and type of fishing gear. The vulnerability level of yellow fin tuna, skipjack and tuna-like species in Palabuharatu still in the lower categories, so that its utilization can be continued [28]. However, there are indications that the size of the tuna caught around FADs is still juvenile. Purse seine operation around FADs resulted in juvenile and undersized fish compared to if the purse seine tuna operated in the free schooling [29]. So did catches from the handling, on average they are still not worth catching [30].

FADs also contribute to fish mortality by 35% [30] Thus, the use of FADs will have an impact on the sustainability of the stock, the composition of the catch and its habitat [32]. Widodo et al., [33] indicate the status of tuna resources in the Banda Sea is already encountering overfishing. Nurdin et al., [34] suggested the resource utilization status of tuna around FADs have exceeded MSY. Based on data from the IOTC [35], bigeye, yellowfin and skipjack tuna fisheries in the Indian Ocean are not overfished but require better management.

### **3.3 Socio-economic Sustainability Andinstitutional**

On the social aspect of the community, the use of FADs change the operational tactics of fishing vessels that fished in Indonesia [36]. Additionally, the utilization of FADs resulted in conflict between the FADs and non-FADs user [37]. However, there is an indication of the mutually beneficial relations between fishers using purse seine (industry) and hand line (traditional) in utilizing fish resources around FAD [30]. Hand line fishers may catch fish in FAD owned by purse seine and also help keep the FAD from other purse seine fishers outside the

group. This proves the role of Industrial fishing for the fishermen [38].

FADs provide benefits to the economic conditions of fishers. FADs development over a period of 25 years to move into deeper waters resulted in increased catches [26]. These conditions are also accompanied by rising income received by fishermen. Income from FADs fishing in Kendari is above the minimum wage set by the government, which means the fishermen income is above average [39]. Fishing effort around FADs using handline fishing gear in waters off Bengkulu is still feasible to be developed [40]. One of the strategies to improve the fishermen economy and productivity is by operating four gears at once [30]. The coastal communities in Indonesia have a high diversity. Coastal communities generally have livelihoods as fishermen, but the fishermen characteristics are different between regions. The fishing communities can also play a role in the management of FADs as done in the artisanal fishery in the waters of the Guadalupe [41].

Besweni [42] suggested alternative policy management of FADs through zoning, improvement of financing mechanisms and investment, setting the number of fishers and the number of the fleet. Expected impact from good management of FADs can improve food security [43]. Management of FADs is not carried out only by the government but requires the role of fishing communities or Co-based management [41]. Co-based management is widely used in fisheries management in Southeast Asia [44]. Co-management as an institution is not just about rules but about creating opportunities where knowledge and values articulated, a culture born, and society was created [45]. The community could be one effective institution to apply in fisheries management. Co-management is an appropriate approach in Indonesian managing coastal zone as it allows for the development of a model of containing a balance of power between Governments, communities as a whole and a wide range of individual stakeholders [46].

### **3.4 The Implementation of SDG's and Related Regulations on Tuna FADs Fisheries in Indonesia**

Based on the SDGs number 14, tuna resources associated with FADs must be sustainable. To realize this BPS [47] and also mentioned in the Minister of Marine and Fisheries Regulation No. 45 / PERMEN-KP / 2015 on Strategic Plan of the Ministry of Marine and Fisheries Year 2015-2019. However, in the implementation of the MMAF's "RENSTRA" which is the implementation of the RPJMN 2015-2019 could not cover the SDGs Goals completely.

Some of the things that have been done in managing Indonesia's tuna fishery are: Management of 11 Fisheries Management Areas in a sustainable manner (relevant to goal 14.2); Following the rules and resolutions of the Regional Fisheries Management Organization (RFMO) in determining the Total Allowable Catch amount (TAC), the eradication of IUU Fishing, the preparation of harvest strategy, and the application of Marine Stewardship Council (MSC) for the purpose of certification of tuna fishery products to be marketed (relevant to goal 14.4, 14.6, 14.7); Determination of tuna fishing conservation area through Minister of Marine Affairs and Fisheries Regulation No. 4 / PERMEN KP / 2015 on Fishing Prohibition in FMA-174 which aims to conserve tuna resources (Relevant with goal 14.5).

Tuna fishing communities in the world including Indonesia gives attention to the management of FADs. Based on the nature of the highly migratory tuna, tuna fisheries

management must be done on a regional basis. Indonesia joined with the two regional organizations in the management of tuna fisheries: Western and Central Pacific Fisheries Commission (WCPFC) in the Pacific Ocean and the Indian Ocean Tuna Commission (IOTC) in the Indian Ocean. So the FADs fisheries management must comply with the provisions from both regional management organizations. Table 1 describes the resolution and related regulations FADs fishery.

**Table 1.** Regional and national resolution on fisheries FADs

No	Organization	Resolution	Concern
1	Western Central Pacific Fisheries Commission (WCPFC)	Conservation and Management Measure (CMM) 2009-02	Conservation And Management Measure on The Application of High Seas FAD Closures and Catch Retention
2	Indian Ocean Tuna Commission (IOTC)	Resolution 15/08	Procedures On A FADs Management Plan, Including A Limitation On The Number Of Fads, More Detailed Specs Of Catch Reporting From Fad Sets, & The Development Of Improved Fad Designs To Reduce Incidence Of Entanglement Of Non-Target Species
3	MMAF, Indonesia	Minister Regulation No 107/KEPMEN-KP/2015	Fishery Management Plan for Tuna, Skipjack, Mackarel
4	MMAF, Indonesia	Minister Decision No KP No. 26PERMEN-KP/2014	FADs Deployment

Described in Table 1. Conservation and Management Measure 2009-02 WCPFC on Conservation And Management Measure on The Application of High Seas FAD closures and Catch Retention whose objective: (1) to ensure a consistent and robust implementation of the FAD closure and keep the number of results catches in a safe condition (catch retention, see 2008-01 WCPFC CMM) in the sea area off the Pacific between 20°S-20°U through the specification of minimum standards, (2) to apply high standards regarding the application of the FAD closure and keep the number of catches in a safe condition in order to exclude the possibility of catching the target fish species in FAD or young fish as the 'discard'. WCPFC CMM 2008-1 regulates that the closure of FADs (FAD closures) for purse seine vessels in the area 20°S-20°U from 1 August to 30 September 00.00 24.00 annually. There has been no research that informs about the effectiveness of the FADs closure against the size of the fish caught after the closure.

It is believed that the presence of FADs closure gives tuna resources the opportunity to increase the size from juvenile into the adult fish and fish spawning adults gain the opportunity to do so. Theoretically, the closure of fishing around FADs for a month will enable new recruitment. Thus the FAD closure may be one option in the management of tuna resources in the waters of the Banda Sea. The implementation was to copy that had been done in the open seawaters, from the beginning of August until

late September.

In the Indian Ocean, the Indian Ocean Tuna Commission (IOTC) issued a resolution on the management of FADs through Resolution 15/08: Procedures On A Fads Management Plan, Including A Limitation On The Number Of Fads, More Detailed Specs From Fad Of Catch Reporting Sets, & The Development Of Improved Fad Designs To Reduce Incidence Of Entanglement Of Non-Target Species. The resolution mentioned provisions of the marking FADs installed and also the obligation to report all aspects of FADs fisheries, including by catch results.

As a member of the WCPFC and IOTC, Indonesia has to comply with the resolution that has been issued. The level of compliance to the resolution is an indicator for the management of the tuna fishery resources. The Indonesian government issued Regulation of the Minister of Marine and Fisheries numbers KP No. 26/PERMEN-KP / 2014 on FADs to ratify the resolution, which states that all FADs must be licensed. The regulation defines the distance between the deployments of FADs, ie below 10 nautical miles. But in reality, this regulation is difficult to implement. CFRD (2016) reported that over 50% of FADs were installed in less than 10 m, and not licensed.

As a follow up to the above issues, the Government of Indonesia through the Ministry of Maritime Affairs and Fisheries issued Decision No. 107 / KEPMEN-KP / 2015 on Fishery Management Plan Tuna, Skipjack and Mackarel. Some of the issues listed there include weak implementation of management policies and structuring of FADs; as well as the capture of juvenile tuna with purse seine using FADs. It is expected that the public can comply with these regulations within 5 years.

Implementation of the regulations to the fishermen is not easy due to a lack of knowledge about these rules. The social approach through co-management is one solution to solve this problem. The fishing communities to be one of the success factors of sustainable fisheries management.

## 4 Conclusion

This paper does not state clearly that FADs should not be used as fishing tools. This paper will provide another view on the use of FADs, especially from the social and economic aspects of society. The use of FADs will allow fishers to increase catches and also their living standards. The government has been very clearly providing for the rules on the use of FADs, only implementation in the field that is still lacking. Co-management became one of the solutions in sustainable fisheries management. The Indonesian government through RFMO has implemented the implementation of the SDG's in fisheries management of tuna resources.

The government should look at the other side of FADs fisheries management outside the rules on FADs itself. For example, by determining the fishing equipment will be operated around FADs. Hand line catches more friendly to the fish resources than purse seine. So, we need a policy that restricts the operation of the purse seine. However, this requires further research beforehand.

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