



The inclusion of fisheries and tourism in marine protected areas to support conservation in Indonesia

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ABSTRACT

With the rapid growth of Indonesia's marine protected area (MPAs) estate in Indonesia, reaching 23.9 million hectares by January 2020, attention needs to be focused on strengthening the effectiveness of MPA management. Consolidating and expanding protection of Indonesia's marine resources is critical with increasing pressure from a fast-expanding population, illegal, unreported, and unregulated fishing, pollution, coastal development, unsustainable tourism and climate change. Biodiversity conservation must therefore concurrently consider multiple economic sectors such as fisheries and tourism, and their synergies with MPA management. This paper aims to outline the current landscape of fisheries and marine tourism pertaining to area-based conservation in Indonesia, to inform and support improved integration into effective MPA management. Four areas to focus efforts were identified: diversification of governance types of community-based management, improved coordination between fisheries and MPAs during planning and management implementation, the development and support of pathways for sustainable tourism, and planning for future conditions. Sustainable development for fisheries and tourism must be incorporated into all aspects of MPA management, whilst recognising that current management systems are insufficient to ensure long-term sustainability for natural resources and local communities, and strategies need to increase resilience of social-ecological systems in anticipation of future conditions.

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1. Introduction

Marine protected areas (MPAs) can be an effective conservation tool to protect ocean biodiversity, enhance fisheries, support resilience, and protect ecosystem services [1–3]. As a nation at the heart of the Coral Triangle biodiversity hotspot that harbours 16 % of global coral reefs [4], Indonesia has rapidly grown the number and extent of its MPAs over the last two decades. As of January 2020, the nation held a total protected marine estate of 23.9 million hectares (ha) [5], with an ambitious target to reach 32.5 million ha by 2030 [6]. Indonesia is highly dependent on marine resources, ranking as the eighth most fish-dependent country worldwide in 2018 [7]. Nearly 60 million inhabitants live within 10 km of the coast and 30 km of coral reefs [8], and fish account for 52 % of all animal-based domestic protein consumption [7]. The population of Indonesia is rapidly expanding, and the coastal population alone is projected to grow up to 240 % by 2060 [9], placing increasing pressure on natural marine resources, along with a growing tourism sector [10]. Consequently, the government and communities are facing enormous challenges to keep marine resources sustainable considering that 95 % of Indonesian marine ecosystems are threatened by destructive fishing practices and illegal, unreported and unregulated (IUU) fishing, watershed-based pollution and coastal development [8]. This pressure is in addition to marine ecosystem exposure to broader climate change stressors [8]. As of 2019, the Government of Indonesia classified only 6.4 % of Indonesian reefs in excellent condition and 22.4 % were considered good, with most reefs in fair (37.4 %) to poor (33.8 %) condition [11]. The continued degradation of Indonesia's reefs will heavily impact the welfare of coastal populations, necessitating more effective management of unsustainable resource exploitation [12]. A detailed review of sustainable development in the important sectors of fisheries and tourism will thus help to identify synergies for improved MPA management.

Indonesia is the second-largest marine capture fishery producer after China [13], with around 55 % of the national catch sourced from coastal areas [14]. The Indonesian fishing industry supports 2.7 million workers in the wild capture sector [14] and a growing fisheries sector saw the contribution to Indonesia's gross domestic product (GDP) reach 2.65 % in 2019, growing steadily since 2015 [15]. Fisheries in Indonesia are dominated by small-scale operations, with around 96 % of Indonesia's fishing fleet consisting of small boats (i.e. smaller than 10 Gross Tons [GT]) [16]. However, disproportionately, these small-scale vessels were responsible for just over 20 % of the total fishery capture effort from 2006 to 2016 [14]. Fishing boats up to 5 GT can operate from shorelines to 4 nautical miles (nm); and boats between 5 and 10 GT can operate from 4 to 12 nm from shorelines (Regulation 5, Table 1), however, most current Indonesian fishery regulations are focused on medium (10–60 GT) or industrial sized fishing fleets (over 60 GT) which account for only 4 % of the fishing fleet and typically do not fish on coral reefs [16]. The government of Indonesia is aiming to increase the sustainability of fish stocks to ensure the long-term welfare and livelihoods of Indonesians.

Tourism contributed USD 62.6 million, or 6 %, to the nation's GDP in 2018, making Indonesia the third-largest tourism economy in Southeast Asia [10,17]. The tourism sector makes a substantial contribution towards employment, accounting for nearly 10 % of total employment in 2019 [18] and is thus prioritised in the Long-Term National Development Plan 2005–2025 and the Masterplan of National Tourism Development 2010–2025. The majority of Indonesia's tourism is nature and culture related, 35 % of which is marine based [19]. SCUBA diving is a major marine tourist attraction, accounting for 55 % of officially recorded marine tourism [20], with Indonesian reefs commonly listed in the global top ten dive destinations [21]. International tourism visits worldwide are expected to increase by 3.3 % per year, reaching 1.8 billion by 2030 [22]. Prior to COVID-19, Indonesia had the ninth-fastest-growing tourist sector in the world, growing 7.8 % in 2018: twice the global average. Foreign tourist arrivals reached 15.8 million in 2018 – an increase from 8.8 million in 2013 [10]; however, the ongoing

Table 1

Key governmental regulations of Indonesia's waters, nationwide and MPA specific. Regulations are listed in date order within hierarchical groups, from Undang-Undang to Peraturan dirjen.

Number	Details	Reference
Nationwide Regulations		
<i>Undang-Undang (UU) / Act of the People's Representative Council</i>		
1	Ban on destructive fishing gears Defines small-scale fishing as catching fish for daily needs with vessels < 5 GT	UU RI No. 45/2009 [27]
2	Waters up to 12 nm offshore are controlled by provincial governments and waters over 12 nm offshore are managed by the national MMAF office, along with marine resource management within these areas	UU RI No. 23/2014 [28]
3	Defines small-scale fishing as catching fish for daily needs with vessels < 10 GT	UU RI No. 7/2016 [29]
<i>Peraturan Menteri Kelautan dan Perikanan (Permen KP) / MMAF Ministerial Regulation</i>		
4	11 Fisheries Management Areas (FMAs) cover Indonesia's waters for MMAF to manage fisheries activities for medium and large fishing vessels. Each FMA is intended to represent areas with similar resources and biophysical characteristics	Permen KP No. 18/2014 [30]
5	Fishing vessels < 5 GT can operate within 4 nm from shorelines, whilst 5 GT - 10 GT vessels can operate 4–12 nm from shorelines. Fishing vessels > 30 GT are permitted to operate over 12 nm from shorelines	Permen KP No. 71/2016 [31]
6	Total capture fishery production target is 10.10 MT by 2024	Permen KP No. 57/2020 [32]
7	Boats over 10 GT and less environmentally friendly fishing gears (e.g. managed through the length of nets and mesh size) are prohibited from fishing in coastal areas	Permen KP No. 18/2021 [33]
<i>Keputusan Menteri Kelautan dan Perikanan (Kepmen KP) / MMAF Ministerial Decree</i>		
8	Humphead wrasse (<i>Cheilinus undulatus</i>) size-restrictions (illegal to catch individuals weighing between 0.1 and 1.0 kg and >3.0 kg)	Kepmen KP No. 37/2013 [34]
9	Total Allowable Catches (TAC) for particular fishery species	Kepmen KP No. 50/2017 [35]
10	Species-specific restrictions e.g. protection for sawfish (<i>Pristidae</i> family) and whale sharks (<i>Rhincodon typus</i>)	Kepmen KP No. 1/2021 [36]
<i>Peraturan Direktur Jenderal Perikanan Tangkap Nomor (Perdirjen) / Capture Fisheries Director General's Regulation</i>		
11	Conservation areas contribute to the fishing quota in each province	Perdirjen No. 2/2020 [37]
MPA Regulations		
<i>Peraturan Presiden (PP) / Presidential regulation</i>		
12	MoEF MPAs are split into 2 categories: Nature Reserve Area and Nature Conservation Area	PP RI No.28/2011 [38]
<i>Peraturan Menteri Kelautan dan Perikanan (Permen KP) / MMAF Ministerial Regulation</i>		
13	MMAF MPA partnership for communities and customary practices	Permen KP No. 21/2015 [39]
14	Fishing boats above 10 GT are prohibited from operating within MMAF MPA boundaries	Permen KP No. 475/2016 [40]
15	MMAF MPAs are split into 3 categories: Parks, Reserves/Sanctuaries, and Maritime Conservation Areas	Permen KP No. 31/2020 [41]
16	Representatives from the MMAF MPAs and local communities are included in the consultation mechanism in the FMA's Council	Permen KP No. 22/2021 [42]

COVID-19 pandemic caused a 75 % decrease in tourist visits from 2019 to 2020 [23].

In Indonesia, MPAs have a dual function of supporting small-scale fisheries management in coastal waters as a component of the ecosystem approach to fisheries management (EAFM) strategy [24] and protecting marine biodiversity, including in well-known tourism destinations. However, the fisheries and tourism sectors are managed under different ministries both inside and outside MPAs. The Ministry of Marine Affairs and Fisheries (MMAF) manages fishing activities outside of MPAs for medium and large fishing vessels (i.e. >10 GT), whereas

marine resource management up to 12 nm from coastlines is managed by the provincial government under the Decentralization law (Regulation 2, Table 1). The tourism industry is managed by the Ministry of Tourism and Creative Economy. Furthermore, MPAs can be established by either MMAF or the Ministry of Environment and Forestry (MoEF) (Fig. 1), depending on their conservation aims [25]. The majority of MPAs are managed by MMAF and are intended to protect, preserve, and sustainably use marine biodiversity and therefore have an additional focus on the sustainability of fisheries, whilst the objective of MoEF-managed MPAs focusses on the preservation of plant and animal species [26]. MoEF manages its MPAs centrally from Jakarta with field teams in the MPAs. However, MMAF MPAs can either be managed by the provincial government (provincial MMAF MPAs) or directly by MMAF in Jakarta (national MMAF MPAs) with staff on the ground in the MPA in both cases [25]. As fisheries and tourism are both increasingly important industries in terms of economic benefits and employment, there is a need for strong coordinated sustainable management strategies between stakeholders to allocate resources effectively and efficiently.

A wide range of management strategies are used within MPAs, prohibiting or allowing certain activities that are applied across the MPA or among zones. MMAF-managed MPAs are divided into three main categories: (1) Parks (Taman/Marine Parks) with devoted *Sustainable Fisheries Zones*, *Tourism Zones*, and controlled fishing (Regulation 15, Table 1); (2) Reserves/Sanctuaries (Suaka/reserve for fisheries and/or endangered, threatened and protected marine species) and (3) Maritime Conservation Areas (Kawasan Konservasi Maritim/KKM - historical, heritage, and/or customary), both of which allow tourism and fishing in the *Limited Use Zone* (Regulation 15, Table 1) [26]. MoEF-managed MPAs are divided into two main categories: (1) Marine, Coasts and Small Islands Conservation Areas (Kawasan Konservasi Perairan, Pesisir dan Pulau-Pulau Kecil/KKP3K) and (2) Nature Conservation Areas (Kawasan Pelestarian Alam/KPA) (Regulation 12, Table 1). As zoning within MoEF-managed MPAs is directed towards the preservation of species, fishing is only permitted in the Use Zone/Block (Regulation 12, Table 1). For MoEF- and MMAF-managed MPAs, neither fishing or tourism are permitted within Core Zones (Regulations 12 and 15, Table 1). Within zones that are open to fishers, individual MMAF and MoEF MPAs can impose their own restrictions, but by default the only restrictions applied are the exclusion of vessels over 10 GT (Regulation 14, Table 1) and national fisheries restrictions that apply to all marine areas regardless of MPA status. These nationally applied restrictions include a ban on destructive fishing gears, such as blast and cyanide fishing (Regulation 1, Table 1), and some species-specific restrictions, such as the full protection for sawfish (*Pristidae* family; Regulation 10, Table 1).

This paper aims to outline the current landscape of fisheries and marine tourism pertaining to area-based conservation in Indonesia, to inform and support improved integration into effective MPA management. First, the challenges and opportunities at the nexus of MPAs – fisheries and tourism – are highlighted, considering the balance between sustainable development and the protection of natural resources. The opportunities available to MPA authorities to balance the demands from the two sectors are discussed from the perspective of conflict mitigation. Second, how challenges and proposed opportunities are impacted by the latest development of national policy and regulation and emerging global threats are considered, along with opportunities to incorporate ecological resilience. Finally, the opportunities for fisheries and tourism are discussed, and guidance for integration into effective MPA management is provided.

2. Fisheries and MPAs

2.1. Fisheries and MPAs: challenges

Although there is a legal framework for regulating access of fishing boats to MPAs (Regulation 14, Table 1) [24], implementation of further

regulations is severely hampered. Over 70 % of Indonesian MPAs still have no zoning system in place [43], meaning only nation-wide fishing regulations may apply in such cases (Table 1). Even in MPAs zoned to manage fishing activities, the enforcement of restrictions is highly dependent on human and financial capacity of management bodies at the provincial and MPA levels. Compliance is difficult to achieve considering the financial incentives associated with illegal fishing activities. For example, in Komodo National Park¹ (Lesser Sunda Islands), protected humphead wrasse (*Cheilinus undulatus*) spawning aggregations provide lucrative illegal fishing rewards [44]. While MPAs are frequently regarded as mutually beneficial solutions for development and conservation, successful achievement of this balance is rare [45], and trade-offs frequently occur. For example, when fishery restrictions are implemented to enable stocks to recover, the benefits for fisheries are not immediately felt [46]. Tensions often arise when MPA rules and regulations are designed and implemented in areas with strong cultural foundations that are not adequately considered in a local context [47]. To illustrate, initial zoning of some MPAs resulted in community grievances and non-compliance due to a focus on economic and ecological aspects of the marine environment, whilst neglecting social and cultural spaces such as traditional fishing grounds [48,49]. Consequently, this led to rezonation with community participation [48]. Community involvement in MPA governance can benefit both biodiversity protection and the provision of ecosystem services, although balancing and reconciling different aims remains challenging [50].

In Indonesia, the definition of a ‘small-scale fishery’ is unclear, making enforcing regulations in coastal areas, where the majority of MPAs in Indonesia are located (Fig. 1), problematic [51]. Regulation 3 (Table 1) defines small-scale fishing as catching fish for daily needs with fishing vessels < 10 GT, while Regulation 1 (Table 1) defines small-scale fishing as catching fish for daily needs with vessels < 5 GT.² Increasingly, Indonesia is coalescing around a 10-GT definition [51]. Although the majority of Indonesia’s fishing fleet meet the Regulation 3 (Table 1) definition of small-scale fishing, [16], and are therefore allowed to fish within MPAs with no zoned fishery restrictions, most fisheries management efforts currently focus on larger boats prohibited from fishing in coastal areas (Regulation 7, Table 1). Furthermore, Indonesian definitions do not align with international classifications. The new IUCN definition of industrial fishing is ‘> 12 m long x 6 m wide motorised vessels, with a capacity of > 50 kg catch/voyage’ [52] which does not translate well to Indonesian industrial fishery classification (over 30 GT). The IUCN states that industrial fishing should be excluded from MPAs completely [53]. However, Indonesian regulations need alignment with this newly defined guidance as they currently focus on the sustainable and highly restricted fisheries within MPAs. A narrow classification of fishing based solely on vessel size may also not be the best approach, as other vital information is not considered. For example, as environmental impacts of fishing gears vary, simple regulations of gear use can promote sustainability of fisheries even without outright bans on fishing [54].

Given that one objective of MMAF MPAs is to support human well-being through sustainable fisheries, the linkage to Fisheries Management Areas (FMAs) must be considered. Indonesia’s waters, covering an area of 6,287,000 km², are divided into 11 FMAs i.e. areas used by MMAF to manage fisheries activities for fishing vessels over 10GT (Regulation 4, Table 1). MPAs in Indonesia are often located nearshore in order to conserve areas facing anthropogenic pressure, whilst also delivering socio-economic values for communities, however the number of MMAF MPAs within each FMA varies considerably (ranging from 1 to

¹ Komodo National Park is a terrestrially-designated MoEF protected area, however it is managed as a multi-use MPA as it contains extensive ocean area.

² Regulation 3 will supersede any contradicting regulations, such as Regulation 1, therefore small-scale fishing is recognised as catching fish for daily needs with vessels < 10 GT.

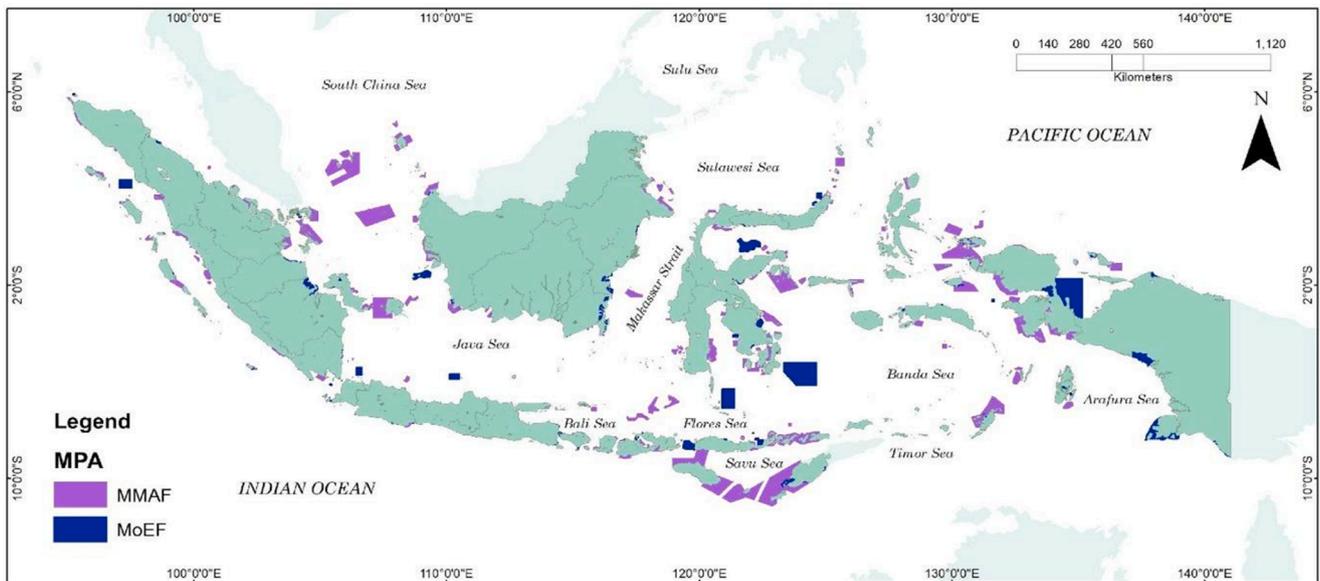


Fig. 1. Distribution of MPAs managed by the Ministry of Marine Affairs and Fisheries (MMAF) and the Ministry of Environment and Forestry (MoEF) in Indonesia. Figure shows MPAs as of January 2020.

13) (Fig. 2) [55]. An EAFM approach is adopted to develop management plans, and each FMA has, or is in the process of establishing, a management commission that receives input from an advisory and scientific panel [56]. However, because the management commissions are currently in the early development stage, governance and management of fisheries resources are not yet integrated with biodiversity conservation goals [56]. Furthermore, these commissions are not located in the same MMAF division as MPA management bodies, hampering cooperation between FMA and MPA managers. Provincial governments also only control coastal waters up to 12 nm offshore; areas > 12 nm offshore are managed by the national MMAF office (Fig. 2), whilst no

authority for coastal management is delegated to district- or regency-level government (Regulation 2, Table 1).

A centralised structure can be problematic given the large geographic area and cultural diversity of the country, for example where fishery laws and sanctions have failed to consider community fishing regulations [57,58]. When initially established in 1999, MMAF used mostly top-down approaches to fisheries management [59], but recent attempts aim to regulate small-scale fisheries through empowerment or recognition of traditional management systems [60]. This effort has had mixed success because of low compliance and commitment from those involved in fisheries management [61,62]. It is difficult for

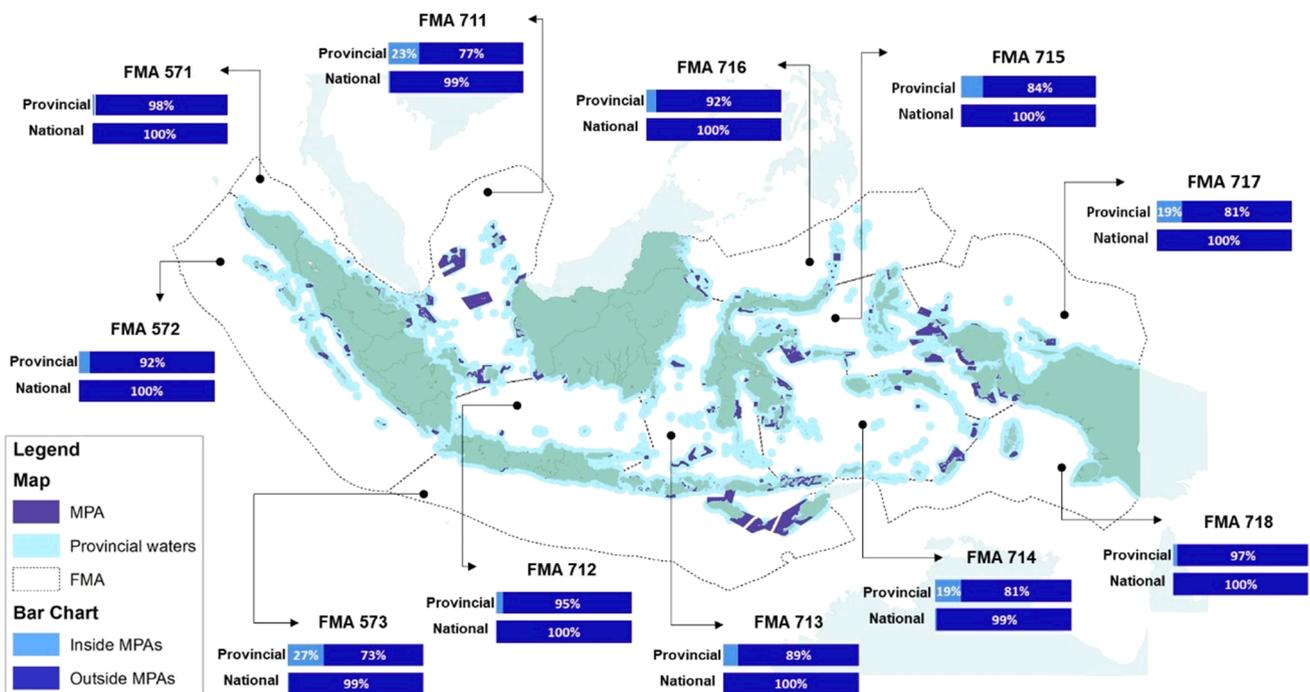


Fig. 2. The distribution of MMAF MPAs within 11 Fisheries Management Areas (FMA) in Indonesia, with a 12-nautical-mile radius around the coastline to represent waters under provincial government. The percentage bars indicate the proportion (ha) of provincial (within 12 nautical miles of the coastline) and national (outside 12 nautical miles of the coastline) jurisdiction of each FMA within MPAs. Figure shows MPAs as of January 2020.

community-based protected areas in Indonesia to be formally recognised as MPAs even if IUCN definitions are met [53], as is the case with locally managed marine areas (LMMAs) [25]. Failing to consider or integrate existing management foundations can reduce legitimacy, leading to the perception of MPAs as being implemented by ‘external elites’ [63].

Low compliance with fisheries management has contributed towards overexploitation of common fishery species populations in Indonesia, as is now the case for 50 % of wild-capture fish stocks [14]. Solutions have been sought by introducing size-specific national fisheries regulations for fish and the adoption of Total Allowable Catches (TACs) for some species (Regulation 9, Table 1). Specific protection has also been directed to several endangered commercial marine species, such as whale sharks (*Rhincodon typus*; Regulation 10, Table 1). For humphead wrasse, it is illegal to catch individuals weighing between 0.1 and 1.0 kg and > 3.0 kg (Regulation 8, Table 1). However, even where there is ongoing concern about the status of a resource, annual targets for fishery production, informed by the TAC [14], tend to increase: the total capture fishery production target is 10.10 MT by 2024, compared to 7.53 MT in 2019 (Regulation 6, Table 1). Whilst some of this gain could be explained by increasing confidence in stock assessment and better co-ordination around biodiversity conservation and fisheries between authorities, it is not clear that this accounts for the observed growth in fishery production targets. For the blue swimming crab (*Portunus pelagicus*), an exploited fishery species, MMAF implemented a TAC of 34,753 tons which was exceeded consecutively from 2010 to 2018 [14,64]. This wide centralised approach to fisheries can lead to challenges in regulation enforcement and compliance when managing individual and local fishery stocks [65,66]. Such factors have led to over half of Indonesia’s 11 FMAs showing no opportunities for immediate expansion of production [14].

2.2. Fisheries and MPAs: Opportunities

With the current momentum to create new MPAs and increase management effectiveness e.g. by establishing zonation within existing MPAs and developing MPA networks, there is an opportunity to more strategically zone MPAs to benefit fisheries. As of late 2020, for MPAs managed by MMAF, core zones must define the conservation features they are trying to protect, in particular areas that function as spawning, nursery, and feeding areas, with updated minimum conservation feature coverage requirements of 10 % within the Park category and 70 % within the Reserve/Sanctuaries category (Regulation 15, Table 1) – an increase from the previous requirement of 2 %. Zones that restrict extractive activities inside MPAs, such as core zones, can benefit fisheries when fishing efforts are high and stocks are overexploited, MPA design considers connectivity, and the restrictions are highly enforced [67], however this also requires fishery areas outside of core zones to be well managed. For example, fish spill-over from recovering populations within core zones to surrounding fished areas and larval connectivity from the protection of spawning biomass can deliver fisheries outcomes [68,69], with a suggestion that depleted fisheries can be rebuilt by covering a generic target of 20–30 % of the fished habitat within core zones [69].

There are benefits associated with areas that permit fishing yet have strict regulations to adhere to, such as fisheries targets. The implementation of maximum catch strategies needs to be carefully considered in the future to ensure that they are seen as a maximum for fisheries, rather than the TAC being held as a fishery target. Sustainable fishing may mean reduced fishing and fish consumption in some instances, particularly in the short term, but it is important to consider food security and socio-economic factors when regulating subsistence fisheries. MPA implementation, similar to implementing strict catch management strategies, may initially reduce fisheries yields [46], where recovery times to sustainable biomass can be over decades [70]. The resulting long-term reduced fishing and fish consumption opportunities will impact those most reliant on coral reef provisional services that have

little choice or opportunities for alternative livelihoods [71]. In Indonesia, fisheries management needs to centre around ensuring that communities and people with strong dependencies on fish are not marginalised, and alternative options for income and protein sources are created. The interplay between avoiding coral reef fisheries over-exploitation and ensuring socio-economic goals, or in many cases, basic food security needs, is an example of a wicked conservation problem [72] where a solution that meets all criteria is almost impossible to reach.

Moving forward, it is important to consider how MPAs can improve the sustainability of Indonesian fisheries outside of MPA boundaries, especially for MPA contributions to FMAs. The respective contributions of MPAs to FMA reef fisheries need to be evaluated to account for their suitability in fisheries management, establishing how current MPA management and future MPA designations could contribute to improved fisheries yields in adjacent areas. The MMAF has issued regulations which calculated the conservation area as an important contributing factor to the fishing quota in each province (Regulation 11, Table 1) as they can help to sustain and increase fish stocks [68,69]. Representatives from the MPAs and local communities are also required to be included in the consultation mechanism in the FMA’s Council (Regulation 16, Table 1). One tool to align fisheries management and spatial controls could be management strategy evaluation. This tool models various management options which include output and input control, including the spatial control applied in MPAs to provide trade-offs among management objectives for the stakeholder [73]. There are also key opportunities highlighted here for future partnerships between the FMA and MPA management commissions to integrate conservation activities with regional fisheries management. Recently an MPA network has been designed for FMA 715 (Fig. 2), covering waters of six provinces (West Papua, Maluku, North Maluku, North Sulawesi, Central Sulawesi and Gorontalo), to support fisheries management and aid biodiversity protection [74]. Although implementation has not yet started, the MPA network provides valuable opportunities to improve the sustainability of fisheries in each province, whilst increasing FMA-MPA coordination at both the national and provincial levels. To ensure that fisheries implementations within MPAs apply sustainability principles to protect biodiversity, MPA managers need to strictly apply, and preferably enhance, the FMA’s fisheries utilisation strategy that regulates the allowable fish catch, fishing gears and fishing vessels.

As many forms of customary marine resource management benefit local fisheries, it is important for customary governance within MPAs to receive increased recognition for sustainable fisheries management. This recognition can be achieved by accepting more flexible forms of co-management, with government delegation of authority to local communities. How formal cooperation is undertaken to engage communities and customary practices is arranged through the MMAF regulation on MPA Partnership (Regulation 13, Table 1). Customary areas should also be captured in formal zonation plans with appropriate zone types given, and communities recognised to continue to manage these areas within the MPA. For example, on-the-ground implementation was initiated in 2017 within the Anambas MPA (Riau Archipelago) through a collaboration agreement between the Anambas Islands Marine Recreational Park Authority and the Batu Belah Bersatu Community Group to manage the 573,37 ha area-based fisheries at Mensabang Village [75]. The community was granted rights to fisheries management within the MPA under a capture fisheries subzone. A sense of ownership and control over resources can be created when communities are involved, reducing the ‘external elites’ perception [63,76]. In turn, better stewardship is likely to increase compliance whilst reducing the risk of conflict [77].

There are opportunities for other effective area-based conservation measures (OECMs) to be incorporated into fishery sustainability efforts beyond MPA boundaries in Indonesia [78]. OECMs provide ‘positive and sustained long-term outcomes for the in-situ conservation of biodiversity’ [79], such as sites that provide important ecosystem services. Although OECMs are not currently recognised by the Government of

Indonesia [78], they show great promise for the future. There are diverse types of area-based management currently existing in Indonesia that can be recognised as OECMs. Rights-Based Fisheries Management can be incorporated in this way, allocating fisheries rights to distinct groups (e.g. catch volumes, number of vessels, access to certain fishing grounds), and increasing the well-being of small-scale fishers without expanding overall fishing effort [24]. Territorial Use Rights in Fisheries (TURFs) are a separate initiative to MPAs with a governance structure run by local communities to manage fishery access, where certain fishers are granted entrance to a specific area of marine resources [80], and, if locally monitored and rules enforced, can be highly successful in areas with traditional claims over fisheries. For example, in Aceh (Northwest Sumatra), *Panglima laot* has been practised for centuries, where coastal resource management incorporates traditional wisdom [81]. Here, a set of rules and regulations such as fishing time and allowable fishing gears are applied to an organisation of local fisher associations [82]. In some cases, the traditional fishery practices comply with the IUCN MPA definition but are not recognised as part of conservation efforts within Indonesia – in such circumstances, TURFs offer opportunities for legal recognition as OECM.

OECMs also include area-based initiatives incorporating customary and traditional management that have been implemented for generations around Indonesia, such as *sasi* i.e. temporal or spatial bans on natural resource harvesting, such as seasonal fishery area closures [50, 83]. Such strategies are associated with high levels of compliance and a contribution to biodiversity conservation similar to that of MPAs. Examples of this are LMMAs incorporating shared governance, where stakeholders from the local community, government, non-governmental organisations (NGOs), and academia are frequently involved in decision-making. Although LMMAs are not formally recognised as MPAs in Indonesia, they are commonly involved with wider LMMA networks and incorporated into traditional structures. One example is Tanimbar Kei LMMA, which was established as a partnership between community members and an NGO (the Indonesian Locally Managed Marine Area Network; I-LMMA) and is strongly aligned with customary institutions [84]. The LMMA received legal recognition for ownership and governance and has acquired an income through seasonal fishing licences sold to fishers from external communities [84]. Positive impacts have since been reported, such as an increase in both size and harvest of *Trochus*,

along with an increased coverage of hard corals [84]. Tanimbar Kei LMMA therefore provides an example of the successes possible from a diverse governance structure, without formal MPA recognition.

3. Tourism and MPAs

3.1. Tourism and MPAs: challenges

Tourism in Indonesia is distributed unevenly throughout the archipelago (Fig. 3); Bali, with less than 1 % of Indonesia's landmass, receives half of all foreign visitors [19], leading to some MPAs receiving disproportionately high tourist visits. The impacts on the surrounding ecosystem and communities can be detrimental when tourism is not well regulated and sustainable development plans are not in place. Intensive tourism infrastructure development decreases water quality through coastal development and sewage run-off [85], causing high sedimentation and eutrophication, potentially leading to an increase in the prevalence and severity of coral diseases [86,87]. The Gili Matra Islands on the north-west side of Lombok have been developed for tourism activities since the 1990s and demonstrate the detrimental effects that tourism can have on ecosystems [88,89]. Patterns of landscape change have been identified on the islands as a result of sand mining, coral exploitation, and reclamation for construction of tourism facilities, along with a decrease in live coral cover in the Gili Matra Marine Park [90]. To minimise the impacts of tourism on MPAs, regulation attempts have been made, such as for tourism directed towards popular megafauna e.g. in Nusa Penida, where manta rays (*Mobula alfredi* and *M. birostris*) and bump-head sunfish (*Mola alexandrine*) aggregations occur. However, the number of boats allowed to enter these areas is unregulated, and compliance and enforcement with voluntary codes of conduct for appropriate tourist-species interactions are low [91]. Details on tourism implementation, such as total allowable number of tourists per area per day, are also not controlled by national regulations.

Tourism infrastructure can further lead to socio-environmental conflicts; for example, with the number of tourists increasing every year, the need for resources such as energy, food and water are prioritised for visitors over the local communities [93]. Employment opportunities offered through the tourism industry are usually low-level positions as businesses are frequently owned by foreigners, and the

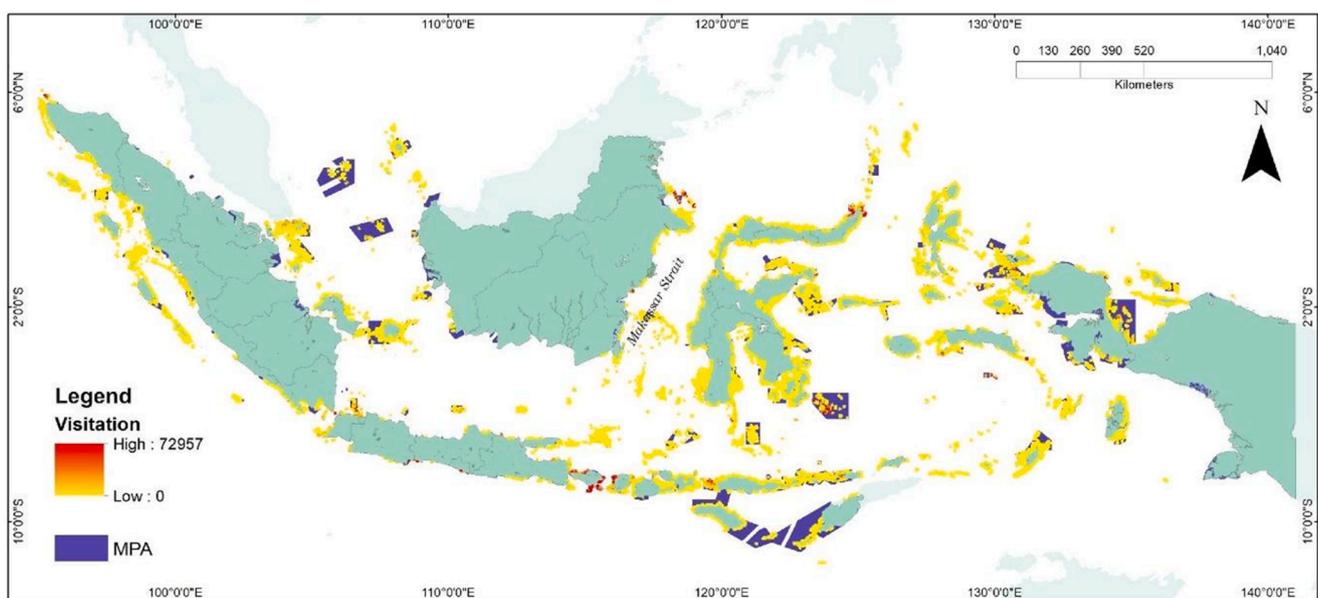


Fig. 3. The average distribution of visitations to coral reefs in Indonesia in relation to MPA location. Coral reef tourism layer was sourced from Spalding et al. [92], modelled from 2008 to 2012 economic data (visitor and tourism expenditure), the coral reef footprint in 2014, Flickr photos from 2005 to 2012 (to inform the spatial distribution of visitor activity) and the locations of dive shops, hotels and dive sites as of 2014. Figure shows MMAF and MoEF managed MPAs as of January 2020.

availability of jobs is seasonal with the flow of tourists [93]. International tourism is not a realistic option for many highly remote areas, and care needs to be taken to avoid pushing this as a promising option for development. Such strategies are likely a false economic promise to isolated communities as large investments in infrastructure, such as access routes and hotels, risk the degradation of the ecosystems that both support subsistence activities and attract tourists to visit.

Ecotourism i.e. experiences that are 'nature based, ecologically sustainable, environmentally educative, locally beneficial and (participant) satisfactory' [94,95], is often directed towards undisturbed and remote natural areas where little infrastructure to support tourism exists (e.g. [96]). The attitude of local communities towards tourism in these circumstances is dependent on the proposed benefits that they will receive, as seen in Wakatobi National Park, a dive ecotourism centre that was established in 1995 along with a research ecotourism centre in 1996 [97]. However, the ways in which each establishment interacted with the local communities were variable [97]. The main forms of employment offered to the local communities by the dive ecotourism centre were low-paid roles such as maintenance and cleaning, and resources such as food are mainly outsourced and imported [97]. The low potential for mutually beneficial social interactions and limited economic benefit for local communities resulted in negative attitudes and distrust towards the centre and the tourists who visited [97]. In contrast, the research ecotourism centre relied on local communities for accommodation, food, and labour, and research activities frequently involved the local people and focus on social aspects of the MPA [97]. However, restrictions in the area, such as *core zones*, are likely to reflect the interests of tourism centres over local communities. For example, the protection of pristine reefs is aimed at attracting divers rather than ensuring sustainable fishery catch [97]. Growth in the tourism industry may enable operators to influence MPA management to reflect their own interests, leading to centres benefiting from management decisions over local communities, further leading to their disempowerment and increasing mistrust of the industry.

3.2. Tourism and MPAs: opportunities

Marine tourism is considered a sustainable finance mechanism by MMAF and MoEF to provide livelihoods for local communities within MPAs. However, future plans need to carefully consider and incorporate local communities to avoid user conflicts and ecosystem degradation, as evidenced, for example, by the controversial large new development in Komodo National Park, coined 'Jurassic Park', where there is concern over local communities losing existing control over land and resources [98]. Indonesia aims to develop ten national priority tourism destinations, known informally as 'the new Balis' and, up until 2020, the focus for infrastructure development was targeted towards five sites (Borobudur, Central Java; Mandalika, Lombok; Lake Toba, North Sumatra; Labuan Bajo, Flores and East Nusa Tenggara) [99]. However, the impacts on tourism visits are yet to be seen due to the travel restrictions imposed as a result of the COVID-19 pandemic. The Ministry of Tourism and Creative Economy and MMAF have also identified 37 areas for diving tourism development across the country. If tourism is managed sustainably in Indonesia, initiatives such as these have the potential to promote positive ecological, economic, and social outcomes, including a greater awareness and protection of marine environments [100], and can further lead to a reduction in extractive pressures through fishing [101,102].

With the intention of mitigating negative impacts of tourist visits on MPAs, initiatives should be built together with stakeholders. Selat Dampier MPA within Raja Ampat (West Papua) introduced codes of conduct in an attempt to control growing tourist visits [103]. To enforce these regulations, a ranger station was established in the popular dive area of Manta Sandy in 2017 as part of collaborative management between NGOs, tourism operators, and local government and villages [103]. The station ensured that tourists and operators were adhering to

codes of conduct such as tourist volumes, and any violations of the regulations resulted in sanctions [103], providing an example of the opportunities available for diverse governance and management in Indonesian MPAs. However, where diverse governance and management is proposed for MPAs, care must be taken to ensure that actions are in the best collective interest of the stakeholders [104]. For example, a collaborative governance structure in Nusa Penida MPA encountered issues with stakeholder engagement and action due to an ineffective management structure and a lack of communication between local communities and foreign stakeholders [104].

Involving tourism stakeholders in the management of MPAs can increase both the economic benefits directly received from tourism and the levels of compliance with implemented regulations [58,105]. Admission fees are a common implementation for MoEF and MMAF MPAs and earnings can bolster MPA management and support for local communities, in turn providing incentives to support conservation [100,105]. In Bunaken National Park (North Sulawesi), tourist visits were found to be more than double the annual carrying capacity [106]. Doubling the price of admission was therefore found as the best strategy to reduce visitation, benefitting the stakeholders involved, including the local government, the national park agency, local businesses and research institutes [106]. In Raja Ampat, the local authority implemented an admission charge for a network of 20 MPAs as a form of a Payment for Ecosystem Services (PES) arrangement [107–109]. Approximately 40 % of the revenue from the entrance fee is disbursed to a community fund, with the rest allocated to management costs [107]. Despite entrance fees, visitors to the MPA increased 30-fold since 2007, indicating the willingness of tourists to contribute to the PES arrangement, however care needs to be taken to ensure that tourist visits do not exceed the maximum carrying capacity. Nevertheless, entrance fees can be unsuccessful in cases of improper implementation, as in Kaimana MPA, where fees were poorly publicised and applied [109]. As the Ministry of Tourism and Economic Creative shifts its focus from increasing tourist visits to using tourism to increase community income [110], approaches like these support conservation goals by presenting incentives for local communities and tourism stakeholders [111]. For example, under the Coral Reef Rehabilitation and Management Program (COREMAP) led by MMAF and financed by the World Bank and the Asian Development Bank, a Seed Fund is available to village organisations in order to provide individuals with start-up loans, steering employment opportunities away from low-level positions [112].

Opportunities can further be provided for the welfare of local communities along with biodiversity protection when ecotourism is opted for over mass tourism [93], placing emphasis on the quality of tourism over the quantity of visitors. Community-based tourism is a form of ecotourism strongly recommended by MMAF as a more sustainable option over extractive activities [113]. Community-based tourism relies on the participation of local communities in all aspects of the MPA, including initial development and day-to-day operations. This approach also opens opportunities for tourists to involve themselves with marine conservation activities, such as ecosystem restoration, enabling the creation of volunteering packages and opportunities for tourists. However, the implementation of such strategies requires in-depth and careful planning to ensure their sustainability and attraction. Private sector governance models also show promising opportunities for tourism, as in the case of Misool Marine Reserve, a private no-take area created in 2005 where increases in fish biomass were observed [114]. Private no-take areas also present opportunities for recognition by the Government of Indonesia as OECMs, as discussed previously.

4. External threats

Climate change threatens Indonesia's marine ecosystems and fishery and tourism industries, along with the conservation efforts addressed with MPAs. Even under optimistic climate scenarios, severe coral bleaching and mortality events are expected to become an annual

occurrence [115]. Such events severely degrade coral reef ecosystems [116], including the fish communities that support fisheries [117]. Fishing communities often respond to the decreased fishery catches with short-term strategies that can further degrade the marine environment, such as a change to more destructive gear types or a change in fishing locations that may contravene regulations [93]. As a conservation measure that limits fishing and access, MPAs are unable to protect against coral bleaching and mortality (e.g. [118,119]), however coral health, water quality, fish populations and algal cover are key factors in post-bleaching recovery [120–122]. Effective management to ensure compliance with fishery and tourism regulations, such as a ban on destructive fishing methods, is extremely important when considering resilience to climate change to promote effective ecosystem recovery. Careful planning of MPA implementation and zoning can also help to promote ecosystem recovery through the protection of ecological refugia [123], although climate refugia on coral reefs are likely very limited [124]. However, this would also require ongoing monitoring to form a robust dataset of coral reefs and their condition. As with recovery from COVID-19, vulnerability to climate change of both human and ecological communities in Indonesia is an unresolved challenge that needs urgent consideration in the context of MPA design, along with broader needs for emissions reductions.

In March 2020, travel restrictions relating to COVID-19 were imposed globally. Travel constraints halted the Indonesian tourism industry, and many fisheries were forced to close, with heavy reductions in incomes within local communities. Shortly after COVID-19 was first detected in Indonesia, government-managed fish landing port facilities were closed, leading to a reduction in fish exports by up to 70 % [125]. In response to these closures, the government offered support for industrial scale fishers, including the availability of cold storage facilities for fish stockpiles, but little support was provided for small-scale fisheries [126]. As the majority of Indonesia's fisheries are small-scale, they lack the resources to be resilient to economic shocks, such as COVID-19. COVID-19 had catastrophic impacts on small businesses and fishers through large decreases in total catch value, potentially explained by the closure of restaurants and shops around Indonesia. However, most fishers and traders continued fishing, despite receiving lower prices for catches [126]. With the closure of most tourism operations almost overnight, fishing provided alternative income and food security. Communities that relied on tourism initiatives such as entrance fees experienced a major reduction in budgets for MPA operations because tourism ceased, resulting in weakened enforcement of fishing regulations in multiple locations across Indonesia [127]. The COVID-19 pandemic therefore illustrates the broadly un-resilient, unsustainable nature of international tourism incomes when faced with global change.

As the world, and Indonesia, recover from COVID-19, opportunities arise to reconsider the ways in which tourism and fisheries play a crucial role in creating resilient social and ecological systems. A resilient community, i.e. one with the ability to 'withstand external shocks to its social infrastructure' [128], is better able to 'survive, adapt to, and occasionally transform itself' in the face of unexpected and uncertain environmental change [127,129]. In Wakatobi National Park, international visitors, particularly the high-end dive tourism sector, have been identified as the main drivers of tourism growth, making this area vulnerable to change [130]. An increase in community-led tourism run by resident communities and targeted towards the growing middle class of Indonesia is therefore recommended to incorporate more resilience, though the financial benefits are likely to be lower than international tourism. An increase in government-provided resources and support for communities is also required, for example, previous initiatives have focused on promoting domestic travel by increasing the number of public holidays [19]. Foreign operators should also closely align themselves with local initiatives [129].

Flexibility within community livelihoods is extremely beneficial in times of uncertainty. In Nusa Penida, for example, communities formerly employed in the tourism industry have taken up the traditional

practice of seaweed farming as an alternate income stream [131]. In Raja Ampat, community managed areas such as those involving *sasi* have functioned well despite the impacts of COVID-19, indicating the importance of local traditions for community resilience [132]. However due to the halt in tourism revenue, field patrol teams have been reduced in number, leading to a reduction in compliance with fishery regulations [132]. In response, cooperation in management activities has continued; for example, communities have been designated with patrolling their surrounding areas, allowing the government bodies to patrol more remote areas [132]. Reduced staff numbers have demonstrated the ability of some MPA management bodies to still operate effectively, allowing future efforts to focus on improving management practices. A new strategy is therefore in development in Raja Ampat with an improved focus on the management of tourism numbers to reduce environmental degradation [132].

5. Discussion

With the expansion of MPAs in Indonesia, and many MPAs in the early stages of development [43], ample opportunities exist to better integrate the fast-growing fisheries and tourism sectors into effective MPA management. Four areas to focus efforts to support improved integration of fisheries and tourism into MPA management in Indonesia were identified: diversification of governance types of community-based management, improved coordination between fisheries and MPA management, the development and support of pathways for sustainable tourism, and planning for future conditions. Complementary to MPA management at the provincial level, there needs to be an increase in the dedicated local management bodies in collaboration with the district stakeholders to ensure local knowledge and community needs inform conservation planning and implementation, and the sustainable management of fisheries and tourism.

Indonesia needs to diversify governance types of community-based management to increase the sustainability of both the fishery and tourism sectors. More flexible forms of co-management strategies need to be included within MPA governance, with the aim of delegating authority to local communities. Governance initiatives with collaborative management must incorporate community involvement, and MPA management and zoning plans need to capture and recognise community management in customary areas, such as those practicing *sasi*. Further to this, improved coordination between the management of regional fisheries (FMAs) and MPAs will aid in increasing fishery sustainability. During the process of developing fishery management commissions within FMAs, MPA managers and provincial MPA management officers need to be integrated to ensure collaborative decision making [24,133]. Fishery regulations within MPAs need to align with local contexts such as *sasi*, TURFs and LMMAs to achieve higher levels of compliance by local communities, and for MPAs to be able to support sustainable fisheries, surveillance and enforcement must receive better attention [67].

Given the anticipated return of tourism to Indonesia after COVID-19-related travel restrictions have eased, there is an opportunity to rethink the unsustainable development pathways of tourism and move towards more sustainable tourism in the future. A focused effort should be directed towards understanding carrying capacity of tourism to minimise negative ecosystem impacts that can inform MPA management. For example in order to track tourist numbers, a 'one-gate' approach for entry into MPAs has been proposed for Raja Ampat [132]. Further, there also needs to be the development of financial mechanisms that strive to provide equitable benefits to local communities, and regular monitoring and evaluation to evaluate the impact of sustainable tourism to the marine environment and social-economy of the local community. All MPA management and planning needs to be developed in anticipation of future conditions - including threat mitigation such as marine pollution reduction, addressing destructive fishing and overfishing and impacts of climate change on marine ecosystems, as this will impact both tourism

and fisheries. Conservation and management strategies crucially need to include implementation plans to increase resilience in social-ecological systems [73,134,135]. Such initiatives will aid in the contribution of MPAs to regional fisheries management and sustainable tourism within a world characterised by global climate change and biodiversity crises.

CRedit authorship contribution statement

Sylvie N. Tranter: Conceptualization, Writing – original draft, Visualization. **Estradivari:** Conceptualization, Writing – original draft. **Gabby N. Ahmadi:** Conceptualization, Writing – original draft, Project administration, Funding acquisition. **Dominic A. Andradi-Brown:** Conceptualization, Writing – original draft, Project administration, Funding acquisition. **Dominic Muenzel:** Conceptualization, Writing – original draft. **Maria Beger:** Conceptualization, Writing – original draft. **Amkieltiela:** Visualization, Writing – review & editing. **Christian N. Handayani:** Visualization, Writing – review & editing. **Firdaus Agung:** Writing – review & editing. **Amanda K. Ford:** Writing – review & editing. **Abdullah Habibi:** Writing – review & editing. **Mohamad Iqbal:** Writing – review & editing. **Nils C. Krueck:** Writing – review & editing. **Muhammad E. Lazuardi:** Writing – review & editing. **Umi Muawanah:** Writing – review & editing. **Renoldy L. Papilaya:** Writing – review & editing. **Tries B. Razak:** Writing – review & editing. **Agus Sapari:** Writing – review & editing. **Fikri F. Sjahruddin:** Writing – review & editing. **Laura Veverka:** Writing – review & editing. **Safran Yusri:** Writing – review & editing.

Data Availability

No data was used for the research described in the article.

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