FAUNA & FLORA INTERNATIONAL

Investigating Solutions to Marine Plastic Pollution in Cambodia

A Review and Synthesis of Scoping Research from Coastal & Marine Sites

Contents

Credit: Bianca Roberts/FFI | Front cover credit: Matt Glue/FFI

Contents

This report was prepared by Bianca Roberts as an initiative of the Coastal & Marine Conservation Programme, Fauna & Flora International, Cambodia.

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About FFI Cambodia's Coastal & Marine Conservation Programme

This report is part of FFI's programme of work that supports the Fisheries Administration (FiA) and the Ministry of Environment of the Royal Government of Cambodia (RGC) to protect coastal and marine biodiversity, sustainably manage fisheries resources and improve livelihoods of local fishers and communities. FFI is a leading international NGO working on marine and coastal conservation in Cambodia. Over the past 10 years FFI's growing programme of work has focused on building community, government and local partner capacity for biodiversity conservation and the design and management of an MPA network, whilst tackling key threats such as illegal fishing and most recently, plastic pollution.

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Abbreviations

CFi	Community Fisheries
FFI	Fauna & Flora International
FiA	Fisheries Administration
HH/HHs	Household/s
ID/IDs	Individual/s
IUU	Illegal, Unreported and Unregulated (fishing)
KII/KIIs	Key Informant Interview/s
KR-MNP	Koh Rong Marine National Park
KSV	Koh Sdach Village
KSA	Koh Sdach Archipelago
KRA	Koh Rong Archipelago
MFMA	Marine Fisheries Management Area
MoE	Ministry of Environment
MoT	Ministry of Tourism
MEF	Ministry of Economy and Finance
MoI	Ministry of Interior
MPA	Marine Protected Area
RGC	Royal Government of Cambodia
SoCMoN	Global Socioeconomic Monitoring Initiative for Coastal Management
SUP	Single Use Plastic
SWM	Solid Waste Management
WTP	Willingness To Pay

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Executive Summary

This report reviews and synthesises research on the status and drivers of plastic waste and pollution in the coastal and marine ecosystems of Cambodia, identifying and articulating avenues to reduce marine plastic pollution.

The immense and increasing volume of plastic in the oceans has been identified as a significant global threat (2–7), with the unique physical characteristics of plastic leading to wide spread and lasting pollution across a vast array of natural environments (8). Marine plastic pollution has far reaching implications, harming species and habitats, threatening human health & wellbeing, altering the function of ecosystems and their capacity to deliver goods & services, and inhibiting potential for economic growth (6,9–11). Investigating and addressing plastic pollution is crucial to safeguard the environmental, social and economic outputs of coastal and marine ecosystems.

Plastic contamination in the natural environment has drawn much attention in recent years, with the overwhelming visual presence and ubiquity of plastic pollution driving responses globally. Whilst limited data has been collected in Cambodia, the omnipresence of plastic waste, high volume of plastic use in daily life, and absence of effective waste management systems leaves little doubt that plastic pollution presents a challenge. Cambodia is developing rapidly, claiming one of the fastest rates of improvement in the global Human Development Index (13,14), and the rate of plastic consumed is rising in line with the Kingdom's rapid growth (1). A study investigating the use of plastic bags in Cambodian cities found that consumption is "extremely high", with social & cultural norms surrounding shopping habits and disposal behaviours driving use and pollution from littering (54).

Inadequate waste management is a key determinant of the amount of waste entering the ocean (12). Despite Cambodia's rapid development and economic growth, national infrastructure and administrative resources for waste management remain limited, especially outside of urban centres (15–18). The volume of waste produced annually is also increasing in line with economic growth, and it was estimated in 2010 that 87% of Cambodia's plastic waste was inadequately managed (1,12,19–23). Whilst governance around Solid Waste Management (SWM) has evolved over time and political will is strong, gaps remain, and limited capacity, resourcing and enforcement mean existing governance mechanisms are rarely utilised to their full potential.

In response to these challenges, Fauna & Flora International (FFI) began scoping studies in 2018, engaging a number of research partners to quantify and characterize marine plastic pollution in Cambodia in order to identify avenues to address this threat. The primary study, conducted in an island community within the Koh Sdach Archipelago (KSA), included household surveys, waste characterisation analysis and stakeholder mapping. The second complementary study took place in Sihanoukville, a coastal city on Cambodia's mainland, situated at the gateway to the Koh Rong Marine National Park (KR-MNP). This study included Key Informant Interviews (KIIs) to articulate waste management practices and perceptions, and waste characterisation to quantify coastal debris. Additionally, through FFI's programme of work protecting marine biodiversity and strengthening coastal community resilience in Cambodia, data from socio-economic surveys and coral reef surveys has been included. Contextual considerations are also articulated, especially important given the unique characteristics of coastal and island areas which face the challenges of absent of waste management infrastructure, logistical complexities and deficient administrative resources.

Key findings from the research, detailed in Section 4, reveal the significant burden of plastic waste on coastal communities and habitats. Nearly a third of household waste from one island community was comprised of plastic (27%), with the majority found to be bags (57%) and bottles (35%). At this same study site, 96.5% of household waste was disposed of directly into the ocean or onto the shoreline, and 42% of respondents reported burning plastic waste in open areas.

A review of the constitution of household waste and current behaviours highlighted opportunities for reducing plastic use, encouraging waste separation, re-use and recycling of plastics. We identify a need for social and behavioural change methodologies to shift disposal practices and motivate stewardship behaviours. The research also highlighted waste management opportunities, with 75% of respondents being concerned or very concerned about plastic waste, and 92% willing to pay for waste collection services at an average of $2 per month.

Discarded fishing gear was also revealed to be a key source of marine plastic pollution alongside household waste; 52% of respondents from a coastal fishing village reported discarding fishing nets directly in the ocean. This is reflected in coral reef surveys, which show that 78% of reef debris found was fishing gear - primarily nylon nets and monofilament lines. With the community driven to change waste disposal practices, an existing informal economy centred on fishing net recycling was identified, with 30% of nets being sold to local waste buyers. There is scope to expand market-based and circular economy solutions to tackle fisheries waste.

In Sihanoukville, the key port and tourism town of Cambodia, 81% of debris on beaches was plastic, with cigarettes, plastic food wrappers and plastic bags most frequently found. There are indications that the source of macroplastic pollution is from land as well as washed ashore from other areas. Assessments of perceptions and attitudes in Sihanoukville highlight the need to engage private sector actors, especially those working in hospitality and tourism. Additionally, an investigation into the generation and management of waste by the rapidly growing construction and property development sectors is recommended, to inform strategies to reduce their environmental footprint.

These findings are presented with a comprehensive gap assessment, which highlights where opportunities exist to improve knowledge, research, governance and management in Cambodia (Section 5). A number of priority recommendations are set out based upon the findings, which include site and context specific interventions, as summarised below:

Recommendation 1. Reduce plastic use: Reducing unnecessary and wasteful plastic use is viewed as a priority recommendation as it addresses plastic pollution generation at the source.

Intervention Opportunity 1.1: Reducing plastic use to stem plastic waste generation and marine plastic pollution, by:

1.1.1 Reducing plastic use in coastal communities, focusing on plastic use by both private households and the fisheries sector, including:

a. *Household:* incentivising affordable and reusable alternatives; improving access to clean water; regulating imports and/or use of certain plastic products at key locales; and
b. *Fisheries*: enabling the use of higher quality fishing gear with a longer lifespan; gear and gear use restrictions; fishing gear recycling initiatives.

1.1.2 Reducing plastic use by the private sector, through market-based solutions and improved stewardship behaviours; with a focus on the hospitality, tourism, construction and development sectors.

Recommendation 2. Support opportunities to move towards a circular plastics economy: Opportunities exist for current practices to be optimised or adapted to enable coastal stakeholders to step towards circularity, however, framing such opportunities within the Cambodian context will be key to success.

Intervention Opportunity 2.1: Investigating and enabling circular economy opportunities at coastal sites, by:

2.1.1. Assessing and strengthening existing opportunities, with a focus on supporting communities to develop and expand their existing recycling and re-use practises and livelihoods; dovetailing existing circular practices with improved SWM systems; and

2.1.2 Investigating novel opportunities, through private and third sector partnerships, including scoping of new enterprises that adopt circular approaches.

Recommendation 3. Improve residuals management: Establishing and improving SWM systems is a critical measure to prevent plastic waste entering coastal and marine ecosystems. Two main sources of marine plastic pollution were identified at the focal site, that is 1) household waste and 2) fisheries waste.

Intervention Opportunity 3.1: Managing household waste to prevent marine plastic pollution and support community wellbeing, by:

3.1.1 At the focal site, supporting local leaders to trial feasible and measurable SWM methods;

3.1.2 Outside of the focal site, utilising lessons learnt from the SWM trial to inform interventions at other sites.

Intervention Opportunity 3.2: Managing fishing waste to prevent disposal into the environment and secure sustainable livelihoods, by:

3.2.1 Enabling and strengthening livelihoods opportunities through collaborative partnerships, with a focus on recycling and repurposing of used fishing gear;

3.2.2 Fisheries regulation and enforcement, including adapting existing legislation, regulation and enforcement mechanisms to include locally appropriate measures that reduce fishing gear discards and gear use; and

3.2.3 MPA planning, monitoring and management, including ensuring that measure to reduce & manage fishing waste are taken into account in MPA frameworks.

Intervention Opportunity 3.3: Coastal and marine clean ups to address marine plastic pollution currently in situ. It is recommended that best practice guidelines be developed to maximise the effectiveness and impact of clean-ups.

Enabling conditions for each intervention are set out in Section 6. These enabling conditions describe pathways to foster change in support of each intervention, including: (1) **building capacity** of actors and stakeholders to enable informed action and leadership (2) strengthening and operationalising **governance mechanisms** to empower action by local authorities, private sector and communities; and (3) fostering **social and behavioural change** to address barriers to change, motivate the adoption of new habits and incentivise stewardship behaviours.

Finally, the findings highlight the critical need for Cambodia to adopt circular economy approaches. The circular economy model is targeted at moving beyond the current take-make-waste extractive model of linear resource use, towards a closed loop use of circular resource use that aims to eliminate waste (24) – a vision that requires iterative, large scale and systemic change. This report considers interventions through a circular economy lens, identifying feasible opportunities to reduce, reuse and recycle across the plastics lifecycle to support movement away from linearity, with the ultimate goal of reducing marine plastic pollution.

Credit: Bianca Roberts / FFI

1. Introduction

1.1 Plastic Pollution in Coastal & Marine Ecosystems

Marine debris, particularly the accumulation of plastic in the oceans, has been identified as a key global environmental threat, alongside climate change, ocean acidification and biodiversity loss (2–7). Plastic's unique chemical properties make it durable, strong, lightweight, cheap to manufacture and non-decomposing (3). These characteristics make plastic an attractive material but also pose the risk of long-term environmental contamination (25,26). Plastic's durability can allow it to persist in the environment for thousands of years, and its low density can drive dispersal over hundreds of kilometers (8,27). Aside from thermal treatments such as incineration, plastic cannot be destroyed, and instead breaks down into smaller pieces which accumulate in ecosystems.

The first synthetic polymer was developed in 1907 by Belgian chemist Leo Baekeland, with the "almost inexhaustible" applications of plastic being widely exploited in the 1940s and 1950s when mass production began (3). By the 1960s, reports and scientific research provided early evidence of marine species dying due to ingestion or entanglement in plastic waste, raising concerns about the risks to wildlife (28). Understanding of the scale of marine plastics broadened in the 1970s, with quantification of the high proportion of plastic waste in plankton samples, on beaches and in sediments. Research in the North Pacific, including identification of the 'Great Pacific Garbage Patch', prompted the first International Marine Debris Conferences, which continued into the 1980s and 1990s (28). Renewed research interest began in the early 2000s with the discovery that microplastics are a ubiquitous pollutant, and the number of countries introducing policies to reduce Single Use Plastic (SUP) has increased since the millennium (29).

Globally, the annual production of plastic products increased 200-fold between the 1950s and 2014 (6), and it is estimated that over a third of all plastic produced today is for disposable packaging (3). Contemporary studies estimate that approximately 60% of all plastic produced since the 1950s persists in the environment to this day (3,30). Plastic pollution is now found worldwide from the poles to the equator, including all major ocean basins, remote shorelines, deep ocean trenches and most freshwater and terrestrial ecosystems (6,8,31,32). It is estimated that 275 million metric tons (Mt) of plastic waste was generated in 192 coastal countries in 2010, with between 4.8 to 12.7 million Mt entering the ocean (12). A later study estimated that 8,300 million Mt of virgin plastics have been produced globally as of 2015, of which 79% accumulated in landfills or the natural environment, and just 9% was recycled (30,31). Based on current production and waste management trends, 12,000 Mt of plastic waste is predicted to exist in landfills or the natural environment by 2050 (30). Plastic is now so ubiquitous it has been proposed as a geological indicator of the human era (33).

1.2 Marine Plastic Pollution as a Threat to Biodiversity

Worldwide, 693 species have been recorded interacting with marine debris, with plastic making up 92% of these interactions (10). The impact of plastic pollution on marine life is clearly observable at an individual scale, with cases of entanglement and ingestion being well reported (28,34), including of threatened, endangered or critically endangered species (10,11). Population and habitat level consequences of direct interactions and changes to the environment are less understood (34) but have been observed, particularly in seabirds (35–37). Despite the body of evidence, the impacts of plastic on marine life are thought to be vastly underreported (11). Some critical research findings are summarised below:

Ingestion

- 208 different species have been recorded ingesting marine plastics (10), including 56% of cetacean species (39) and an estimated 90% of all seabird individuals (34).
- Ingestion of plastic can have both lethal and sub-lethal effects on marine life, including blockages and obstructions leading to injury or death, poisoning through leaching of toxins, malnutrition and starvation from false satiation (26,38,39).
- Reduced reproduction and growth rates, restricted mobility and reduced longevity all cause harm over longer temporal scales (26,38,39).
- The consumption of SUP bags is of particular concern, especially for species that target jellyfish such as sea turtles and cetaceans (25).

Entanglement

- Entanglement affects at least 243 marine species, including half of all seabird species, 66% of marine mammals and all species of sea turtles (10,38).
- Entanglement is the form of marine plastic interaction most likely to result in death (10).
- Entanglement can cause injuries which may compromise an individual's ability to hunt, forage and escape from predators (26).

Microplastics and Toxicity

- Microplastic pieces contain toxic chemicals such as BPA and phthalates that have been shown to have adverse effects on a variety of aquatic organisms (40–42).
- Microplastics also act as sources and sinks for persistent organic pollutants (POPs) and endocrine disruptors such as xenoestrogens (31).
- Microplastics can be transferred up trophic levels, raising concerns around bioaccumulation and biomagnification (41,43), including potential human health risks due to their presence in seafood (44).
- Leaching of chemicals from, or adsorbed by, microplastics increases the risk of disease, reproductive disorders, altered hormone levels and potentially thinning of eggshells for marine life (25). Although these sub-lethal effects are not well understood and can be difficult to record in situ, harmful concentrations of some plastic pollutants have been recorded in the marine environment (11).

Transport of Disease and Invasive Species

- Plastic's low density means it is easily dispersed over long distances by winds and currents, as well as vertically in the water column.
- The introduction of hard plastic surfaces to soft sediment environments may facilitate the spread of invasive, alien species to sensitive coastal and marine environments (10,45).
- In some locations macroplastic substrates are so widespread that they have altered the composition and abundance of species (31).
- Plastic pollution can support microbial colonization by pathogens. One study found that the likelihood of disease jumped from 4% to 89% when coral became entangled in plastic (46).

Impact on Natural Habitats

- Macroplastic pieces, especially lost and abandoned fishing gear including lines, nets and other equipment, damage coral reefs and associated fauna (26).
- The accumulation of plastic on the seafloor may inhibit the exchange of gases between waters and sediment, disturbing or smothering benthic dwelling organisms and potentially interfering with the sequestration of carbon (31,7).
- The deep sea has also been identified as a major sink for plastic debris, with micro-plastic fibres found to be four times more abundant in deep-sea sediments than sea surface waters (32).

1.3 Marine Plastic Pollution as a Social and Economic Threat

Marine economies form the basis of market systems in many countries and the value of marine ecosystems globally was estimated at US$16.5 trillion in 2015 (47). Marine plastic litter is thought to affect this, costing the fisheries and tourism sectors alone US$13 billion per annum globally (48). One Cambodian study found that 72% of tourists visiting the Kingdom disliked the litter present, and 13% said the volume of litter deterred them from wanting to visit again (49). The tourism sector itself is also a contributor to marine pollution and needs to adopt stewardship practices should it wish to protect the natural environment on which it depends (47). Notably, the aforementioned figures exclude the less tangible and much harder to quantify, intrinsic ecosystem services, such as cultural, aesthetic and recreational values, and were these taken into account the cost of plastic pollution would be much greater.

Cambodia is developing rapidly, with a GDP growth rate of 7% annually and one of the fastest rates of improvement in the global Human Development Index (14). A boom in construction projects and improvements in infrastructure and public services have had impacts on the Nation's environment and natural resources (13,14). Coastal tourism is a growing industry and development of the islands and coastline is rapidly increasing (15). The Ministry of Tourism (MoT) aims to increase the number of tourists travelling to Cambodia, and multimillion dollar infrastructure development projects are underway on Koh Rong (50) and the mainland coast at both Sihanoukville & Koh Kong (51). Despite such rapid growth, Cambodia is ranked as the 19th most vulnerable country to climate change associated extreme weather (52) and has a regionally high economic vulnerability (53), meaning that livelihoods in Cambodia have limited capacity for adaptation to shocks and stressors.

Plastic pollution is also a threat to human health. As touched upon above, plastics become increasingly toxic as they break down, with some early research suggesting microplastics entering seafood and other food types could present a human health risk (9,44). Mismanaged plastic also blocks drainage systems and dams, which can cause flooding, increasing the risk of water-borne and mosquito vector diseases (9).

The consideration of human rights and gender equity is also key, with different groups being impacted by plastic waste in different ways, and disproportionate impacts on vulnerable and marginalised peoples. The informal waste sector in Southeast Asia almost exclusively employs the urban poor, including children, resulting in already vulnerable people facing heightened health and safety risks in addition to low wages and limited social protection. Gender norms see women typically acting as primary care givers and managers of households, governing the use of plastic and the generation of plastic waste (54). In Cambodia, women are primarily responsible for operating market stalls, food shopping and food preparation, meaning on average they use more plastic bags (54). Women are often employed in plastic manufacturing and form a substantial proportion of the informal waste management sector, despite paid waste management jobs being taken almost exclusively by men (47). Gender considerations are crucial for a number of reasons, not least to identify meaningful opportunities to work towards gender parity and empowerment, and to avoid entrenching existing hierarchies (47).

1.4 Cambodia's Coastal and Marine Ecosystems

Situated in the Gulf of Thailand, Cambodia's 435 kilometre coastline encompasses 69 islands and an array of interconnected ecosystems, including extensive coral reefs, vital seagrass beds and internationally significant Ramsar protected mangrove forests (55). These habitats support a diversity of marine life and essential ecosystem goods and services, including acting as physical barriers to extreme weather events, regulating climate and providing natural waste treatment (56,57). Limited resources and capacity in Cambodia have meant that little marine research has been conducted in the country, with NGOs taking the lead over the last two decades. The primary threats to Cambodian marine ecosystems include Illegal, Unreported and Unregulated (IUU) Fishing and unregulated coastal development (13,58,59).

Marine ecosystems underpin the Cambodian economy, bringing in US$12 million in benefits annually (13) through fisheries (artisanal, commercial and aquaculture) and increasingly, tourism (diving, snorkel tours and boat trips) (60). A high proportion of Cambodians still rely directly on natural resources for their subsistence and livelihoods needs (14,61). Marine fisheries account for 1.14% of the GDP (2014 data) (55) and 30% of the population rely directly on small-scale fisheries for their livelihoods (62). The vast majority (88%) of the coastal population rely on fish as their primary source of protein (63).

Credit: Roger Bruget / Kuda Divers

1.5 Marine Plastic Pollution in Cambodia

The scale of waste entering the ocean in Southeast Asia exceeds global averages due to the rapid rate of development, limited or absent SWM systems, governance deficiencies and poor enforcement (26,47). Rapid socioeconomic development has increased the region's output of marine debris, of which 80% is estimated to be plastic (47,64). As a global marine biodiversity hotspot, Southeast Asia boasts the highest coral reef biodiversity globally, a quarter to a third of the world's mangroves and a substantial proportion of the world's seagrass habitats (26,65). This means that pollution in Southeast Asia presents a disproportionately high threat to marine life and biodiversity. Over half of the 4.8-12.7 million tonnes of marine plastic waste generated globally each year originates from China, Vietnam, Indonesia, the Philippines, and Thailand (12). Fifteen of the top 20 most polluting rivers in the world are found in Asia, including the Mekong in 11th place (66). The Mekong river, which flows through Cambodia, is estimated to output between 18,800 and 37,600 tonnes of mismanaged plastic waste into the ocean annually (66).

Little data or research exists to quantify the threat of marine plastic pollution in Cambodia. A review of marine plastics research in Southeast Asia compiled in 2019 found that no formal research had been conducted in Cambodia to date[1]. No information is available on hotspots, source differentiation, ecological and environmental impacts or discarded fishing gear. Lyons et al (2019) recommended that surveys, monitoring and identification of sources and hotspots should be conducted, and that methods should be standardised to studies previously conducted in Southeast Asia wherever possible (67).

Whilst a robust evidence base is still emerging, the inescapable visual presence, prevalence of plastic use in daily life, and absence of effective waste management systems leaves little doubt that plastic pollution presents a challenge for the Kingdom. The extremely high volume of plastic bag use is one major driver, with urban Cambodians estimated to consume 2,158 plastic bags per person per year (54). Phnom Penh's population is thought to use more than 10 million plastic bags each year (68), with used plastic bags costing over US$100,000 per year in maintenance of the city's sewage and drainage systems. This causes similar problems in the coastal city of Sihanoukville, where 60% of waste collected from drains is plastic bags (49). Poor disposal practices, high consumption levels, and the types of plastics most commonly used drive the amount of plastic pollution produced (1,49). The severity of the problem for Cambodia has been highlighted in local and international media, particularly the highly visible coastal and marine pollution (21,69). The Royal Government of Cambodia (RGC) intergovernmental and non-governmental organisations have also highlighted their concern (20), and a National Taskforce Against Plastics has been formed by the Ministry of Environment (MoE). The RGC, and the MoE in particular, have expressed increasing commitment to act on the problem, including proposing a ban on single use plastic products in late 2019 (22,23,70,71).

1.6 Solid Waste Management in Cambodia

In a global review, mismanaged solid waste was found to be the largest source of macroplastic pollution, with a total of 3.87 Mt being lost into marine environments per annum (72). Poor waste management is a major determinant of the amount of waste entering the ocean (12). Managing increasing levels of solid waste is a challenge faced by many nations (73), particularly in Asia where rapid development has driven the generation of municipal waste (16).

Cambodia represents a compelling case study of this trend. Despite developing rapidly in the last two decades, Cambodia's infrastructure and administrative resources remain limited in many areas (74), including waste management (16–18). Based on 2010 data, it was estimated that 87% of Cambodia's 344,000 tonnes plastic waste was inadequately managed (12,19), with total overall tonnes of plastic waste believed to have increased dramatically in the last decade (1,20). An array of anecdotal and secondary evidence also highlights Cambodia's struggles with mismanaged waste (20–22,70).

Solid waste management practices in Cambodia include landfills (the majority having limited technical design and management), burning, and informal systems centred around waste picking for recyclables by individuals known as "ecchay" (16,18,68,75). In Phnom Penh, private SWM contractors are primarily responsible for waste collection and transportation (75), in addition to the informal waste sector comprised of more than 2000 ecchay picking sellable waste to generate income. Anecdotal evidence suggests the ecchay form part of large waste trading networks that transport waste across the Thai and Vietnamese borders for sale. Recycling and composting initiatives have been established by some NGOs and private enterprises, but are currently limited in scale (17).

[1]At the time of writing this report, a research project led by the World Bank was in progress.

Systems for the administration, management, collection, transportation and disposal of waste are predominantly concentrated in the population centres of Phnom Penh, Sihanoukville, Siem Reap and Battambang (17). Even in Phnom Penh, insufficient financial resources, human capital and technical capacity sees the SWM contractor struggling to cope with increasing levels of waste; a pattern thought to be observable across the country (17).

Outside of cities, waste management systems are lacking or non-existent, which is problematic given nearly 80% of the population lives outside of urban centres (76). Provincial authorities have struggled to adapt to the overburdened system (18), resulting in high concentrations of mismanaged waste (18,77). Even in suburban areas in the vicinity of cities, 66% of waste is openly burned, and 20% is buried or disposed of in public spaces (16,68). In rural areas, burning, dumping and burying of refuse are the primary methods of waste disposal in the absence of formal systems (77). A 2018 Asian Development Bank report highlighted “deteriorating environmental conditions” around Koh Rong due to a “lack of sanitation and inadequate solid waste management” despite the growth of tourism associated development (15). Around 63% of total waste in Koh Kong province is recyclable, but with no formal recycling systems, opportunities remain largely unrealised or are managed by the informal waste sector (18). The contextual challenges around SWM in Cambodia, which lead to a high proportion of mismanaged waste, are therefore likely to be a key factor impacting the volume of marine plastic pollution.

At the time of writing this synthesis, Cambodia’s SWM systems have reportedly come under review by the RGC, with the goal of improving the services offered and increasing transparency and accountability. It is unclear, however, how this initiative will impact areas outside of urban centres, especially the coastal and marine sites that are the focus of this research synthesis.

Credit: Matt Glue / FFI

1.7 Governance Mechanisms for Plastic and Solid Waste Management in Cambodia[2]

The legislation and policies of Cambodia outline the leading role of the MoE in the Kingdom's waste management systems. More recent sub-decrees have identified additional responsibilities for the Ministry of Interior (MoI), Ministry of Economy and Finance (MEF) and the MoT. Legislation dictates that responsibilities are highly decentralised, primarily to provincial level, with the option to further delegate to municipal, district and commune administrations. As a result, the government actors expected to be involved in waste management can be unclear. Although there exists a larger governance framework covering waste management in Cambodia, three key sub-decrees are particularly relevant to this report:

Sub-Decree 36 on Solid Waste Management (1999): The RGC ratified foundational Sub-Decree No. 36 on SWM on the 27 April 1999 with the goal of protecting the health of the Nation's citizens and its environment by governing "collection, storage, transportation, recycling and disposal of municipal waste". The managing authority of the sub-decree, the MoE, is responsible for its enforcement, including monitoring SWM activities (Article 6) and establishing national standards and guidelines (Article 4). Crucially, the sub-decree devolves responsibility to provinces and cities, which are expected to develop "short, medium and long-term waste management plans for their areas" (Article 5). Provincial, municipal and local authorities have responded to this by contracting waste management to private companies, although in many areas waste management systems are absent. The sub-decree asserts that the MoE is responsible for approving any "domestic investment in the construction of landfill, incinerator, storage sites or recycling plant for household waste".

Informal waste management systems - which centre on the transport recyclables to Thailand and Vietnam for sale - are common in some parts of Cambodia, including coastal areas. Although such systems are arguably a necessity given the deficient formal systems, they are technically prohibited without the proper permissions (Article 9); "the export of the household waste from the Kingdom of Cambodia abroad cannot be conducted unless approved by the Ministry of Environment, and [holding an] export license from the Ministry of Trade and permit from the import country". It is not known whether the existing informal networks have appropriate licenses, though anecdotal evidence suggests they do not.

Sub-Decree 113 on Management of Garbage and Solid Waste of Downtowns (2015): Sub-Decree No. 113, prepared in August 2015, regulates SWM in urban areas with "effectiveness, transparency and accountability". It builds upon Sub-Decree 36 by further devolving responsibility of SWM, including to the MoI (Article 6), and delegating responsibilities to Capital and Provincial Departments of Environment (Article 8) and Municipal and District Administrations. Capital and Provincial Administrations are also given power to further delegate duties to Commune, Sangkat and Khan levels as they see fit (Articles 9-13).

Importantly, Sub-Decree 113 describes how to sort and manage solid waste and outlines penalties for households, businesses and construction sites that fail to meet these requirements. This sub-decree also touches upon fee collection, stipulating that a maximum service fee is to be determined by the MoI, MoE and MEF (Article 33). The sub decree stipulates that, "Income generated by the management of garbage and solid waste of downtowns is personal income of municipal and district administrations" (Article 34). Finally, the sub-decree describes that municipal and district administrations may utilize their budgets to support activities related to the management of solid waste.

Sub-Decree 168 on Plastic Bag Management (2017): Sub-Decree 168 is specific to the "reduction, import, production, distribution and use of plastic bags" to improve "public health, environment and aesthetics". It outlines permissible dimensions of plastic bags in Cambodia and penalties for non-compliance. Sub-Decree 168 identifies the same responsible ministries, with the addition of the MoT (Article 8), which is responsible for public education and identifying indicators for "aesthetics".

Since being formalised in October 2017, changes have been implemented in some areas, including the introduction of plastic bag taxes at some supermarkets. However, with responsibility for implementing this sub-decree spread across four Ministries and all Administrations from provincial level down to smaller subdivisions, progress in other areas has been slow. For example, the sub-decree bans the import, local production, distribution and use of "thin plastic carrier bags" with a bottom width less than 25 centimetres and a thickness of less than 0.03 millimetres. There has been little enforcement of this ban and these small, low quality carrier bags remain ubiquitous in markets and shops nationally.

[2]It is noted that information about the legislation of Cambodia has been sourced from informal translations.

2. Aims and Objectives

The goal of FFI Cambodia's Coastal & Marine Conservation Programme is to protect marine biodiversity and strengthen the resilience of coastal ecosystems and communities. The programme has been working towards this goal with the RGC, NGOs and coastal communities since 2010. To effectively tackle marine plastic pollution in Cambodia, FFI worked with partners to conduct scoping research that solidified our understanding of this threat.

The overarching objective of this research review and synthesis is to investigate and articulate the status and drivers of plastic pollution in the coastal and marine ecosystems of Cambodia. More specifically this report aims to:

- identify gaps, opportunities and barriers to addressing marine plastic pollution; and
- bring together a breadth of research and information to develop contextually viable recommendations targeted at reducing marine plastic pollution.

In support of these objectives, findings have been sorted into three broad categories:

1. Environmental and biophysical factors;
2. Socio-economic factors; and
3. Governance and management systems.

For the purposes of this report we use the term "marine plastic pollution", which we define as any item comprised of a plastic polymer present in a marine or coastal ecosystem. The research synthesized in this report focuses on "macroplastic" pollution, that is, particles of plastic measuring more than 5 mm in diameter. This focus on macroplastics is due to resource, staffing and time limitations, as well as the omnipresence of macroplastic pollution in Cambodia. It is acknowledged, however, that microplastics are a significant component of marine plastic pollution that must also be addressed.

3. Overview of Methodology

3.1 Rationale for Site Selection

A chain of islands off the coast of Koh Kong province, known as the Koh Sdach Archipelago (KSA), was identified as the focal site for FFI's scoping research. FFI has a strong working relationship with the KSA community and government actors, at national and subnational levels. Both the KSA community and authorities have shown a strong desire to address mismanaged waste and prevent waste entering the ocean. FFI has conducted research and supported Community Fisheries (CFis) in the area for a number of years to protect biodiversity and build community resilience (55). The vision for this focal site includes the establishment of a Marine Fisheries Management Area (MFMA) to protect marine biodiversity, strengthen marine resource management and secure sustainable livelihoods that support community wellbeing. Field observations made by FFI staff, community and partners also emphasized the need for plastic pollution interventions in the KSA with this site both contributing to, and suffering the acute impacts of, marine plastic pollution.

Research was also reviewed from two secondary sites - Sihanoukville and the Koh Rong Archipelago (KRA). The KRA was included in this synthesis due to FFI's long term work in the area, which includes supporting the establishment and management of Cambodia's first large scale Marine Protected Area (MPA). FFI's remit includes data collection at multiple sites in the KRA, and a strong history of productive engagement with communities, government, private and third sector stakeholders in the area.

Sihanoukville was included in this research synthesis as a rapidly growing coastal city experiencing high intensity development. Both field observations and media coverage have identified Sihanoukville as a potential epicentre for mismanaged waste flowing off-land into marine ecosystems, particularly concerning given its vicinity to the KR-MNP.

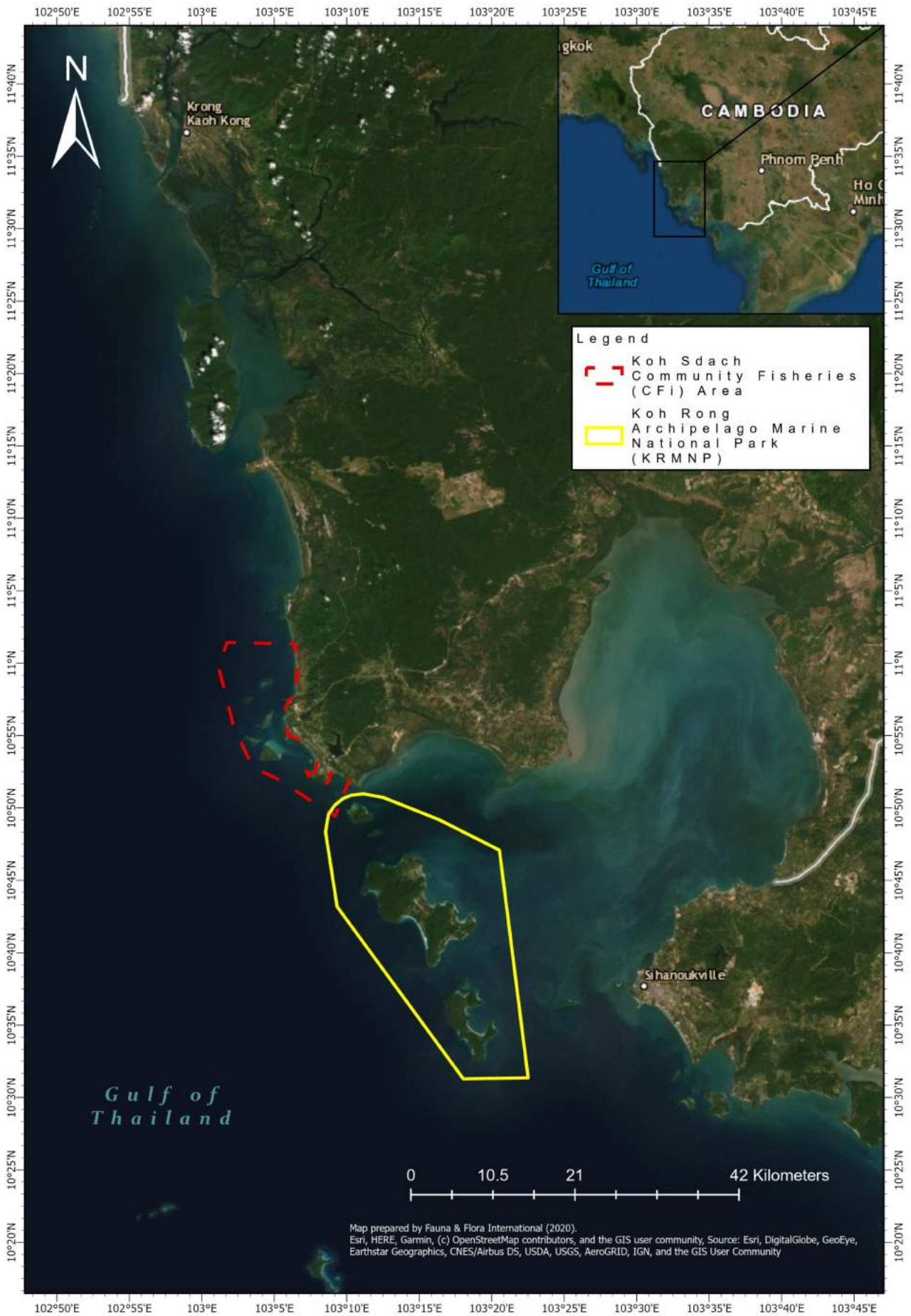


Figure 1: Map of project sites, including Sihanoukville, Koh Sdach Archipelago and Koh Rong Archipelago.

3.2. Site Description and Methodology

This synthesis report compiles research conducted across coastal and marine sites with a mix of quantitative and qualitative methodologies. Quantitative methods were used to measure and characterize marine plastic pollution, including coastal debris, marine debris and household waste. Qualitative methods include household surveys, KIIs and socio-economic surveys, which gathered insights regarding community demographics, knowledge, attitudes, perceptions and behaviour linked to solid waste and plastic pollution.

3.2.1 Focal Study Site: Koh Sdach Village, Koh Sdach Archipelago

The KSA includes nine islands located off the coast of Koh Kong province of south-west Cambodia, in the Gulf of Thailand. This archipelago is an area of significant marine biodiversity and valuable ecosystem services covering 16,158 ha of fishing ground (55).

Data collection took place in Koh Sdach Village (KSV) located on Koh Sdach Island. Administratively, Koh Sdach commune has three villages: Koh Sdach, Peam Kay and Prek Smach. KSV has a larger population compared to the other two villages, which are both located on the mainland.

Recently, the Fisheries Administration (FiA) and Koh Kong provincial authorities, with support from FFI, identified KSA to be designated as an MFMA. This would see the archipelago become the next MPA in Cambodia alongside the KR-MNP and Kep MFMA. This would create a network of MPAs along Cambodia's coastline, supporting the protection of interconnected coastal and marine habitats on a larger scale. Crucially, this designation presents an opportunity to integrate measures to address marine plastic pollution within MPA frameworks for the first time in Cambodia.

Koh Sdach Village, where SWM systems are absent, is heavily effected by mismanaged waste. Credit: Bianca Roberts / FFI

3.2.2 Koh Sdach Methodology

The objective of the research conducted in the KSA was to gather key insights around knowledge, attitudes and practices with regards to plastic use and disposal, and quantify and characterise solid waste from households, with a specific focus on plastic products and their pathway to becoming marine plastic pollution.

Activity	Methodology	Output
Household (HH) Surveys (2018)	The questionnaire contained 64 questions (mostly closed questions) and was divided into two sections: i) demographic information collection and socio-economic assessment; and ii) solid waste generation and disposal behaviours and perceptions, including awareness and willingness to pay for and participate in SWM systems.	120 HHs surveyed
KIIs (2018)	KIIs in KSA selected stakeholders based upon their mandates with regards to SWM and plastic pollution, including: 1. provincial departments of local government; 2. private waste management contractors; 3. commune level government, including commune and village chiefs; and 4. other stakeholders, including social enterprises, NGOs and schools. The questionnaire was semi-structured and included open-ended questions, enabling respondents to discuss in-depth their roles and responsibilities, economic and social interests and perceptions around KSA's current waste management systems, with a specific focus on plastic waste.	Two KIIs conducted in KSA (plus six KIIs conducted in Preah Sihanouk and a further 28 KIIs conducted as part of socio-economic surveys).
HH Waste Characterization (2018)	The volume (by weight) and composition of solid HH waste was analysed. Thirty HHs were asked to participate, and of these 24 HHs agreed, providing researchers with the waste generated by their HH over a 24-hour period.	23 kg of HH waste was collected, weighed and sorted.
Reef Debris Survey (2019)	As part of FFI's broader remit, coral reef monitoring is conducted biannually with project partner, Kuda Divers. Reef monitoring typically takes place in October and January. The methodology adopted is based on a modified Reef Check methodology, with parameters defined by Savage et al (78). Two teams of three to four surveyors recorded biophysical information along two 50 metre transects per coral reef site. Data was collected on 'impacts', including the number of individual plastic items, discarded fishing nets and monofilament lines.	Marine debris counted along 29 transects across 15 sites.
Socio-economic Assessment (2019 & 2020)	The most recent socio-economic assessment for KSA was conducted following the SoCMoN Guidelines for Southeast Asia (79). This assessment utilised convenience sampling to collect data for the HH interviews, as random sampling was not feasible in the study area due to the availability of respondents. Data were collected from 70 HHs out of the total of 395 fisher HHs (that is HHs where fishing is the primary source of income).	Two focus group discussions (FGDs), 28 KIIs, 70 HH interviews, field observations, and secondary data was collected.

3.2.3 Secondary Study Site: Sihanoukville

Preah Sihanouk is a coastal province located in south-west Cambodia. The capital city of Preah Sihanouk Province, Sihanoukville, is located on the coast of the Gulf of Thailand. Sihanoukville is an economic hub and home to Cambodia's largest deep-sea port, which handles 70% of the Kingdom's import and export market (80).

Sihanoukville is experiencing a rampant development boom. Media coverage emphasises the transformation of this seaside town into a hub of coastal construction and gambling-centric tourism funded largely by Chinese investors (80–82). This has also reportedly brought organised crime and money laundering to the city (83–86) and the impact of plastic waste in Sihanoukville is thought to be substantial. An article published by the Guardian described the city as having "mountains of plastic", with plastic pollution and other mismanaged waste found at such a density on beaches and in the ocean that the water and sand cannot be seen – an observation confirmed by FFI field teams (21). A study conducted by 17 Triggers in 2015 identified that participants in Sihanoukville were more likely to litter compared to those in Siem Reap or Phnom Penh "because they felt like somebody else would pick it up" (54). Construction and property development have increased levels of pollution and environmental degradation around the city (82). Sihanoukville represents a gateway for waste to be carried into the ocean, of particular concern given the city's vicinity to Cambodia's largest marine protected area, the KRA-MNP.

3.2.4 Sihanoukville Methodology

In Sihanoukville, researchers conducted a coastal plastics audit accompanied by a qualitative study that collected perceptions of local stakeholders regarding SWM and plastic pollution, with a focus on the hospitality and tourism sectors.

Activity	Methodology	Output
Coastal Plastics Audit (2018)	The coastal plastic audit was undertaken on three high-traffic beaches in Sihanoukville during peak tourist season. The four sites were chosen, as follows: • two on Otres beach; • one on Occheuteal beach; and • one on Independence beach. Due to the intensive development of the shorelines surveyed, sites were chosen based on the availability of unobstructed 100m stretches of beach. Each section of beach was then broken down into twenty, five-meter-wide transects perpendicular to the water's edge. The audit was conducted using the standardized methods outlined in the NOAA Marine Debris Program field guide, specifically the standing-stock survey methodology, which utilises discrete transects to assess debris density (87). The team used the Marine Debris Tracker[3] to log data, with a focus on collecting macro-plastics. Debris density and distribution was calculated instead of the more common approach of weighing collected waste to better account for lightweight materials.	Coastal debris density calculated at four sites.
KIIs (2018)	KIIs were conducted in Sihanoukville. As with the KSA interviews, a semi-structured interview style was adopted to enable respondents to provide valuable descriptive data based upon their own observations and perceptions. The interviews targeted businesses affiliated with the tourism and hospitality sectors, as key sectors driving coastal development and economic growth. The research team complemented these KIIs by meeting with sub-national government, including provincial offices of the MoE, MAFF, and the municipal government. The manager of Sihanoukville's waste collection contractor, KSWM, was also interviewed to gain insight into the SWM systems in the province. To ensure consistency between interviews, a questionnaire was developed to meet three primary objectives: • To gain local perceptions of the plastic problem; • To assess capacity for and interest in transitioning away from SUP; and • To investigate the availability of resources for the improvement of SWM systems.	Six KII's conducted.

[3]The Marine Debris Tracker was developed by the NOAA Marine Debris Program and the Southeast Atlantic Marine Debris Initiative.

3.2.5 Secondary Study Site – Koh Rong Archipelago

The KR-MNP encompasses the two main islands of Koh Rong and Koh Rong Sanloem and eight associated small islands, located within Preah Sihanouk Province, south-west Cambodia. The KR-MNP is one of only two formal MPAs in Cambodia with active marine conservation management and patrols (88). This site includes a number of ecologically diverse and socio-economically vital habitats, including seagrass beds, coral reefs and mangroves (89). There are four villages on Koh Rong and two on Koh Rong Sanloem. International tourism is well established in the KRA, with continued growth forecast and plans for further large-scale development (15,90). FFI has worked with the FiA since 2010 to support the establishment and management of this crucial hub of marine biodiversity.

In 2014, FFI conducted a socio-economic baseline assessment of KRA, finding that communities in the archipelago had relatively high levels of economic activity and livelihood diversification at the HH level. Most HHs were found to engage in a mix of small business, fishing, tourism and small-scale agricultural activities. These findings indicated relative resilience to shocks and stressors, suggesting that HHs in KRA should be able to adapt to small changes in economic, social or environmental factors (91). A follow-up socio-economic study in 2017 assessed the knowledge, attitudes and perceptions of KRA stakeholders towards marine conservation management activities, and the findings illustrated strong local awareness of and compliance with marine management regulations. However, it also revealed poor tourism sector awareness and compliance, and highlighted an underestimation of tourism impacts (92).

Plastic debris on Palm beach, Koh Rong (Koh Rong Archipelago). Credit: Bianca Roberts / FFI

3.2.6 Koh Rong Archipelago Methodology

In the KRA, researchers conducted a number of KIIs to complement the data collected at other sites and develop a more holistic idea of the stakeholder landscape in coastal communities. As in KSV, coral reef health checks are conducted as part of FFI's broader remit to protect biodiversity and support the management of the KRA-MNP.

Activity	Methodology	Output
Marine Debris Surveys (2019)	Reef health surveys were conducted by FFI, Song Saa Foundation and Kuda Divers. These reef health checks also included surveying for any anthropogenic impacts, including marine debris. A total of 20 sites were surveyed within the KR-MNP, with the widely used Reef Check methodology being selected. Dividing in two teams of three to four surveyors, each team completed two transects per site. Impact surveys were conducted using four 20 metre x 5 metre belt transects at each site. It is noted that the data collected on marine debris was scaled back and not the primary focus of the study, however the frequency of "trash", specifically fishing nets and plastic, was recorded.	Marine debris data collected across 20 sites with two transects per site.
KII's (2018)	The KIIs with stakeholders in KRA followed the same methodology as in KSA (see above).	Six KII's conducted.

4. Results and Discussion

The results and findings are presented and discussed across three broad categories:

1. Environmental and biophysical factors;
2. Socio-economic and behavioural factors; and
3. Governance and management systems.

4.1 Environmental and Biophysical Factors

> *Plastic waste is actually causing severe impact[s] on marine biodiversity. Some fish think that plastic waste is food, and they eat plastic or [get] trapped in plastic.*
>
> Koh Rong Sangkat Chief (2018)

4.1.1 Disposal Practices and Household Waste Entering Marine Ecosystems – Koh Sdach

The HH waste characterisation study (N=24) found the majority of HH waste (by weight) to be organic food waste (60%). Nearly a third of HH waste was comprised of plastic (27%), and of this the majority was found to be bags (57%) and bottles (35%) (Figure 2). This study focused on the total weight of each category to determine the most common type of plastic, meaning some types of plastic may have been over or underrepresented due to their relative weights. For example, although "snau" (polystyrene) is commonly used for food containers in Cambodia, it was found to contribute only 0.2% of HH waste suggesting it may have been underrepresented due to its light weight.

According to the chief of KSV, the majority of waste found in marine ecosystems is HH waste that has been disposed of directly into the ocean. The findings of the HH surveys (N=120) support this perception, with nearly 70% of respondents disposing of HH waste directly into the ocean, and a further 27.5% of respondents disposing of HH waste on the shoreline. When specifically questioned about plastic waste, 48% of respondents stated they dispose of plastic waste directly into the ocean, and a further 42% of respondents reported burning plastic waste in open areas. Ninety percent of respondents advised they had disposed of waste into the ocean at least once.

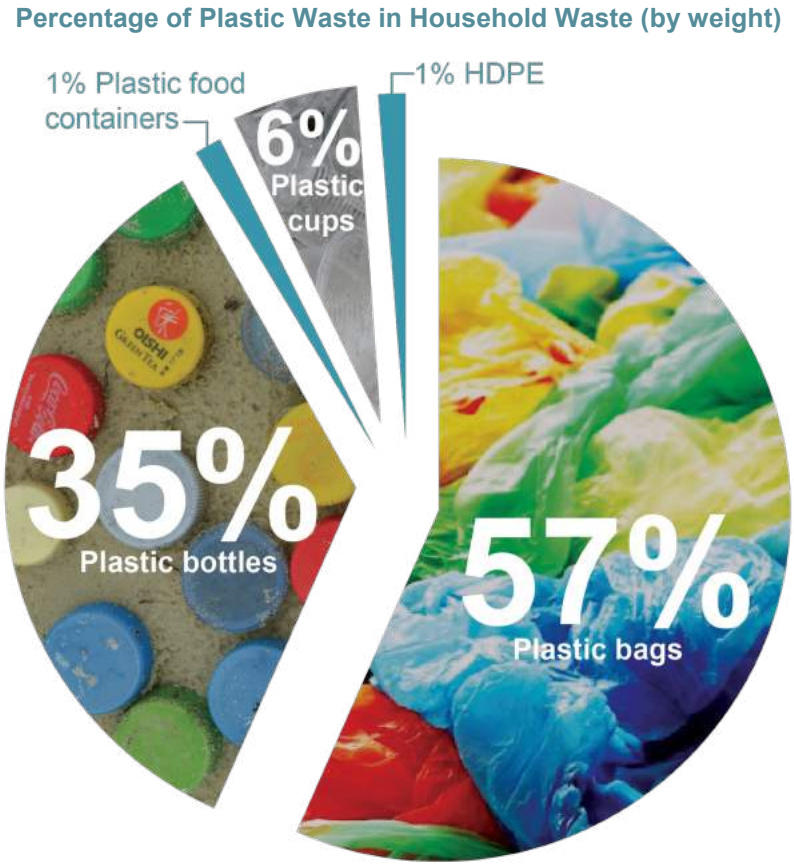


Figure 2: Breakdown of plastic waste found in household waste from Koh Sdach Village^

Despite being mandated under Sub-Decree 113, waste separation is uncommon in Cambodia. When queried about waste separation, specifically if they separate plastic waste from their household waste, 64% of respondents said "no". Following on from this question, when asked why they did not separate plastic waste, 48% of respondents advised that it is not a habit to separate waste, a further 17% advised they do not understand how to separate waste, and 16% advised they do not want to spend time separating waste.

4.1.2 Fisheries Waste – Koh Sdach Archipelago

Given fishing is the primary source of income in the KSA, it is not surprising that this sector both contributes to, and is impacted by, marine plastic pollution. In Cambodia, fishing equipment (e.g. nets, monofilament lines, ropes and buoys) is predominantly made of plastic and typically purchased from Thailand and Vietnam, with dealers importing these products for local markets. Researchers in KSV observed that the fishing nets sold were not comprised of high-quality polymers. Fishers supported this observation, reporting that on average nets only last between 2 or 3 months before degrading beyond usability, and are prone to photo-degradation.

The main causes of fishing gear entering the ocean were reported as:

- direct disposal of used fishing gear (and other waste) overboard;
- accidental loss of fishing gear, most often due to snagging on other vessels or the sea bed;
- loss due to bad weather conditions and navigation errors; and
- non-compliance with fishery rules, that is, discarding of fishing gear into the ocean in the event of IUU fishing.

The majority of respondents in the HH surveys (52%) reported discarding of fishing nets directly in the ocean, and 30% of people reported selling used nets to middlemen in the commune (Figure 3). Households in KSV reported using between 16-24 nets per year. With 395 HHs reporting fishing as their primary occupation, it is estimated that between 6,320-9,480 nets are used by fishing HHs in KSV each year. With 52% of respondents discarding of nets directly into the ocean, it is estimated that 3,286-4,930 nets may be entering the ocean from fishing HHs in KSV annually (though more detailed data collection is needed to qualify this finding).

^Diagram photo credit: Shutterstock & Bianca Roberts / FFI

Historically, recycling of fishing materials has not been commonplace in KSA due to the absence of revenue opportunities. A small number of community members, most often female members of the HH, recycle used fishing nets to produce hammocks and rope. One respondent reported purchasing used nets from fishers, and earning between US$15-$30 per week selling hammocks made from the recycled nets. Fishers also hire local community members to repurpose nets to make rope, paying between US$2-$2.50 per batch (with each batch containing 8 “dia”; dia being a 180-meter length of rope or net). It was also reported that copper is gleaned from used nets and rope. The emergence of markets for recycled products has incentivized local recycling activities, although the long-term viability of these markets requires further investigation. More details about these recycling and re-use focused livelihoods were collected as part of recent socio-economic studies, with results set out in section 4.2.1.

Used Net Disposal Practices (Koh Sdach Village)

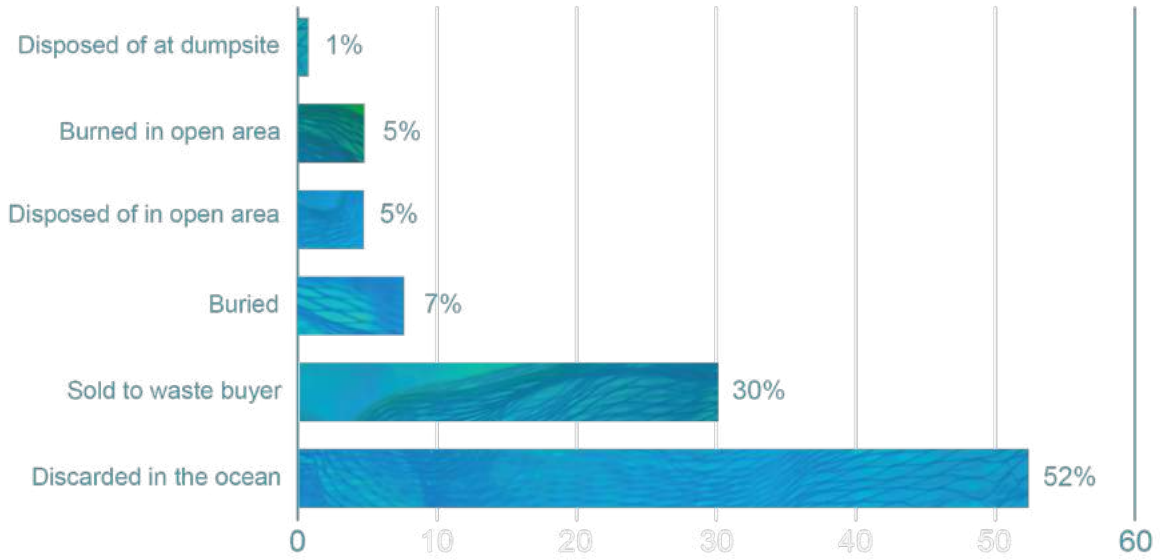


Figure 3: Methods of disposal of used nets in Koh Sdach Village*

4.1.3 Waste Flows and Market Chain of Plastic Waste – Koh Sdach

There were found to be two main sources of marine plastic pollution from the KSV community: 1) mismanaged household waste and 2) mismanaged fisheries waste, primarily nylon nets and monofilament lines.

The value chain and market potential for recyclables in KSV was investigated, and of 120 HHs surveyed, 16% reported selling waste, that is, PET, fishing nets, plastic bags and aluminium cans. The most frequently reported types of waste sold were fishing nets and aluminium cans, which also had highest average resale value per kilo, being US$9.31 and US$4.22 respectively. Reportedly, the informal waste sector is less affected by customs regimes, making the transport of waste to Thailand and Vietnam easier for informal actors. As set out above, this is prohibited under Sub-Decree 36 without the proper permits; and with a ban on the import of recyclables to Thailand & Vietnam expected to be implemented in the coming years (93), the future of Cambodia’s informal waste management sector is uncertain. In order for sustainable recyclables management, domestic opportunities need to be scoped and established for coastal and island sites.

It was also found that community members in KSV hold beliefs and attitudes that may disincentivise recycling activities, including that respondents feel ashamed to sell plastic waste because it is worth less money than other recyclables (e.g. aluminium). One respondent in Koh Sdach commented:

“if we sell plastic waste [such as] bottles, we will be considered a poor family, whereas aluminium cans or aluminium bottles are sold at a higher rate; so it is acceptable to sell aluminium waste as there is no shame”.

Additionally, when queried about how they use plastic recyclables, 20% of respondents advised they gave recyclables to others in need. These findings suggest that community perceptions and social norms may be

*Diagram photo credit: Pietro Jeng / Unsplash

acting as barriers to change, preventing the adoption of behaviours that could support SWM systems and circular approaches. Social and behavioural change methodologies present an avenue to foster new attitudes and motivate stewardship behaviours, though further research is needed to inform such initiatives.

4.1.4 Marine Debris – Koh Sdach and Koh Rong Archipelagos

In KSA, a total of 268 items of marine debris were recorded across 15 sites during dive surveys in 2019. Marine debris counted were categorised as: fishing nets, monofilament lines, glass and plastic. Of this, the majority was fishing waste (78%), consisting of nets and monofilament lines. A total of 150 nets were counted across 29 transects, with an average of 10 nets per site. A further 59 individual monofilament lines were counted, with an average of four lines per site. The next most common debris recorded after fishing waste was plastic waste, which made up 16% of marine debris counted.

In KRA, a total of 247 items of marine debris were recorded across 20 sites during dive surveys in 2019. Marine debris counted were categorised as: fishing nets, plastic items and general trash. A total of 168 nets were counted across 20 sites, with an average of 2 nets counted per site, making up the majority (66%) of marine debris recorded. An additional 66 items of general trash and 12 plastic items were counted. It is noted that FFI is working with partners, communities and key actors to strengthen data collection, specifically to ensure that marine debris data collection is consistent across sites.

Key to considerations of marine debris, a large-scale construction project is progressing within the bounds of Botom Sokor National Park, located on the mainland some 500 metres from KSA. This development acquired 20 percent of Cambodia's coastline for 99 years and includes the construction of an airport, seaport, hotels, a golf course and casinos (51). It is anticipated that the volume of marine debris will increase due to waste generated by this large-scale coastal development both during and after its construction. Given the lack of SWM systems or regulation of the private sector, these debris are expected to travel from the coastline into the ocean; posing a risk to the planned MFMA at KSA.

In Brief: Insights from 9 Years of Reef Check Data

The Cambodian Coral Reef Monitoring Network (CCRMN), established in December 2019, has compiled reef monitoring data from surveys conducted in Cambodia over the last nine years by different organisations into a central database.

1,765 pieces of discarded fishing gear (nets and lines) have been observed on 1,310 dive surveys since 2010 in the Koh Rong Archipelago, Koh Sdach Archipelago and outer islands of Koh Tang and Koh Prins.

Dive surveyors have also recorded the serious damage to marine life that this discarded fishing gear causes, such as damage and death to soft and hard corals. Dive teams often spend significant time carefully cutting and removing vast lengths fishing nets and lines to rescue corals and other reef fauna.

Credit: Matt Glue / FFI

4.1.5 Coastal Debris – Sihanoukville

The coastal plastics audit at Sihanoukville logged a total of 5,695 pieces of debris across three beaches, broken down into four sites. At all four sites plastic was the most commonly logged debris type, making up 81% of debris collected. Cigarette butts were the most frequently found type of plastic, followed by plastic food wrappers and plastic bags. Metal was the second most commonly logged debris type (12%), which was most often aluminium beverage cans and fragments.

Debris accumulation was most severe on Occheuteal beach, where more than half (59%) of the total amount of debris was collected. The shoreline of Occheuteal beach is a high traffic area, with many food vendors operating near the water's edge, which likely contributed to the high volume of debris at this site. Plastic debris density was also highest at Occheuteal beach, as well as at Independence beach. The shoreline at Independence beach had the highest distribution of plastic debris, an unexpected outcome given this site is much narrower than the other three and is separated by concrete seawall, resulting in much lower patronage. This finding may suggest that the plastic debris at this site did not originate from the land and may have washed ashore from elsewhere. It is noted that many tourist stalls and food vendors on Otres and Occheuteal beaches have ceased operation since this study took place, having closed in January 2020 at the behest of government authorities acting to "restore the beauty" of these beaches (94).

4.2 Socio-economic and Behavioural Factors

4.2.1 Demographics & Socio-Economic Characteristics - Koh Sdach Village

Understanding local perceptions and socioeconomic characteristics is crucial to determining the drivers of plastic pollution. The 2019 and 2020 socio-economic surveys conducted by FFI in KSV found that people had low levels of livelihood diversification, with most depending on fishing as their sole source of income. This indicates limited resilience to shocks and stressors and suggests the community is highly unlikely to be able to adapt to changes in social, economic and environmental factors, especially those that threaten fisheries.

Table 1: KSV Demographics

No.	Description		Number of individuals (ID)/ Households (HH)	Total
1	**Population**	Male	1361 IDs	2434 IDs
		Female	1073 IDs	
2	**Household**	Male-headed	567 HHs	589 HHs
		Female-headed	22 HHs	
3	**Ethnicity**	Khmer	-	586 HHs
		Vietnamese	-	3 HHs
4	**High School Completion (from Grade 1 to 12)**	Male	270 IDs	516 IDs
		Female	246 IDs	
5	**Occupation as fishers**	Primary	395 IDs	401 IDs
		Secondary	6 IDs	

Source: Koh Sdach commune record book (2018)

Livelihoods in KSV

The socio-economic studies completed in KSV found that 97% of male and 100% female respondents stated their primary source of HH income was fishing. The remaining 3% stated their primary income source as guiding tourists. Operating small businesses was the second most important source of income for the community, after fishing. Respondents noted that the main businesses are grocery and food shops, guesthouses and boat services, many of which are dependent on tourists.

In contrast to the HH survey data collected in 2018, it was reported in the 2019 surveys (N=28) that fishers do not throw used nets into the ocean as they are now brought to the island for sale to waste buyers (who also collect aluminium cans). This could reflect actual changes in waste net disposal practices, be attributable to factors such as awareness raising efforts or may highlight the expansion of markets for recycled products. However, this discrepancy could also reflect reporting bias or differences in experimental design, with the 2018 research team focusing on all HHs, and the 2019 research team focusing solely on fishing HHs.

Case Study: Waste Buying

Samnang[4] is one of two waste buyers in KSV purchasing old nets and aluminium cans for resale in Thailand and Phnom Penh. She buys around 2 tonnes per month of used nets, ropes and cans.

Samnang buys and resells used fishing gear in Thailand at the following rates:

- Gillnets: 1,200 - 1,300 KHR/kg;
- Seine nets or trawl nets: 500 KHR/kg;
- Ropes: 600 KHR/kg.

Samnang also sells cans in Phnom Penh at the price of 3,700-3,800 KHR/kg. She advised that she does not buy plastic bottles because they are difficult to sell and have a very low resale value of just 1 Thai Baht/kg.

Samnang would like to purchase a compactor to increase the volume of waste she is able to export. Compactors, however, cost around US$10,000 making such a purchase prohibitively expensive.

Credit: Bianca Roberts / FFI

Timeline and visioning exercises were conducted as part of KIIs and FGDs, with results suggesting that most respondents had no clear positive vision for the future of their village, that is, they did not see what they could change to make their village better. Participants also perceived the future economic development of the village to be uncertain as fisheries resources will decrease due to increased fishing effort. The majority (90%) of the HH respondents said that they did not wish their children to become fishers in the future. This was attributed to fishing being a competitive and physically intensive activity that faces instability due to the increasing scarcity of resources. Eco-tourism, however was perceived as an emerging economic opportunity. Successful eco-tourism will require protection of coastal and marine ecosystems, and especially pertinent is the reduction of KSV's abundant and inescapable marine plastic pollution and mismanaged waste.

[4] Name changed.

Case Study: Net Making

Three distinct groups of net makers were identified in KSV. Bora[5], the head of one net-making group, was interviewed. He leads a team of six people (one male, five female) from four neighbouring houses. Bora is contracted by fishers to make new crab gillnets, which are sold for US$4.25 per dia. In one day, his team can produce around 21 dia of crab gillnets, and each person earns around US$12.50 a day from this enterprise. There is currently high demand from fishers for crab gillnets, and Bora advised that business is booming. He noted that nets are used for around 1.5 months, at which point they are collected from fishers and sold to waste buyers on the island.

The prevalence of female actors across both net making and waste buying livelihoods presents an opportunity for gender inclusion strategies within interventions to reduce marine plastic pollution.

Credit: Pablo Sinovas / FFI

4.2.2 Perceptions and Attitudes towards SWM and Plastic Pollution

Key Informant Interviews conducted in KSV, including discussions with the village chief, highlighted that local authorities are concerned about solid waste, especially plastic waste. The HH survey results from 2018 reiterated this, with the majority (75%) of respondents stating they were concerned or very concerned about plastic waste. When questioned about SWM systems, 69% of respondents reported that they are highly or very highly concerned about the lack of a waste collection services. The main reason respondents were concerned about the lack waste management were blocked waterways and drains resulting in flooding and increased water-borne diseases. Interestingly, when asked what problems plastic waste could cause, 72% of interviewees agreed that it affects marine biodiversity, making it the most popular answer, followed by it causing public health issues (with 65% agreement). However, when asked if they utilise any plastic waste reduction methods, 60% of respondents said "no". Whilst the research findings suggest a low level of awareness of how to manage or address pollution in KSA, some residents are taking action. For example, the Principal of the local primary school has started a program to reduce the amount of plastic used by students:

"*Plastic waste is the main problem in Koh Sdach as more people drink water from plastic bottles. At school there are campaigns and awareness raising events for plastic (on a monthly basis) organized by the district authority. At school, I have started a school programme of not using plastic for packing students' lunch. The programme will be implemented step by step at school, and will be successful in the future*."

In Sihanoukville, key informants from the hospitality and tourism sectors demonstrated enthusiasm for improved SWM and concern regarding illegal disposal practices, with the shoreline and ocean being reported as common sites for illegal dumping, often by private citizens. Pervasive coastal pollution was reported by all informants, with the most common types of SUP observed being, bottles, bags and polystyrene food containers. Fishing waste was also reported as a commonly observed coastal debris.

[5] Name changed.

4.3 Governance and Management Systems

4.3.1 Solid Waste Management - Koh Sdach Village

In 2013, a waste collection system was established by a local businessman in KSV. Waste was collected and incinerated approximately 500 meters from the commune centre. However, by 2015 this service had ceased for the following reasons:

- the service was not regular and timing for waste pick-ups was not established;
- the service did not cover all areas in the commune, for example, people living on the pier did not receive the service; and
- there was no proper strategy of fee collection, in that the contractor had to visit each household to collect fees.

Since this service ceased there has been no waste collection in KSV.

Willingness to Pay for Waste Collection

> *I really worry about plastic waste on the island, which comes from tourists and local residents...I am willing to pay for the collection service.*
>
> *Koh Sdach Village Resident*

Ninety-two percent of respondents were willing to pay for waste collection services in KSV. Of the 110 respondents willing to pay, 82.5% said they would prefer curb side / house-to-house collection and most preferred to pay around US$2 per month in fees. The majority preferred to pay fees as part of their electricity bill (51%), an outcome that would require local authorities to negotiate with the island's electricity company, which is privately owned by a community member. A feasibility study is necessary to determine what methods of waste management are suitable for KSV, and the amount of fees required for services to be both accessible and financially viable.

Although the majority of respondents were willing to pay for waste collection, 8% advised they were not, citing the following reasons:

- I cannot afford waste collection (20%);
- the previous waste collection service was not sufficient (20%);
- the local government should pay or be responsible for waste collection, and there is no need for individual participation (30%);
- I am satisfied with the current situation, and prefer to dump directly into the sea (20%); and/or
- I don't believe the waste collection service would actually happen and/or waste collection services are unrealistic (10%).

4.3.2 Solid Waste Management - Sihanoukville

Qualitative data collected in Sihanoukville suggests that the city's SWM system is overwhelmed and operating at a sub-optimal level, reportedly due to a lack of government support and resourcing. Improper waste disposal practices by both businesses and individual HHs exacerbate these systemic and governance issues. Key Informant Interviews suggest that between 80-100% of waste is typically collected. Despite this, customer dissatisfaction and uncertainty were clear, with informants expressing doubt about the effectiveness of the waste contractor, KSWM[6]. One informant stated they observed garbage collectors dumping waste into a field once the trucks were full, however this was not substantiated by KSWM. Interviews with the Sihanoukville Municipality highlighted the need to monitor the performance of SWM contractors. Overall, informants were willing to pay more to receive a higher quality service, but also said that the government should provide some funding to improve SWM services, including through taxation.

[6]It is noted that KSWM was the waste contractor at the time of data collection, however, they reportedly no longer act in this capacity.

Key Informant Interviews with KSWM illustrated that they perceive the government to be a crucial player in the improvement of SWM systems and addressing coastal plastic pollution. They prioritised government support in the form of technical guidance and resourcing, advising that they are required to pay the government to operate. KSWM also highlighted the difficulty of fee collection and access to the province's landfill, emphasizing that this and other expenses undercut profitability.

When questioned about the technical capacity and availability of staff, KSWM advised that an adequately skilled workforce does not exist in Sihanoukville. KSWM suggested that an improved system could include sorting of waste prior to collection. It is noted that cleaning and separation of waste is not common in Cambodia, despite being set out in Sub-Decree 113, and would require new habits to be formed. From KSWM's perspective, the ecchay play an important role in SWM systems, and within their company model, workers can collect and sell recyclables for personal profit.

4.3.3 Solid Waste Management – Koh Rong Archipelago

In KRA, SWM services are delivered to some communities by a local business owner. This system involves the business owner coordinating the collection and transport of waste from multiple sites in the archipelago to the mainland, where KSWM transports the waste from the port to the landfill in Preah Sihanouk. According to local authorities, this business owner has a high level of interest in SWM because mismanaged waste poses a threat to their tourism-centric businesses. The current SWM system in KRA, whilst essential given the lack of alternatives, is based solely on the initiative of one individual with unknown technical capacity and minimal (if any) regulation, monitoring or accountability. Anecdotal reports suggest that waste leakage into the ocean during transport is an issue.

A bag of rubbish on a popular tourist beach in the Koh Rong Archipelago. Credit: Bianca Roberts / FFI

4.4 Stakeholder Landscape

Research teams investigated the stakeholder landscape in Koh Kong and Sihanouk provinces through a series of KIIs. It was consistently reported by stakeholders that mismanaged solid waste and plastic pollution is an acute and widespread issue of high importance. The majority of informants framed marine plastic pollution as a SWM issue, with many reporting deficiencies of SWM systems as the cause of marine plastic pollution. An urgent need for strong collaboration between stakeholders was identified as an essential component in designing and implementing effective SWM systems & plastic pollution reduction strategies. Key findings are set out below:

4.4.1 Public Sector

Influence: High
Interest: High

Public sector actors, specifically those within the RGC, are key to reducing marine plastic pollution, with scope to enact change through a number of avenues, including:

1. Operationalising existing policies, legislation and other governance mechanisms;
2. Bridging governance gaps and strengthening systems to support other actors and stakeholders to reduce marine plastic pollution;
3. Implementing, managing and monitoring SWM systems (including infrastructure development and ensuring SWM systems are appropriately resourced);
4. Delivering education and outreach activities, especially for community beneficiaries and other locally focused actors;
5. Engaging and regulating the private sector;
6. Fostering collaboration with other actors and stakeholders, and ensuring inter-and-cross-ministerial cooperation is taking place; and
7. Facilitating and ratifying transboundary, regional and international agreements, and coordinating associated funding and support mechanisms from these sources.

All key informants interviewed, including government informants and those from other sectors, viewed the RGC as the primary actor for reducing marine plastic pollution. The perception of informants outside of government, is that authorities are not meeting the expectations or needs of their constituents with regards to SWM.

Opportunities to strengthen government-led action:

Coordinating action & delegating with clarity: As touched upon previously, the roles and responsibilities set out in the sub-decrees of Cambodia can be ambiguous. A representative from Provincial Department of Environment (PDoE), advised that technical support and legal adoption of waste management in communes should be facilitated by the department, while commune councils play a key role as implementers and system monitors. It remains unclear, however what support has been provided by national and provincial government to enable commune authorities to adopt such a role. An informant from the Sihanoukville Municipality called for clearly defined roles within the municipality to enable them to act as the regulatory agency responsible for managing SWM contractors. The Sihanoukville Department of Tourism also called for clearer delineation of responsibility in coastal areas, emphasising the need to collect evidence and minimise pollution at coastal sites.

Utilising existing governance mechanisms: The KIIs highlighted that there is limited awareness of the existing SWM and plastic management policies and legislation across various levels of government. For example, a number of government informants called for increased enforcement and the development of regulations, but were unaware of the existing regulations set out in sub-decrees or under whose remit enforcement would fall. The lack of awareness of existing governance frameworks, highlights the need for capacity building to enable informed action and leadership.

Clarifying resourcing and ensuring financial sustainability: A lack of funding was cited by many government informants as a barrier to SWM system establishment, effectiveness and sustainability. Some government informants advised that no funding is provided to support SWM strategies, whilst others reported they have limited resources. Government informants highlighted challenges around the geographic and logistical complexities of coastal and island sites, emphasizing the impact of this on profitability and sustainability of SWM services, and pollution reduction strategies more broadly.

Heightening transparency & accountability: The need for heightened transparency was not emphasized by government informants themselves but rather was highlighted by informants outside of government, including the SWM contractor, KSWM. Mismanagement and inefficient use of funds was a recurring theme, undermining perceived political efficacy. Whilst informants expressed willingness to pay more for improved services, this was only where money would be used as intended.

With regards to quality of SWM services, it is the responsibility of government actors to monitor SWM contractors, however, there are currently limited measures in place to do so. As previously mentioned, the RGC is currently reviewing the contracts of all major SWM service providers in Cambodia, with the view to developing clearer performance indicators and improving transparency and accountability of SWM contractors.

Other public sector stakeholders that are key to addressing marine plastic pollution include (but were not directly interviewed):

- Education sector actors such as education institutions and academia, who are essential to bridging knowledge gaps and building a pipeline of local technical expertise;
- Law enforcers and regulators, including CFi's; and
- Health sector actors, with whom there has been limited engagement to date despite the health risks presented by plastic pollution and mismanaged waste.

Increased engagement with these actors is recommended moving forward.

A community clean up in Prek Savey Village (Koh Rong Archipelago). Credit: Bianca Roberts / FFI


Mangrove planting, Koh Rong Archipelago. Credit: Jeremy Holden / FFI

4.4.2 Local Community

Influence: Low
Interest: High

Community members are key beneficiaries with a high level of interest in establishing and improving waste management systems and reducing marine plastic pollution. Despite this, community members currently have low power and influence, with limited opportunities to effect government action and/or minimal avenues to raise concerns when systems aren't working at an optimal level.

Opportunities to strengthen community engagement and increase agency:

Feedback and grievance mechanisms: Gaps around grievance and/or feedback mechanisms were identified as a barrier, disincentivising community engagement. It is recommended that interventions to address marine plastic pollution incorporate feedback and grievance mechanisms to heighten accountability, empower low influence stakeholders and optimize interventions in response to community needs.

Education and outreach: Education and community outreach activities were identified by informants as an effective means engage communities in environmental stewardship behaviours and foster community pride.

Collaborative and participatory approaches: Collaborative and consultative approaches are essential to success, and capacity building of provincial and local authorities is recommended to support these actors to utilise such approaches in the development of pollution reduction strategies.

4.4.3 Private Sector

Influence: Moderate to high
Interest: Varies depending on sector

Broadly speaking, private sector actors at coastal sites are both impacted by, and generators of, marine plastic pollution. Given that pollution can threaten profitability, private sector actors can be highly enthusiastic and interested stakeholders. The findings highlight the need to engage the private sector in marine plastic pollution interventions, and are broken down by sector below:

Waste Management Contractors: Historically SWM services in Cambodia have been delivered by private contractors (both businesses and individuals). Further details can be found in section 4.3.2 (above), however interviews with KSWM suggest they are high interest, low influence stakeholders.

Tourism and hospitality: The tourism and hospitality sectors are high influence and high interest stakeholders, especially as sectors that both contribute to, and are impacted by, mismanaged waste and plastic pollution.

Construction & development: Whilst no stakeholders from these sectors were directly interviewed, informants identified construction companies and property developers as key waste generators and perpetrators of illegal disposal. Investigation into waste generation and management by these sectors is recommended.

Other key private sector actors include (but were not directly interviewed by the research teams):

- **Plastic importers and exporters;**
- **Plastics alternative providers;** and
- **Small business owners,** especially retail shops, food vendors and market sellers.

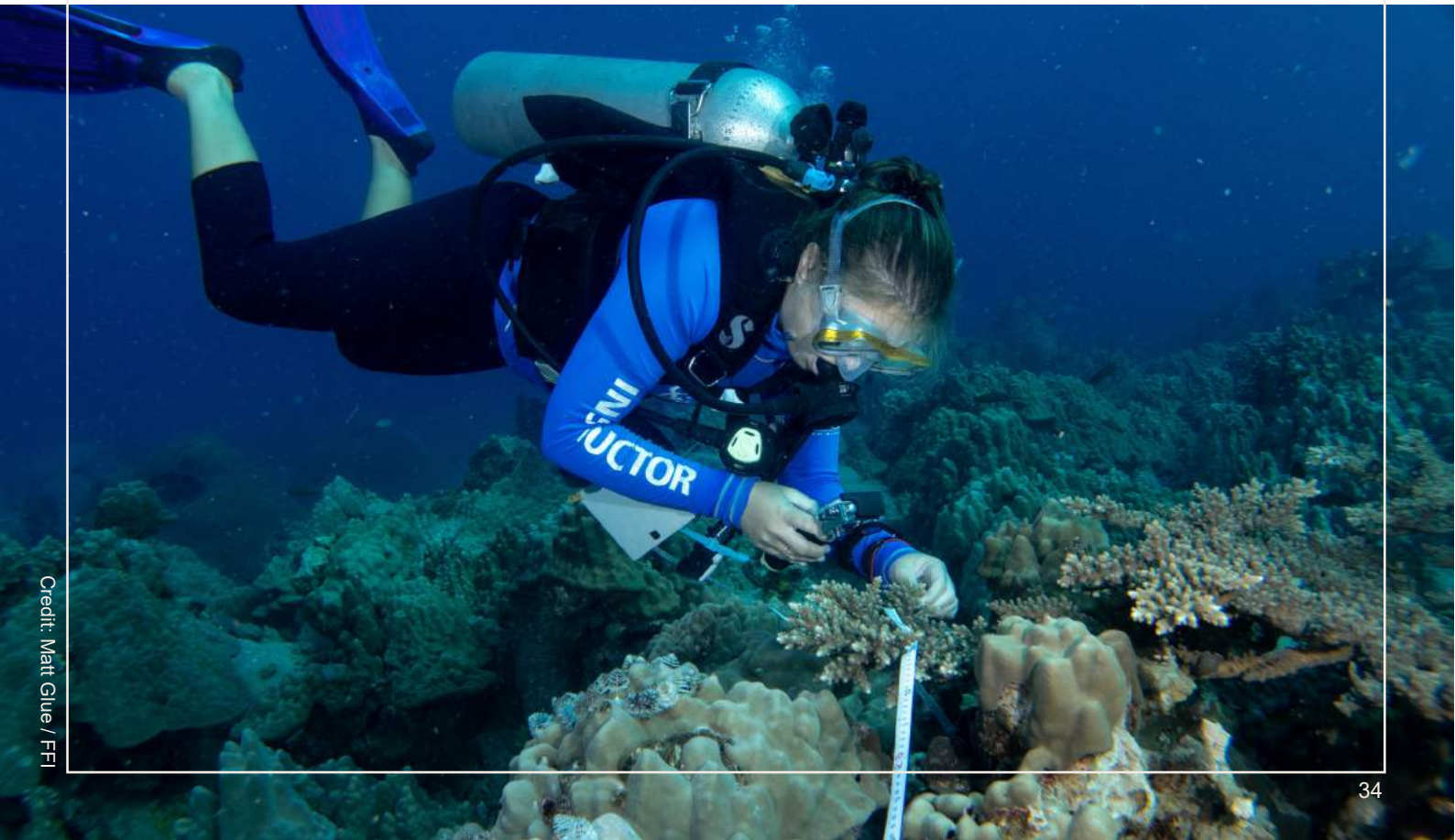
It is recommended that stakeholders from these sectors be engaged to inform and support strategies to reduce marine plastic pollution.

4.4.4 Third Sector

Influence: Moderate
Interest: High

There are a number of NGOs working in coastal and marine areas of Cambodia, though few have a focus on marine plastic pollution or SWM. To date, SWM strategies and reform have largely focused on urban areas. This means that novel partnerships and new avenues for collaboration are required to support strategies to reduce marine plastic pollution.

The perception of stakeholders in KSV is that FFI is a key actor for achieving SWM planning and initiatives to reduce or halt marine plastic pollution. The European Union (EU) and World Bank were also identified as key actors. For long-term sustainability, however, it is essential that SWM systems and plastic reduction interventions are locally-led, with third sector actors adopting a supporting role.



Credit: Matt Glue / FFI

5. Gaps

5.1 Research & Information Gaps

The following information gaps and opportunities for further study have been identified:

Biodiversity impacts of marine plastic pollution in Cambodia: To date little research has been conducted to assess the impact of marine plastic pollution on species, habitats and ecosystems in Cambodia. This information is essential to inform measures that protect biodiversity and develop a baseline to assess whether marine plastic pollution interventions are impactful.

Brand information, source and life cycle of plastics: It is noted that one research team attempted to collect information on brands, although little information was recorded due to the absence of labels on debris and language barriers. Despite some challenges, the collection of brand information presents a relatively accessible, low cost avenue to identify the origin of plastic waste. Anecdotal reports from FFI field teams suggest that Cambodian brands are well represented in the plastic pollution present at coastal sites, in particular Cambodian bottled water companies. Brand information may also present an avenue for private sector engagement to foster accountability. While some information was collected to map waste streams, further research is needed to understand plastic flows and life cycles, and actors along these chains, in order to refine and optimise interventions. Understanding the nature of plastic use and quantifying essential and non-essential use is also vital to inform means to equitably reduce plastic use.

Mapping of large-scale plastic flows (transboundary and freshwater ecosystems): Transboundary plastic flows may present a threat with Cambodia neighbouring a number of countries that face challenges around SWM and/or are high volume plastic consumers. Understanding waste flows through aquatic systems has the potential to inform transboundary cooperation and management of plastic pollution. The transit of plastic from freshwater ecosystems into the ocean is yet to be quantified, however with many rural Cambodian communities living in the vicinity of river systems paired with an absence of SWM in most rural areas, further investigation is warranted to understand downstream impacts in Cambodia and in neighbouring countries, such as Vietnam.

Microplastics: To date, little data has been collected on microplastics in Cambodia[7]. Whilst the dominant visual presence and feasibility of data collection make macroplastics focus for plastic pollution interventions, microplastics are a concern due to their environmental and health impacts (40–42,44). Elucidating the presence of microplastics in marine habitats, seafood and flagship species in Cambodia would add an unexplored dimension to marine plastic pollution reduction strategies.

Development and construction waste: As touched upon previously, Cambodia is experiencing unprecedented economic growth and a national development boom, including at a number of coastal sites. Research quantifying plastic waste and other debris travelling from construction sites into coastal and marine ecosystems is limited. Such data would inform means to engage with property developers and construction companies to enforce regulations that prevent debris flowing off-land and into the ocean.

Data to inform social and behavioural change interventions: It is recommended that social and behavioural change (SBC) methodologies be utilised to foster enabling conditions that support the interventions identified. It is recognised, however, that effecting SBC is a complex goal often realised in response to iterative change over the long term. Implementing impactful and measurable SBC initiatives requires a robust data set and comprehensive monitoring, evaluation and learning. Initial findings suggest some avenues for further research, but a greater depth of understanding is essential to effectively target key audiences, behaviours and sites.

Gender dynamics and opportunities to work towards gender parity: It is crucial that the proposed interventions are informed by research that elucidates gender dynamics and the associated social and cultural norms. This is crucial to ensure that interventions do not harm or undermine beneficiaries, but also serves to identify opportunities to support gender parity. For example, the net making and recycling livelihoods already present in KSA are often led by or employ female community members. Strengthening these livelihoods may present an opportunity to foster female leadership and engagement in the reduction of marine plastic pollution.

[7]It is noted that at the time of writing, a research team from Hull University was collecting data on freshwater microplastic in Cambodia.

5.2 Management & Governance Gaps

> *I am seriously worried about plastic waste on the island. Most people dump directly into the sea. Local authorities should deal with plastic waste.*
>
> *Koh Sdach Village Resident*

Utilising existing governance mechanisms: Cambodia's existing policies and legislation are crucial and their development speaks to ongoing political will and commitment. They are however, only as powerful as their implementation. If limited guidance, follow-up and enforcement continues, these mechanisms could remain largely as documentation rather than being utilised as a means for change.

Clarifying government roles, responsibilities and resources: Across different levels of government there exists limited transparency or accountability. Roles and responsibilities are set out in sub-decrees but overlap, are unclear or omit key elements. The research findings demonstrate that the authorities responsible for SWM were unclear of their roles or the existing governance frameworks. It is also unclear what support has been provided by the RGC to provincial and local authorities, nor if cross-ministerial collaboration is taking place despite multiple ministries being included in sub-decrees.

Resourcing was reportedly the primary barrier to effective waste management and pollution reduction. It is unknown what resources are available from the national government, what amount of funding would be required to implement and manage SWM systems outside of urban areas, and thus how effective systems might be financed sustainably. Furthermore, considerations around "resourcing" should extend beyond funding, and need to take into account the human capital, broader infrastructure and management systems required to realise SWM strategies and reduce marine plastic pollution.

MPA frameworks: There is scope within MPA management frameworks to introduce mechanisms to reduce marine plastic pollution, and marine debris more broadly. This might include:

- building the capacity of provincial and local authorities, including CFis, to support enforcement of waste management regulations where appropriate;
- utilising MPA zoning, planning and management as a means to monitor and reduce plastic pollution; and
- regulating the fisheries sector to reduce the dependency on SUPs, minimise waste generation and improve disposal practices.

It is noted that any regulations targeted at mitigating fishing waste will require collaboration between the MoE and the FiA, with the enforcement of fisheries regulations sitting under the remit of the FiA and waste management regulations falling under the remit of the MoE. Such an endeavour will require cross-ministerial cooperation to be successful.

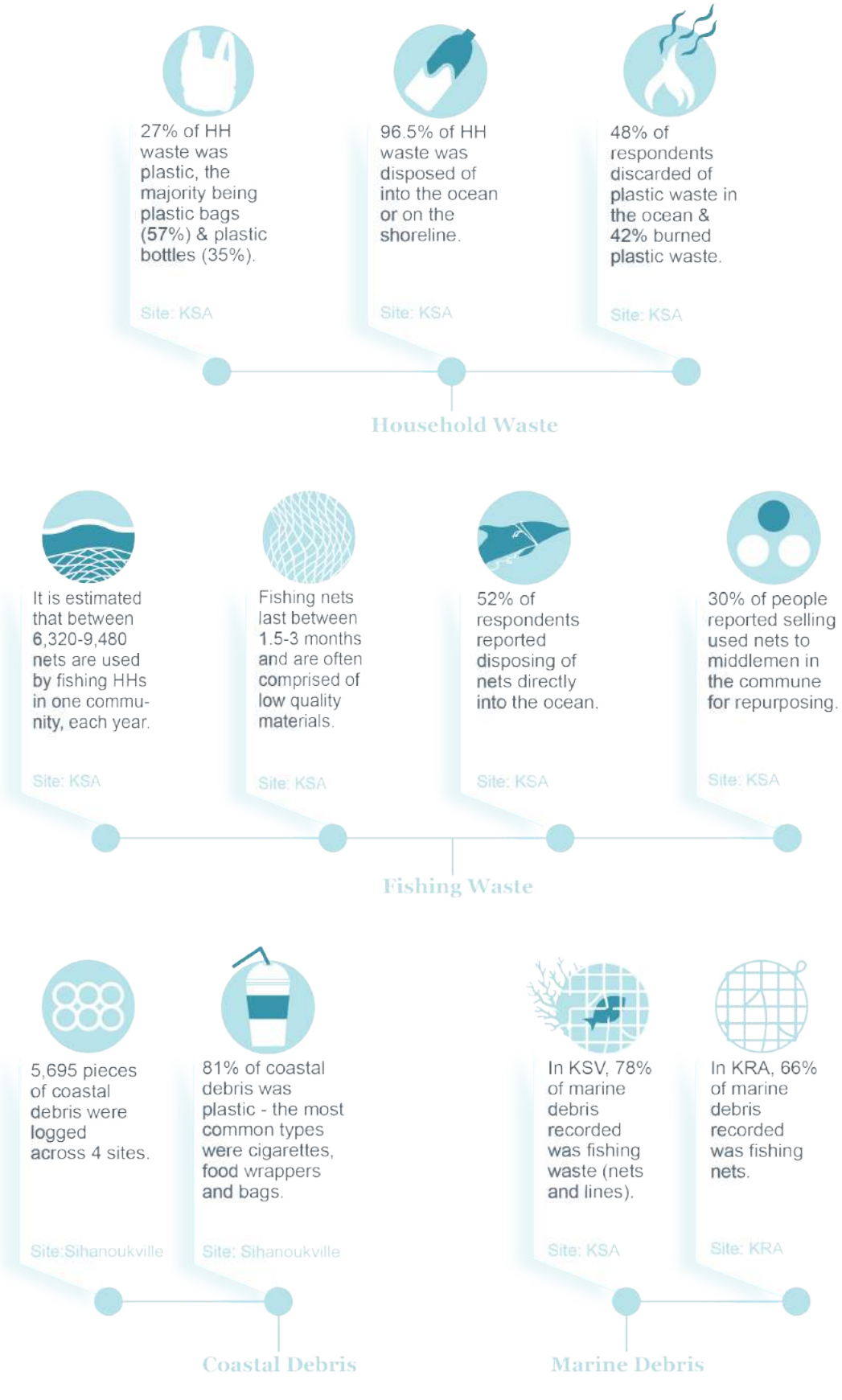
Fisheries and aquaculture market development: A number of large, multi-national donors have expressed interest in developing markets for marine products, strengthening aquaculture and improving fisheries-based livelihoods in Cambodia. This represents a vital opportunity for many coastal communities, however, it is crucial that strengthening these blue economies does not come at a cost to the ecosystems upon which they depend. There is scope for regulation of plastic use and disposal along fisheries and aquaculture value chains to ensure they are managed sustainably.

Credit: Bianca Roberts / FFI

6. Recommendations & Interventions

6.1 Key Findings at a Glance

Environmental and Biophysical Factors



Socio-economic and Behavioural Factors

Governance and Management Systems

6.2 Recommendations

The findings set out in this report have been synthesized to develop recommendations targeted at reducing marine plastic pollution in Cambodia. Within each broad recommendation, interventions have been identified, which detail context specific opportunities at key coastal and marine sites. It is noted that the findings themselves are from specific project sites and have been generalised to develop the following recommendations. Further, the recommendations are interdependent, and cannot always be neatly separated into distinct units. The detail of each recommendation is set out below:

Recommendation 1. Reduce plastic use: Reducing unnecessary and wasteful plastic use, thereby curtailing plastic waste and pollution generation, is viewed as a high priority recommendation. Whilst the subsequent recommendations are integral to minimising marine plastic pollution, they seek to manage and mitigate this threat rather than prevent it in the first instance. Reducing the volume of plastic used also supports the following recommendations, minimising the burden on the systems and stakeholders seeking to address marine plastic pollution.

Whilst minimising preventable plastic use is a priority, it is important that this is not realised by adopting a wholly anti-plastic mentality. Demonising plastic may prove counterintuitive to circularity, preventing people from appreciating the value of plastic beyond its original, intended use. Whilst plastic pollution is a multifaceted threat, plastic products themselves deliver many benefits, especially to vulnerable peoples with limited access to resources, such as clean water. It is vital that strategies to reduce plastic use and plastic pollution do not come at a cost to community, and that the value of plastic is considered.

⇒ **Intervention Opportunity 1.1:** Reducing plastic use to stem plastic waste generation and marine plastic pollution.

Recommendation 2. Support opportunities to move towards a circular plastics economy: Realising a truly circular economy is a vision that requires iterative, systemic change in the long term. The circular economy model is generating international momentum and interest in circular economy approaches is emerging in Cambodia. It is vital to consider how existing practices might be optimised or adapted to support the move away from linearity, however, such opportunities must be framed within the Cambodian context. Employing circular economy thinking at coastal sites presents opportunities to:

- reduce the volume of plastic (and other) waste entering coastal and marine ecosystems;
- reduce pressure on SWM systems by reducing residuals;
- support livelihood diversity and sustainability; and
- incentivise environmental stewardship behaviours.

At this time, circular opportunities at coastal sites most often take the form of recycling, and the landscape for circular economy approaches in Cambodia is challenging. Whilst the word “recycling” is present in a number of sub-decrees, there is currently limited guidance or support within existing governance structures and systems for the adoption of circular approaches. This is compounded by the vulnerability and limitations of existing recycling systems, including that:

- Recyclables markets in Cambodia are largely defined by informal waste sector actors who transport recyclables to Thailand and Vietnam for sale and processing. These borders, however, are reportedly closing to the recyclables trade.
- Without proper licenses, the export of recyclables from Cambodia is prohibited (a potential limitation for some enterprises & informal sector actors).
- Waste separation and cleaning is uncommon and would require citizens to form new habits and adopt new attitudes and beliefs. And;
- It is unknown how much of the waste at coastal and marine sites is actually suitable for re-use or recycling.

Opportunities to work towards circular plastics economies, recycling or otherwise, should be investigated and strengthened, with a focus on domestic, locally-led initiatives.

⇒ **Intervention Opportunity 2.1:** Investigating and enabling circular economy opportunities at coastal sites.

Recommendation 3. Improve residuals management: The current state of SWM systems in Cambodia, the high proportion of plastic in waste, and increasing demand for plastic products are major contributors to the large volume of waste entering the ocean from coastal areas. Establishing and improving SWM systems is a critical measure to reduce marine plastic pollution. Two main sources of marine plastic pollution were identified at the focal site: 1) household waste and 2) fisheries waste.

Household (HH) waste: In the absence of effective SWM systems, coastal communities have no alternative but to dispose of their HH waste into the environment, most often into the ocean or on the shoreline. Plastic waste is frequently burned in open spaces presenting both health and environmental risks. Conversely, sorting and collecting certain types of HH waste presents opportunities for communities benefit financially whilst also contributing to improved SWM.

Fishing waste: Fishing is a significant source of income for many coastal communities. Without interventions to manage fisheries sector waste, it is likely that used fishing gear will continue to be disposed of into the ocean. Fishing waste, especially ghost nets, is a lasting threat to biodiversity and the ecosystems upon which this blue economy relies. The re-use and recycling of used fishing gear links to Recommendation 2, and presents opportunities to strengthen and diversify livelihoods, supporting the resilience and wellbeing of coastal communities. It is recommended that governance frameworks take into account this waste stream, and that SWM systems at coastal sites be designed accordingly.

⇒ **Intervention Opportunity 3.1:** Managing household waste to prevent marine plastic pollution and support community wellbeing.

⇒ **Intervention Opportunity 3.2:** Managing fishing waste to prevent disposal into the environment and secure sustainable livelihoods.

⇒ **Intervention Opportunity 3.3:** Coastal and marine clean ups to address marine plastic pollution currently in situ.

6.3 Interventions

As introduced above, a number of interventions have been identified, which articulate site and context specific avenues to address marine plastic pollution. This report reviews and synthesises some of the first research into marine plastic pollution in Cambodia, and as set out in Section 5.1 there is an urgent need to bridge research gaps as a means to clarify and refine each intervention. Any interventions trialled need to be accessible and contextually meaningful and an iterative roll out is recommended, with interventions being optimised over time based upon feedback. Additionally, trial interventions must be measurable, and evaluation and information sharing will be key to optimisation. The details of each intervention are set out below:

Intervention Opportunity 1.1: Reducing plastic use to stem plastic waste generation and marine plastic pollution.

1.1.1 Reducing Plastic Use in Coastal Communities

Plastic from HH waste: The majority of plastic waste generated by HHs was bags and bottles, and as such reducing the use of these items is a priority. Approaches may include:

- enabling access to re-usable alternatives, for example, reusable bags and/or bottles;
- the provision of goods and services that reduce the reliance on plastic products, for example, water filters to replace bottled water (see contextual considerations set out in Annex 1);
- restrictions on the import of certain plastics at key sites; and/or
- restrictions or taxes around the use of certain plastic products in key areas e.g. bans or taxes on plastic bags at wet markets or shops (supported by Sub-Decree 168).

Community support of such initiatives is crucial, and the possible impacts on beneficiaries must be assessed, as restrictions surrounding plastic products should not come at the cost of community wellbeing, and buy-in is an essential ingredient for lasting change.

Plastic from fisheries: There is scope to reduce the volume of fishing gear used by:

- ensuring fishers have access to higher quality gear and net making or mending materials to extend the life of fishing gear;
- restricting the use of certain types of fishing gear and certain fishing activities, for example, illegal trawling in shallow waters;
- investigating whether certain practices are leading to premature net damage or deterioration; and/or
- scoping and possible expansion of net repurposing and recycling-focused livelihoods (see Interventions 2.1 and 3.2).

1.1.2 Reducing Plastic Use by Private Sector:

Hospitality & tourism: Data collection in Sihanoukville found the hospitality and tourism sectors to be both generators of, and impacted by, marine plastic pollution. Key informant interviews demonstrated a high level of enthusiasm from these sectors towards reducing plastic pollution. Collaborative development of best practice guidelines and regulations is recommended to support the adoption of new practices that reduce plastic use and protect the ecosystems upon which these subsectors rely. It is noted that a number of hospitality and tourism businesses have initiated their own ethical and sustainable practices, and should be encouraged to act as role models and leaders to inspire further action.

Construction & development: Whilst limited information exists, the construction and property development sectors are perceived to be key waste generators, with coastal development at Koh Kong and Sihanoukville presenting a particular threat to current and planned MPA sites. Further investigation is needed to develop a sound evidence base and motivate collaboration to reduce the volume of plastic used (and the amount of waste generated).

Plastic importers & alternative providers: At island sites, like the KRA and KSA, all plastic products are imported, which presents opportunities to reduce plastic imports (provided communities are supportive). Additionally, plastic importers might be enlisted to make available plastic alternatives or to import products that facilitate reuse and recycling (links to Intervention Opportunity 2.1).

There are a number of businesses in Cambodia that sell plastic alternatives. Anecdotal discussions with these businesses highlight challenges, including the high rate of import taxes, which prevent competitive pricing, minimising uptake and threatening profitability.

Small businesses: The findings illustrate that small businesses, including grocers and food vendors, are becoming an increasingly important income source in some island communities. Given the frequent use of plastic by food vendors, grocers and at wet markets, it is anticipated that these businesses are likely to be sites of high, and increasing, plastic use (39). As such plastic streams, life cycles and use by small businesses at coastal and island sites should be investigated as an avenue to reduce plastic use.

Intervention Opportunity 2.1: Investigating and enabling circular economy opportunities at coastal sites

2.1.1 Assessing and strengthening existing opportunities: The findings highlight a number of existing livelihood activities centred on recycling and re-use of plastic, including fishing net repurposing and the trade of recyclables. These existing livelihoods present an opportunity for coastal communities to move away from linear resource use, and it is recommended that participatory approaches be utilised to investigate their market potential and long term viability.

2.1.2 Investigating novel opportunities: Private and third sector partnerships present opportunities for communities to benefit from plastic reclamation. Emerging opportunities at coastal sites include, recycling of nylon fishing

nets into yarn and processing of used plastics to produce plastic pellets. The feasibility of such business opportunities within the Cambodian context is an area for further investigation.

Intervention Opportunity 3.1: Managing household waste to prevent marine plastic pollution & support community wellbeing.

3.1.1 At the focal site: In the absence of SWM systems, the residents of KSV are forced to dispose of their waste directly into the ocean, on the shoreline, or by burning it – disposal behaviours that are unlikely to change unless SWM systems are established. It is recommended that SWM systems be trialled in KSV, and where possible exploit circular economy approaches to maximise efficient resource use and reduce residuals, for example:

- (As identified in Intervention 2.1) strengthening domestic markets for recycled or repurposed products;
- utilising enabling legislation in support of circular approaches, for example Decree 113, which mandates waste separation; and
- producing composted products such as organic fertilisers (waste characterisation surveys found that 60% of household waste was organic matter).

The key findings highlight a number of contextual considerations regarding the proposed trial, which can be found in Annex 1. It is also recommended that the management of fishing waste be considered within the design of the SWM system (links to Intervention 3.2, below).

3.1.2 Outside of the focal site: The SWM trial should be carefully monitored and evaluated to inform SWM interventions at other sites.

Intervention Opportunity 3.2: Managing fishing waste to prevent disposal into the environment and secure sustainable livelihoods.

3.2.1 Livelihoods opportunities: Opportunities exist though collaborative partnerships to assess, strengthen and establish livelihoods based on recycling & repurposing of used fishing gear, including processing used nets and lines into textiles and other products (as touched upon in Intervention 2.1.2). Physical systems of disposal could support fishers to alter their behaviours, for example, used net collection points could be positioned at docks to enable efficient disposal (also supporting ease of collection for recycling or re-use). Further research is required to assess the feasibility of such initiatives.

3.2.2 Fisheries regulation and enforcement: Existing legislation, fisheries regulations and enforcement mechanisms could be adapted to include locally appropriate regulations that reduce fishing gear discards and gear use. Patrol teams (e.g. fisheries officers and the marine inspectorate) also play an important role in the monitoring, awareness raising and enforcement to reduce discarded gear.

3.2.3 MPA planning, monitoring and management: It is recommended that opportunities to reduce marine plastic pollution, especially fishing waste, are taken into account in MPA design and management. Within MPA monitoring frameworks, it is recommended that appropriate regulations are developed. Plastic pollution and marine debris data collection could also be embedded into existing MPA protocols, for example through standardised coral reef monitoring methodologies, sea turtle data collection and deceased marine mammal dissection processes. MPA management frameworks also present opportunities to engage actors across these protected areas in locally accessible data collection, for example enlisting fishers to estimate the volume of plastic in landings, or utilising their historic knowledge to assess how plastic in landings has changed over time.

Intervention Opportunity 3.3: Coastal and marine clean-ups to address marine plastic pollution currently in situ.

Research findings, secondary evidence and anecdotal observations highlight the immense volume of marine plastic pollution currently present in Cambodia. It is acknowledged that cleaning-up waste treats a symptom rather than addressing the root cause of pollution, however, the ongoing biodiversity threat posed by marine plastic pollution once in situ (especially ghost nets), has led to clean-ups being included as the final intervention in this

report. Community clean-ups also present an opportunity to strengthen environmental awareness and community pride, heighten perceived political efficacy and build social cohesion – all foundational components required to foster environmental stewardship. Additionally, there is considerable enthusiasm for clean-up activities in Cambodia, with a number of local clean-up focused NGO's being formed and the government promoting activities, such as clean city competitions.

It is recommended that best practice guidelines be developed to maximise the effectiveness and impact of clean-ups, including:

- developing locally accessible research protocols to enable data to be collected from clean-up activities;
- utilising clean-ups as opportunities for education, awareness raising and SBC to motivate stewardship behaviours; and
- establishing systems to enable waste from clean-ups to be properly managed and/or for resources to be reclaimed from the waste collected.

6.4 Enabling Conditions for Change

The above interventions are reinforced by a set of enabling conditions, which describe avenues to create an environment for change, these are: 1) building capacity, 2) strengthening governance and 3) fostering social & behavioural change (SBC).

Condition 1. Building capacity is key to effecting lasting change and ensures stakeholders have the knowledge and skills required to genuinely engage in, design and manage plastic pollution reduction strategies. Thematic areas for capacity building are:

- impacts of plastic pollution environmentally, socially and economically, including key concepts, such as interdependence;
- ensuring key actors have a sound understanding of governance frameworks (e.g. sub-decrees) and the means to implement management mechanisms (e.g. feedback & grievance mechanisms and monitoring & evaluation systems); and
- strengthening the understanding of circular economy approaches and their potential benefits.

Targeted capacity building will be required with an array of actors, including:

Local Government: As detailed above, SWM sits under the remit of the RCG, with responsibility being devolved to provincial and commune level authorities. As such, capacity development of government actors, especially local authorities, will be essential to inform the improvement and/or implementation and management of SWM systems. Private and third sector partnerships are also key, and a number of organisations have the potential to function as capacity building focal points to support authorities at coastal sites.

Private Sector: Capacity development targeted at the private sector actors should focus on the uptake of new SWM systems and motivating reductions in plastic use and waste generation, with the goal of minimising environmental impact.

Fishers: Building the capacity of CFi's and fishers will be integral to effectively managing fisheries waste, including building understanding of:

1. links between fishing waste, biodiversity and resource availability; and
2. Cambodian legislation & policy, including MPA frameworks.

Community: Capacity building of community is integral to enable informed engagement and support SWM system adoption. Developing the capacity of communities also has the potential to foster leadership and heighten agency, which is crucial to empower these beneficiaries.

Condition 2. Strengthening governance, is key to enabling local leadership and supporting buy-in of interventions to reduce marine plastic pollution. Focal areas for strengthened governance are:

Utilising existing governance mechanisms: As touched upon previously, enabling governance mechanisms exist and could be more fully utilised to reduce marine plastic pollution. The implementation and enforcement of existing legislation and regulations should be handled with contextual understanding and paired with capacity building (Condition 1), that is, constituents should not be penalised for non-compliance with systems that do not exist or have been formalised with limited investment in change management.

Governance for circularity: We propose strengthening governance mechanisms and systems to enable domestic recycling and re-use activities, with the long term vision of enabling circularity.

Governance for SWM: In addition to capacity building, key elements to strengthen management of SWM systems include:

- ensuring different levels of government and ministries are collaborating and understand their own unique roles and responsibilities;
- ensuring that democratic and consultative approaches are adopted to enable local engagement, ensuring systems meet the needs of constituents;
- establishing operational and administrative structures that support effective and transparent management systems; and
- bridging governance gaps to better manage fisheries sector waste.

Condition 3. Fostering SBC, is recommended to address barriers to change, incentivise stewardship behaviours and foster habit formation. The research findings highlighted a number of potential target beliefs and behaviours, including:

Plastic use behaviours: Plastic use behaviours contribute directly to marine plastic pollution, and SBC methodologies present an opportunity to understand the social and cultural norms that drive plastic consumption. For example, ecotourism was found to be an aspirational livelihood in KSV and linking environmental awareness and stewardship behaviours to income potential arising from ecotourism, may motivate stakeholders to reduce the volume of plastic they use. Other opportunities to prompt SBC may include:

- promoting “traditional” wisdom to reduce plastic consumption (e.g. wrapping in banana leaves instead of plastic); and/or
- utilising influencers that currently exist in Cambodia to act as role models and community leaders.

Disposal behaviours & SWM system adoption: Changing disposal behaviours is a key to preventing waste entering the environment and supporting the uptake of SWM systems. The findings identified feelings of shame associated with selling recyclables, which may disincentivise recycling behaviours. SBC initiatives could be utilised to shift these barriers, for example, recycling could be promoted as a modern, aspirational activity that benefits the community, fostering pride and social cohesion. Methodologies including behavioural economics and nudges, could be utilised to motivate SWM system use. SBC initiatives might also target specific behaviours in support of recycling and re-use, such as waste separation and cleaning. For example, bin design could be tailored to prompt waste separation and bin positioning could be targeted at reducing littering.

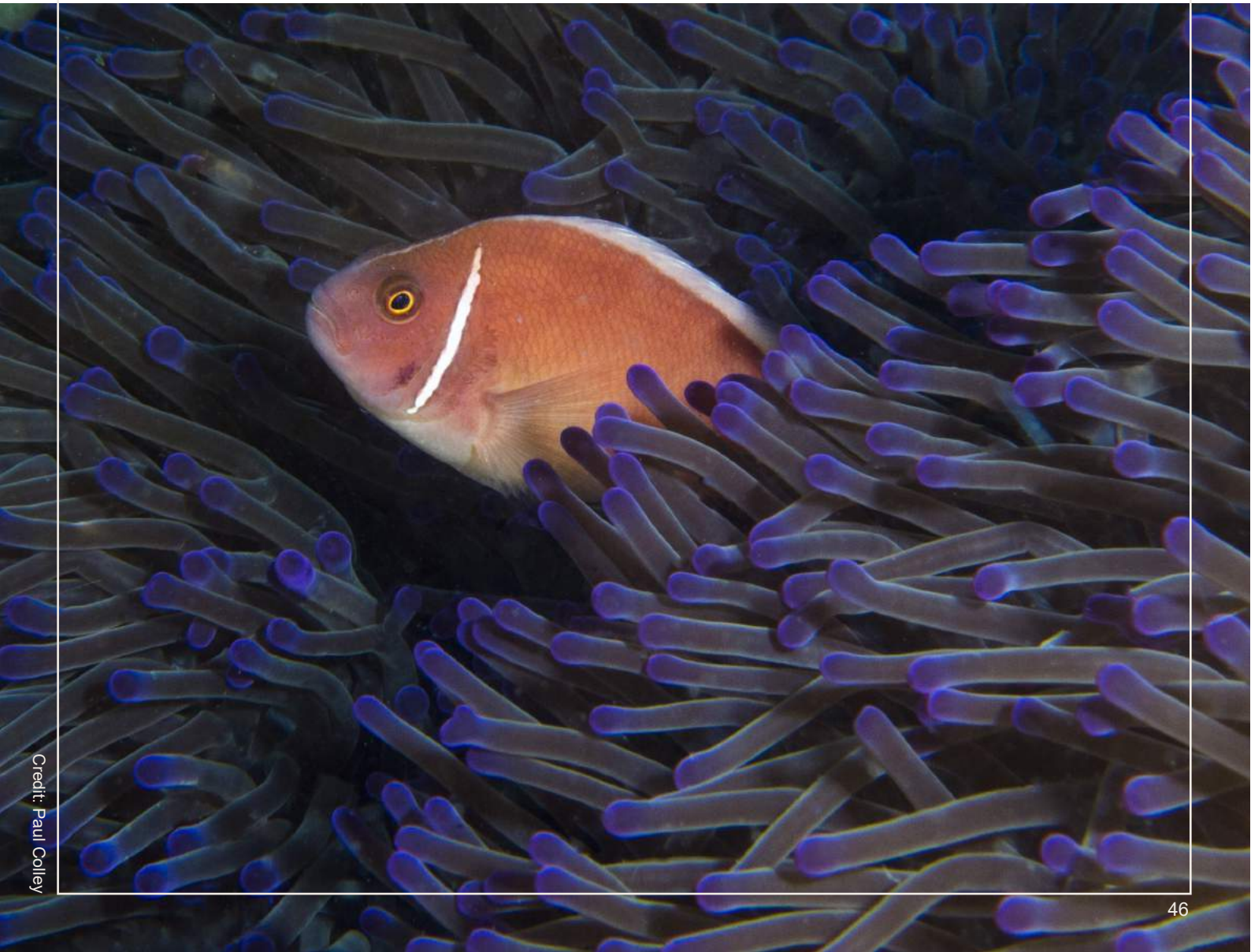
Credit: Bianca Roberts / FFI

7. Conclusion

Marine plastic pollution is a complex and acute challenge that necessitates urgent action. This report sets out a framework for a contextually appropriate response to marine plastic pollution, based upon some of the first research investigating this threat in Cambodia.

Alongside global momentum, awareness around plastic pollution is ever growing in Cambodia. This motivation is an essential ingredient for reducing preventable plastic use and combatting plastic pollution. It is acknowledged that environmental degradation disproportionately impacts vulnerable peoples, and as such measures that engage and empower those most severely impacted by plastic pollution should be prioritised. Enabling locally-led solutions is a priority, and in some communities change is already underway. A number of key actors and stakeholders are identified in this report and collaboration between these groups is crucial to present a united front, garner investment and foster lasting change. Fundamentally, we need to work together to shift the way we think about resource use. It is crucial that we step away from linearity and towards circular economy approaches that protect our wellbeing, and that of future generations. This report introduces locally appropriate avenues that support feasible movement towards circularity, a number of which dovetail with existing innovations led by concerned community members.

This report also highlights gaps that need to be bridged in order to realise sustained change. As with any novel feat, there are lessons to be learnt, and any action taken needs to be iterative, responsive and optimised over time. Cambodia, the Kingdom of Wonder, is at a critical junction – urgent responses are needed to safeguard the ecosystems upon which the nation's people and economies rely. The appetite for change is clear, and moving forward with this momentum is essential, we must act now.



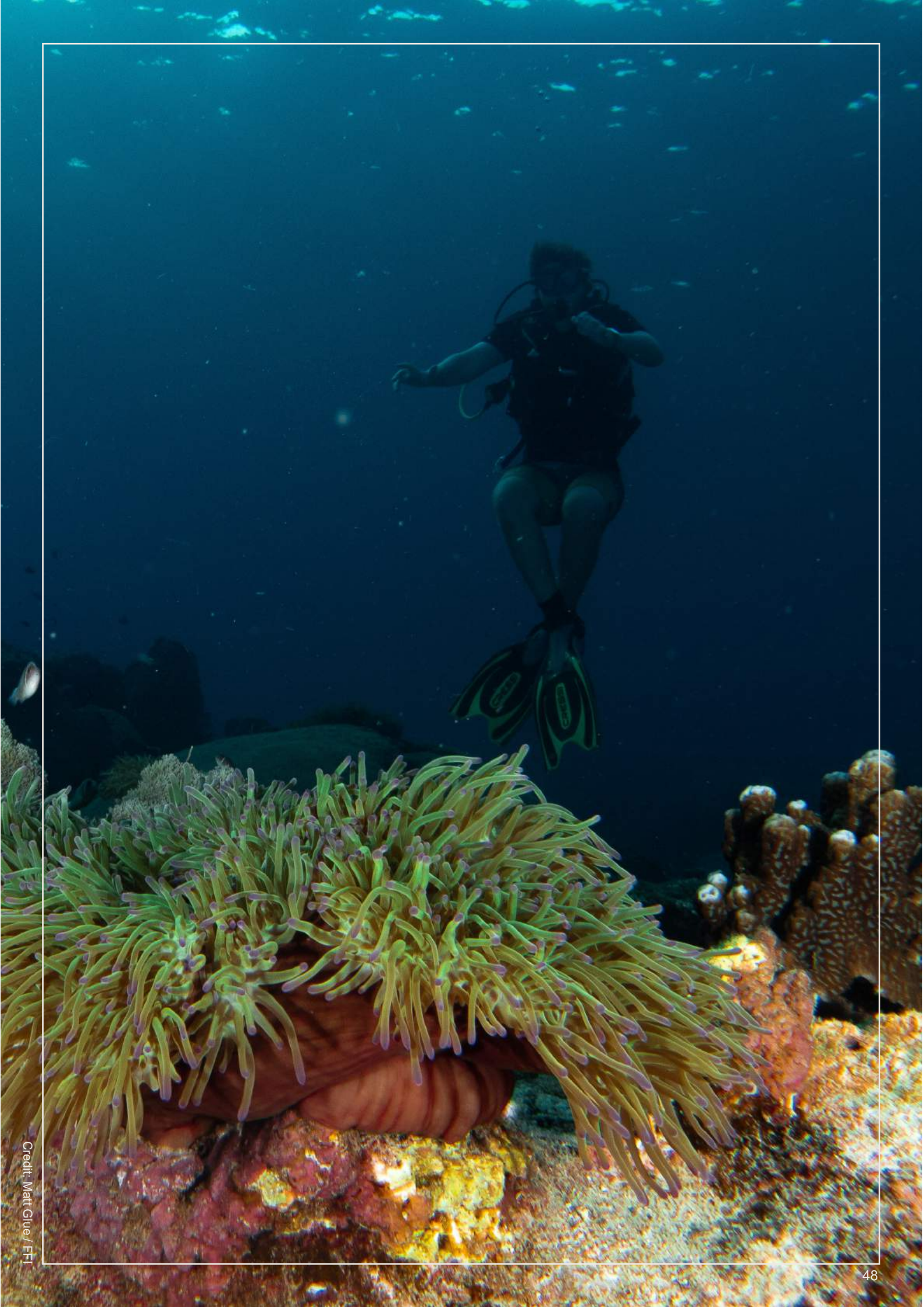
Credit: Paul Colley

8. Annexures

Annex 1. Contextual Considerations for Trialling Solid Waste Management Systems in Koh Sdach Village (KSV)

It was repeatedly highlighted in the findings that any SWM strategies trialled in KSV need to be contextually appropriate. The logistical challenges posed by KSV as a remote, island site cannot be ignored. A number of site specific considerations have been identified, including:

- Supporting local authorities to engage with provincial government is essential to establish a network of support and ensure SWM systems are implemented in line with Cambodian legislation and governance frameworks.
- The implementation of SWM systems in KSV may require partnerships with private contractors, however it is unknown who has the capacity to manage such a contract. Should private SWM contractors be hired, accountability mechanisms will be essential.
- SWM systems on the mainland are currently under review, and transporting waste to the mainland for processing could be both complex and costly. Waste leakage during transport is also an important factor for consideration.
- Financial feasibility of the SWM system needs to be investigated to inform the establishment and management of fair, transparent and sustainable fee structures. The willingness to pay survey emphasized a strong level of community enthusiasm and support for the establishment of SWM systems.
- There is disused landfill site in KSV, however, on a small island where land is at a premium, ensuring there is adequate space for, and safe management of, the landfill site requires technical expertise that is currently lacking. The feasibility of utilising the landfill needs to be reviewed as part of the proposed trial on KSV.
- Compacting of waste to maximise the volume exported off the island could increase efficiency. Additionally, a compactor could be utilised by waste buyers to increase the volume of plastic recyclables transported for sale (noting the caveats around current markets for recyclables).
- Burning waste is a common practice in KSV. The community is pursuing opportunities to purchase an incinerator, and there is scope for this to be subsidised by the MoE however, the availability of funding to support long term maintenance and staffing is unknown. There is also scope for a private sector partnership to support high temperature, low emissions incineration, but again the feasibility of this opportunity requires further investigation. It is crucial that the risks associated with incineration are assessed and understood by the community, especially health and environmental risks.
- Sixty percent of household waste was organic waste. Scoping of opportunities for composted products may present options for reducing residuals and livelihood diversification.
- Given SWM systems have been absent from the island for more than 4 years, the volume of waste currently present in KSV is a considerable challenge. Waste removal and clean-ups will be necessary at a scale that will require coordination, planning and proper resourcing.
- Fishing is the primary source of income for KSV, and measures to manage fishing waste should be built into the SWM trial.
- Water filters have been provided to households in KSV in the past, with limited uptake. Whilst no formal M&E data could be found, anecdotal reports suggest that community members used the filters in the short term, but long term use was rare. A number of reasons were cited, including that people prefer cold water (but do not own fridges), being able to buy multiple bottles of water each day is a symbol of wealth and status, and/or that people do not trust that the filters work. As such it is suggested that the provision of alternatives be accompanied SBC initiatives to foster long term habit forming.
- HH surveys & KIIs highlighted opportunities for SWM interventions to engage the community and consultative & participatory approaches should be prioritised;
- Community perceptions of political efficacy need to be addressed, and have the potential to motivate the adoption of new SWM systems (and stewardship behaviours more broadly). Fostering collaboration between community and local authorities will be key to success; and
- Resource limitations, other than just financial resources, should also be articulated and addressed, including gaps around capacity and technical expertise.



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