



Efforts to promote science-based interventions through an Integrated Marine Debris Management in Thailand



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DMCR/JICA Project on Integrated Marine Debris Monitoring System for Establishment of Marine Debris Center (MDC) for Thailand

- **Objective:** Capacity development through the development of the plan for establishment of MDC
- **Project period:** Feb. 2024 – Feb. 2025 (8 month-assignment in total)
- **Project Outputs:**

Output 1. Review Work: Feb-Sep 2024

- Current status and Challenges on marine debris and plastic pollution monitoring system in Thailand



Output 2. Consultations: Oct-Dec 2024

- Organize technical working groups (Line agencies) and national consultations to elaborate a **plan of the MDC**

Output 3. Provide opportunities for Capacity Development to DMCR officers

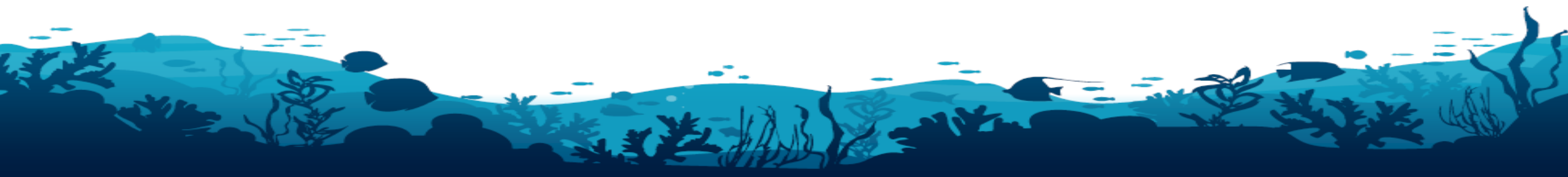


A plan of the MDC by February 2025

- Finalise the plan to establish the MDC for Thailand
- Enhance the national, regional and global networks

Contents

1. Review Result (Policy, Stakeholder, Technical aspects)
2. Status and Challenges of Marine Debris Monitoring
3. Strategic Framework of Marine Debris Center



1.1 Global Trend: INC 5

Draft text of the international legally binding instrument on plastic pollution, including in the marine environment

Fifth Session (INC-5): Official documents



Compilation of draft text of the international legally binding instrument on plastic pollution, including in the marine environment

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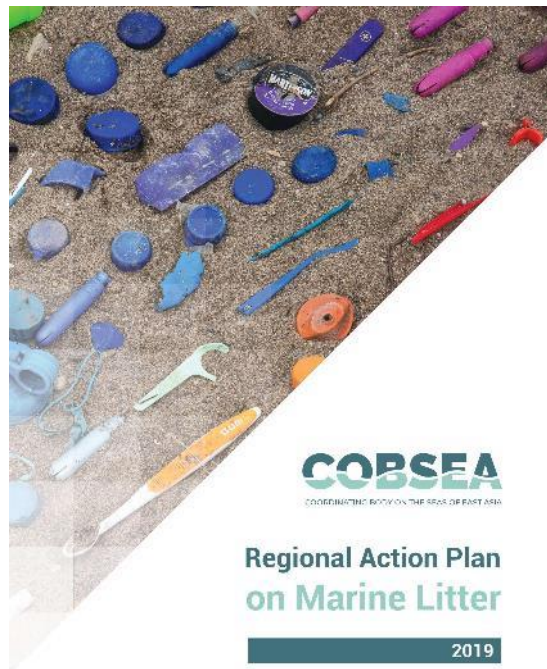
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	4	Periodic assessment and monitoring of the progress of implementation of the instrument* [and effectiveness evaluation]
	4a	Assessment and monitoring

GPML ACTION TRACKS - OBJECTIVES				
Action Track 1	Action Track 2	Action Track 3	Action Track 4	Action Track 5
Science-policy linkages	Action strategies/ roadmaps/plans	Harmonisation of data, standards and methodologies	Sustainable and innovative financing	Access for all
I. Advance and update scientific and technical knowledge for plastic pollution and marine litter	I. Support the development and implementation of national/regional/sectoral action strategies/ roadmaps/plans	I. Support data and metadata documentation, interoperability, and effective use of data	I. Improve coordination of donor financing on priority topics or geographical areas	I. Raise awareness of environmental justice in the context of managing plastic pollution and marine litter
II. Develop risk frameworks to identify priorities for mitigating economic, ecological and social impacts	II. Identify priority areas for intervention	II. Explore voluntary schemes including systems for voluntary sustainability standards	II. Address gaps and opportunities in current funding	II. Enable digital transformation and innovation
III. Bridge science, innovation and policy by promoting effective communication and understanding	III. Improve monitoring and governance		III. Promote plastic-conscious banking, investment, and insurance	III. Foster transparency and access to information
	IV. Identify capacity development needs			
	V. Support project development and facilitate partnerships for action			

1.2 Regional Trend

- **Bangkok Declaration** on Combating Plastic pollution (Jun 2019), and **ASEAN Framework** of Action on Plastic pollution (Nov. 2017)
- ASEAN+3 Marine Plastics Debris **Cooperative Action Initiative** (November 2018)
- **The Coordinating Body on the Seas of East Asia (COBSEA) Regional Action Plan on Marine Litter** (June 2019)
- **ASEAN Regional Action Plan for Combating Plastic pollution (2021-2025)** (adopted in May 2021)
- **Mekong River Commission's Riverine Plastic pollution Monitoring Program/Protocols** (2022/2023)



1.3 National Trend

Enhancement and Conservation of National Environmental Quality Act, B.E.2535

Public Health Act, B.E.2535

Marine and Coastal Resources Management Promotion Act, B.E. 2558

Cleanliness and Orderliness of the Country Act, B.E. 2560

Thailand's Roadmap on Plastic Waste Management 2018 - 2030

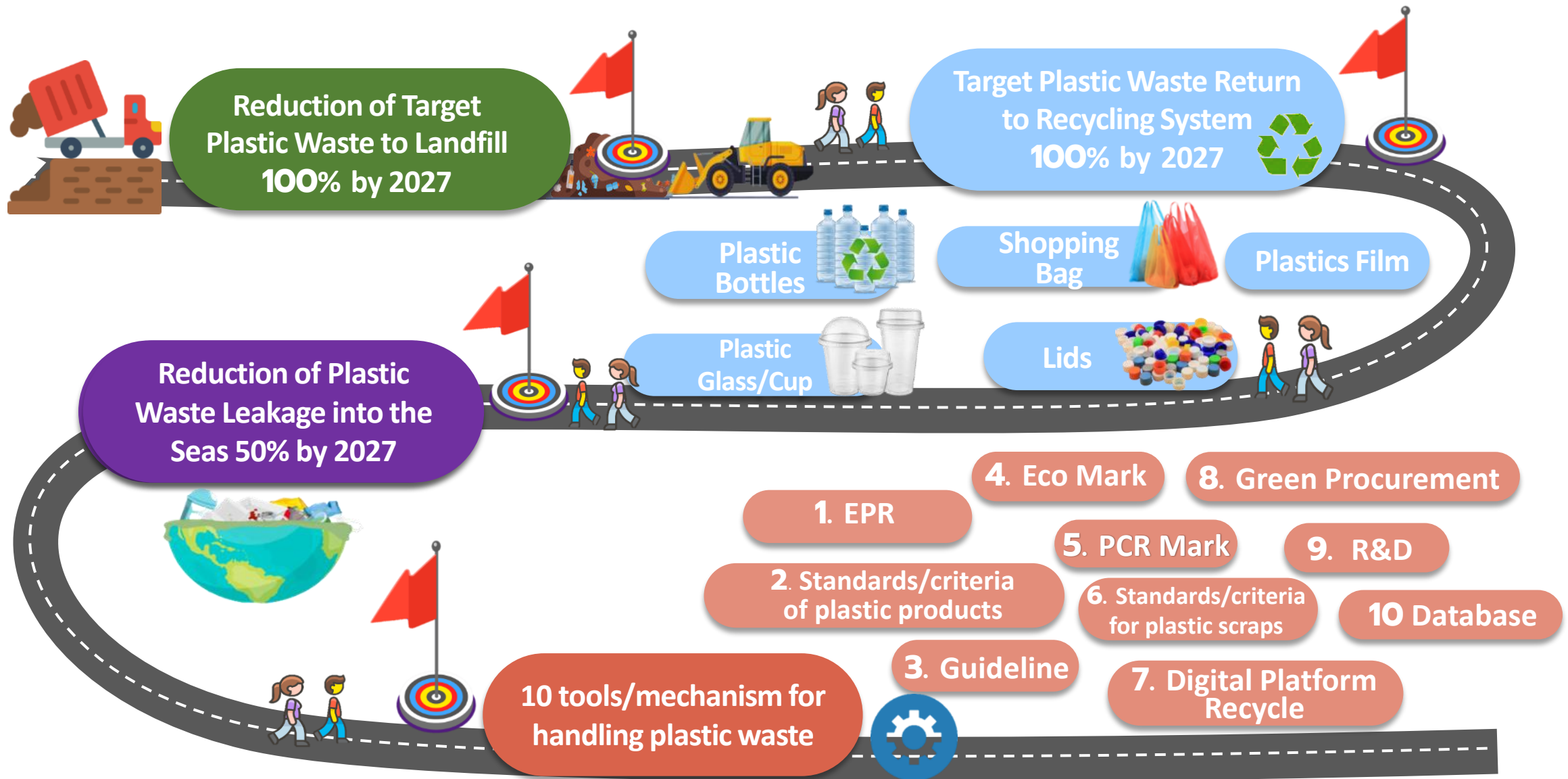
Action Plan on Plastic Waste Management Phase I
(2020 –2022)

Action Plan on Plastic Waste Management Phase II
(2023 –2027)

Action Plan on Marine Debris Management 2023 – 2027

Vision	Advancing towards a comprehensive and integrated management of marine debris from its source , encompassing all relevant sectors .
Principle	Marine waste management consists of 3 main stages from the source to marine waste management elements at the destination (UNEP, 2017) (1) <u>Preventing and reducing</u> the generation of waste that causes marine debris (2) <u>Preventing and reducing</u> waste entering the sea (3) <u>Collecting</u> marine debris from the sea.
Goal	Amount of plastic waste with potential leakage into the seas is reduced for 50% in 2027. (Baseline: 0.02million tons) Given that the majority of the marine litter problem stems from <u>improperly managed plastic waste</u> entering the sea, the goal for operations have been established to implement marine waste management in alignment with the 5-year Marine Waste Management Action Plan (2023 - 2027). This plan is consistent with the Plastic Waste Management Action Plan, Phase 2 (2023 - 2027), specifically under Measure 4, which focuses on the management of plastic waste in the sea.

1.4 Action Plan on Plastic Waste Management Phase II, 2023 –2027 (PCD, 2023)



1.5 Indicator / Action Plan on Plastic Waste Management Phase II (2023 –2027)

Target Value (Percentage)		Baseline	2023	2024	2025	2026	2027
1. Amount of target plastic waste entering landfills reduced							
(1)	Plastic bottles (all types) 1	41%			100%		
(2)	Bottle caps 1	90%			100%		
(3)	Monolayer plastic film packaging (HDPE, LL, LDPE) 1	69%					100%
(4)	Plastic bags 1	94%					100%
(5)	Plastic cups 1	94%					100%
2. Target plastic products recovered for recycling increased							
(1)	Plastic bottles (all types) 2	33%	60%	70%	80%	90%	100%
(2)	Bottle caps						
(3)	Monolayer plastic film packaging (HDPE, LL, LDPE)						
(4)	Plastic bags						
(5)	Plastic cups						
3. Amount of plastic waste with potential leakage into the seas reduced 3		0.02 million tons					50%
4. Ten (10) plastic waste management tools developed		1. Extended Producer Responsibility (EPR) model 2. Plastic product standards (mandatory) 3. Guideline/Agreement on Product Design 4. Eco Mark 5. PCR Mark 6. Standards and characteristics of plastic scraps 7. Digital Platform Recycle 8. List of green products in Green Procurement 9. Specific Research and development 10. National Plastics Database (Central database)					

1.6 Variety of Stakeholders in plastic lifecycle

1. Monitoring of Material Flow (Value chain)

- Source identification and pathway elucidation

- ❑ DIW, PCD, DLA, BMA, 23 coastal provinces, Municipalities
- ❑ Academia, Private enterprises, NGOs

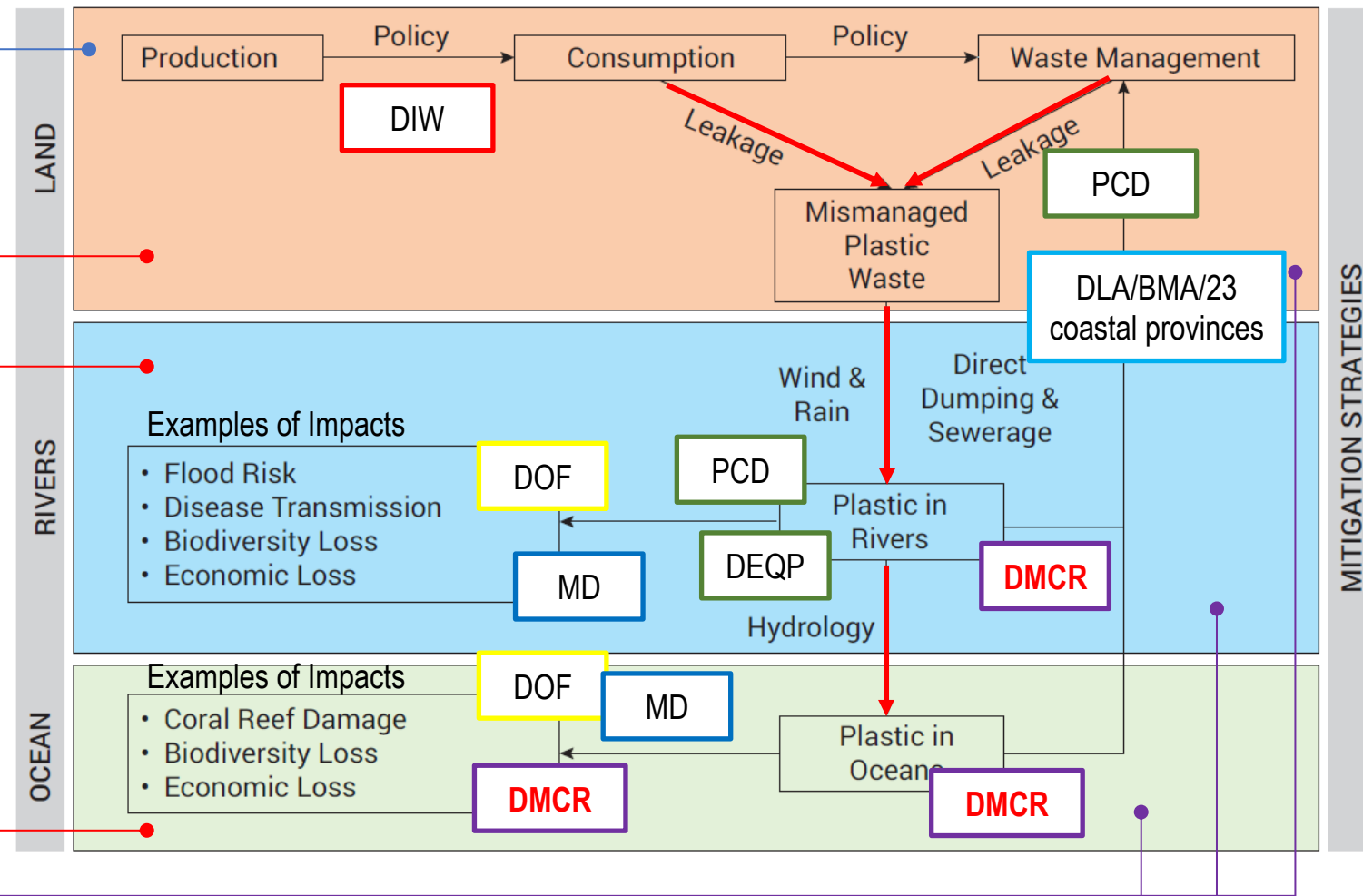
2. Monitoring of plastic leakage (marine debris) (distribution, accumulation, floating and fate)

- Understanding the environmental status of plastic pollution
- Understanding the impact

- ❑ **DMCR**, PCD, **DOF**, MD, BMA, 23 coastal provinces, Municipalities
- ❑ Academia, Private enterprises, NGOs

3. Impact: Assessing ecological impacts

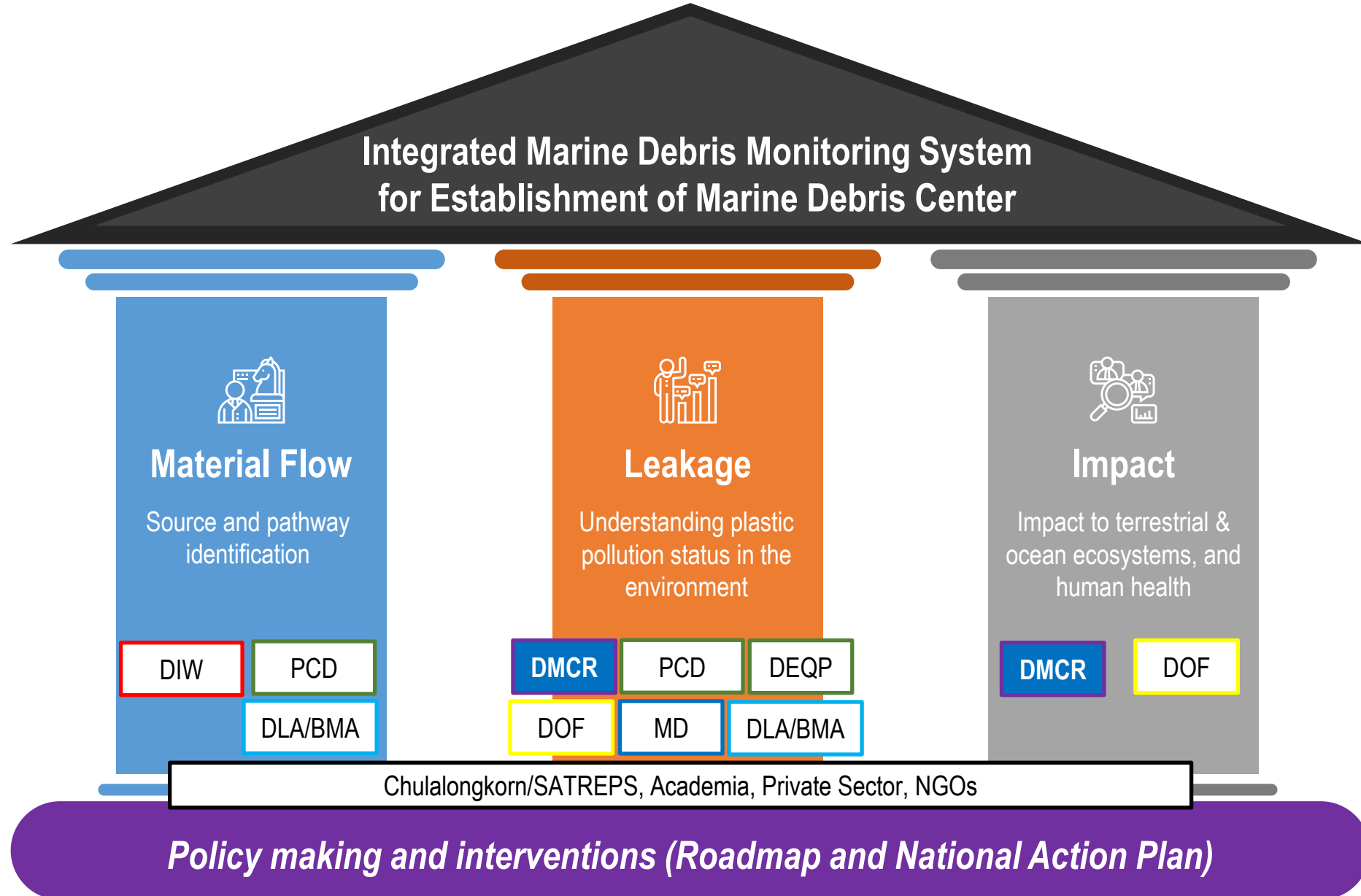
- Impact to terrestrial ecosystems (tbc)
- Impact to ocean ecosystems (**DMCR**)
- Impact to the human health (MOPH/Academia)



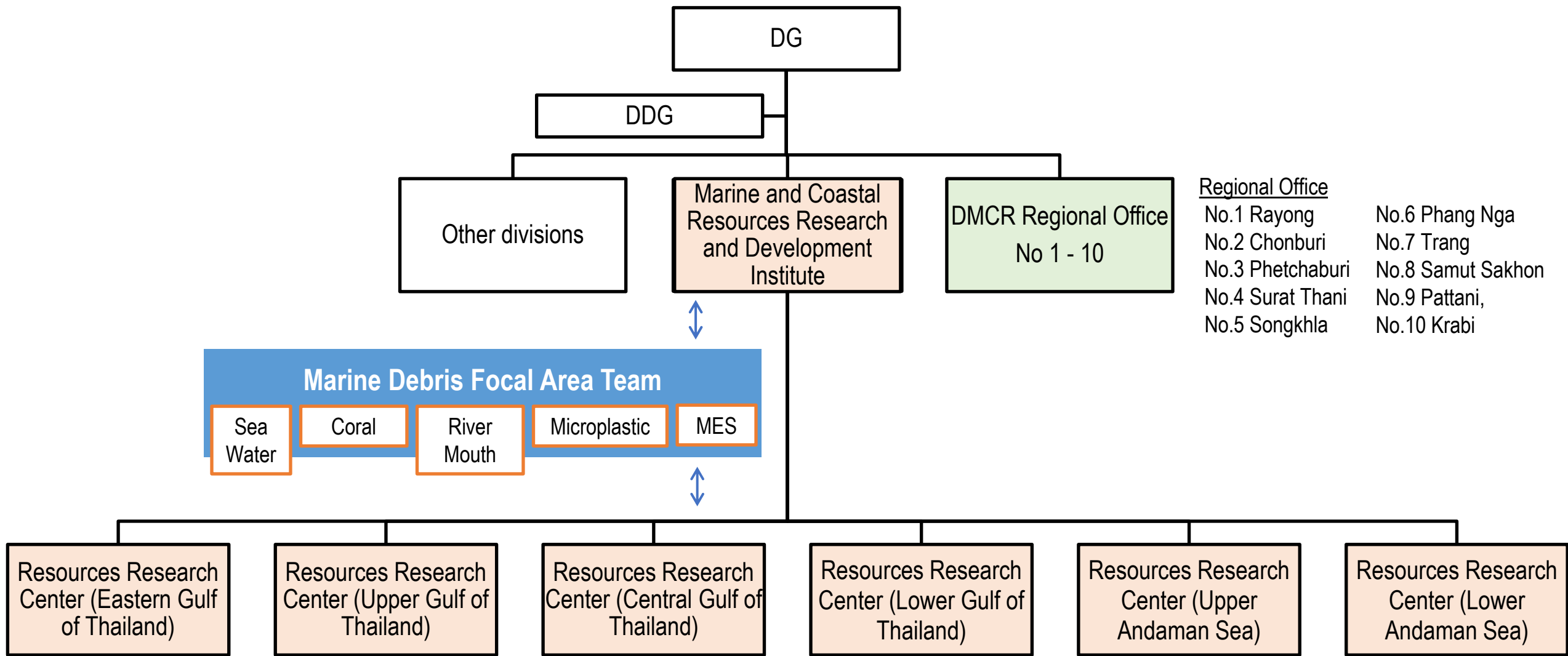
Understand the challenges and priorities to be intervened

Develop policies, strategies, roadmaps and action plans to implement

1.7 Line Ministries responsible for Plastic Pollution

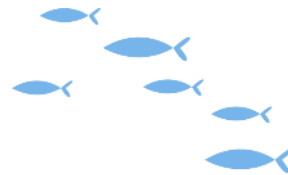


1.8 Marine Debris Stakeholders in DMCR



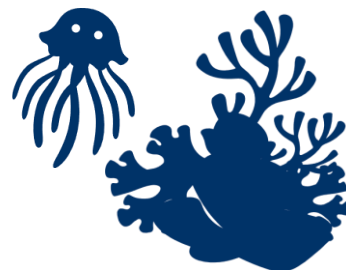
Marine and Coastal Resources Office 1 – 10 (Activities)

1. Marine debris **collection** in marine and coastal ecosystems
2. Marine debris **collection** with related agencies
3. Marine debris **collection** by boom and SCG-DMCR Litter Trap
4. Measurement to reduce marine debris in target areas
5. **Garbage Boat**
6. International Coastal Cleanup Day



Marine and Coastal Resources Research & Development Institute (Researches)

1. Floating plastic debris in **estuary**
2. Effect of marine debris in **coral reef**
3. Effect of marine debris in **endangered species**
(Whale/Sea turtle/Dolphin/Dugong)
4. **Microplastic**



1.10 Technical Overview of Marine Debris Monitoring in Thailand								
Plastic type	Monitoring Programme	Category	Rayong	Samut Sakhon	Chumphon	Songkla	Phuket	Tran
			Eastern Gulf of Thailand	Upper Gulf of Thailand	Central Gulf of Thailand	Lower Gulf of Thailand	Upper Andaman Sea	Lower Andaman Sea
Macroplastic	1. Floating marine debris from river mouths	Leakage		x		(x)		
	2. Marine debris survey on coral reef	Leakage / Ecosystem	x	(x)	x	x	x	x
	3. Plume of debris from coastal observation of macro debris (Manta tow) every 4 years	Leakage	(x)	(x)	(x)	(x)	(x)	(x)
	4. Entanglement/ingestion of debris to marine species	Ecosystem	x	x	x	x	x	x
	5. Branding investigation from beach area	Leakage	x	x	x	x	x	x
	6. Drifted debris at beach and coastal areas (by DMCR regional office)	Leakage (clean-up)	DMCR Reginal Office (10 officers along the coastal provinces)					
Microplastic (MP)	7. MP monitoring along the coastal area (10 stations of sandy beach)	Leakage	x	x	x	x	x	x
	8. Near shore MP monitoring (30 stations of sea surface)	Leakage	x	x	x	x	x	x
	9. Impact of MP to green mussel and zooplankton	Ecosystem	(x)	(x)	(x)	(x)	(x)	(x)
	10. Ingestion of debris to marine species	Ecosystem		x			x	

1.11 Applied Monitoring Methodology

Type of Monitoring	Thai Guideline	Sampling method	Classification	Lab. Analysis
1. Floating marine debris from river mouths	Guidelines for Studying Floating Marine Debris in River Mouths (under development)	Adapted by UNEP/IOC (2009)	Data card adapted from AMETEC Protocol (type of plastic), and ICC data card (Source of activities)	N.A.
2. Marine debris survey on coral reef	Methods for surveying and collecting samples in coral reef ecosystems	N.A.	ICC data card	N.A.
3. Plume of debris from coastal observation of macro debris (Manta tow)	N.A.	CSIRO	CSIRO	N.A.
4. Entanglement / Ingestion of marine species	Impact of marine debris on endangered marine species (not manual, Stranded one, recording, intestines investigation)	(Original)	ICC data card	(Original)
5. Branding investigation from beach area	N.A.	CSIRO	CSIRO	N.A.
6. Drifted debris at beach and coastal areas (by DMCR regional office)	N.A.	<ul style="list-style-type: none"> - 20 mesh litter trap at the end of wastewater pipe - Litter trap / boom - Yellow buoy (to protect mangrove) - Boat collection - Interceptor 	ICC data card	N.A.
7. Microplastic monitoring along the coastal area	Techniques for MP Analysis in Marine Sediments for Practitioners	IOC-WESTPAC WS (beach sampling)), NOAA		NOAA and IOC-WESTPAC
8. Near shore MP monitoring (30 stations of sea surface)	<ul style="list-style-type: none"> - Draft guideline for MP sampling and laboratory procedure in seawater - Quality assurance (QA) and quality control (QC) in MP laboratories across Thailand 	IOC-WESTPAC, CSIRO, MOEJ, NOAA		NOAA, IOC-WESTPAC, MOEJ
9. Impact of MP to green mussel and zooplankton	N.A.	Under discussion: (Collaboration or knowledge exchange / Thai - Chine Collaboration Scheme) IOC-WESTPAC (Biota and water column), NOAA		
10. Ingestion of debris to marine species	N.A.	N.A.	ICC data card	Same with above

Reference. Assessment of Existing monitoring activities

1. Method development	River mouth	Coral Reef	Off-shore Mac	MES	MP at Coastal	Off-shore MP	Biota
1-1. How to measure	Yes	Yes (Line transect 50 m.x3, Belt transect 10 m)	Yes	Yes (observe number of MES affected by marine debris)	Yes (4 Quadrats sampling in 100 meters-High tide line and Mid tide line,	Yes (5 mins of Manta tow, applied from MOEJ)	Yes
1-2. How to determine the mass balance	Yes	Yes (Measurement Techniques)	No	No	No	No	No
1-3. How much amount of leakage into ocean	Yes	Yes (1062 Pieces, 2024) ?	N.A.	No	No	No	N.A.
1-4. What is the standard measuring unit	Yes	Yes (ICC Card piece and type)	Yes	Yes (ICC Card and type)	Yes, items/m ² (applied from WESTPAC guideline)	Yes, items/m ³ (applied from MOEJ guideline)	Yes
2. Baseline assessment	River mouth	Coral Reef	Off-shore Mac	MES	MP at Coastal	Off-shore MP	Biota
2-1. Where is the hotspots (accumulated place)	Yes (Out of 5 river mouths)	Yes, (152 ST)		Yes (According to the stranded area)	Yes (highest density)	Yes (highest density)	No
2-2. What are the sources of the hotspots	No	Yes (Fishery, Nets cover coral reefs)	No	Yes (According to the stranded area)	Yes, by shape and types of material by FTIR	Yes, by shape and types of material by FTIR	No
2-3. What is the most abundant material/item	Yes	Yes, (fishing net)	Yes	Yes (fishery equipment)	Yes, by shape and types of material by FTIR	Yes, by shape and types of material by FTIR	Yes
2-4. How to distribution and mobilize (Pathway)	No	No	Yes (one report)	No	No	No	No
3. Long-term monitoring	River mouth	Coral Reef	Off-shore Mac	MES	MP at Coastal	Off-shore MP	Biota
3-1. Effect of measures	No	No	No	Yes	No	No	No
3-2. Long term trends	Yes	No	No	Yes	Yes	Yes	No
3-3. Transport pathways	No	No	No	No	No	No	No
3-4. Effect of floods	Yes (wet season)	No	No	No	No	No	N.A.

Reference. The Role of Marine Debris Center

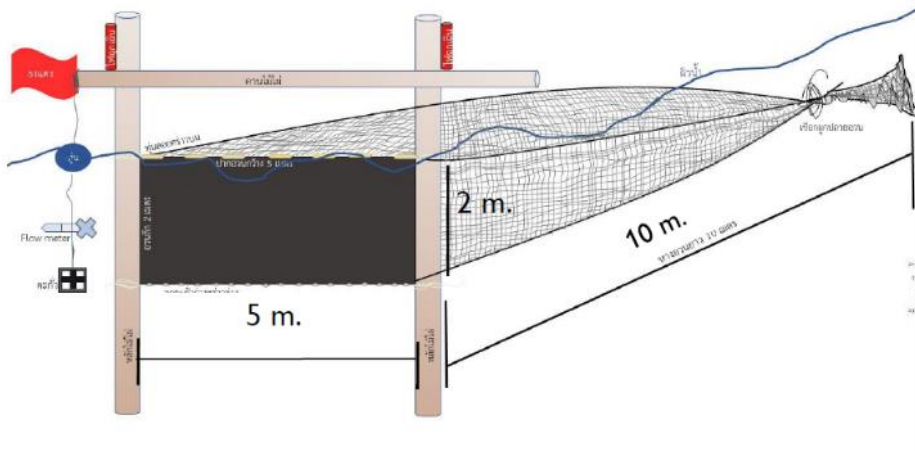
Expand Activities

Plastic Life Cycle Activity	Production	Consumption	Waste Management	Leakage to the land and waterways	Leakage to coastal area & ocean	Impact (Biota)
1. Monitoring / Research / Data Harmonization(in line with plastic life cycle)	Brand Audit Necessary Data Harmonization?	Necessary Data Harmonization?	Necessary Data Harmonization?	River mouth Other necessary monitoring and research activities, Guidelines, Protocols	Beach, Coral Reef, Sea water, Other necessary monitoring and research activities, Guideline, Protocols	MES, Other necessary monitoring and research activities, Guidelines, Protocols
2. Implementation of mitigation measures / Stakeholder collaboration & involvement	Activities after the brand audit with Private sector	Activities with Costal communities	Islands Marine debris PCD / LGs / Private sector	Interceptor/clean up with LGs, Private sector, NGOs Other necessary activities, Research collaboration	Coastal Clean-up DOF, Other necessary activities, Research collaboration	Community awareness DOF, Other necessary activities, Research collaboration
3. Policy Development / Support / Evaluation	Any recommendation to Roadmap / Action Plan	Any recommendation to Roadmap / Action Plan	Any recommendation to Roadmap / Action Plan	MDM strategy, Strengthen implementation based on Roadmap / Action Plan	MDM strategy, Strengthen implementation based on Roadmap / Action Plan	MDM strategy, Strengthen implementation based on Roadmap / Action Plan
4. Capacity Building Programme for researchers in Research Center (and ToT)	Participate the opportunities	Participate the opportunities	Participate the opportunities	Training programme ToT training Regional training	Training programme ToT training Regional training	Training programme ToT training Regional training

Extend Activities

Reference. DMCR floating debris monitoring at river mouth along the northern part of Gulf of Thailand

Floating debris are collected by traps with fishing nets.

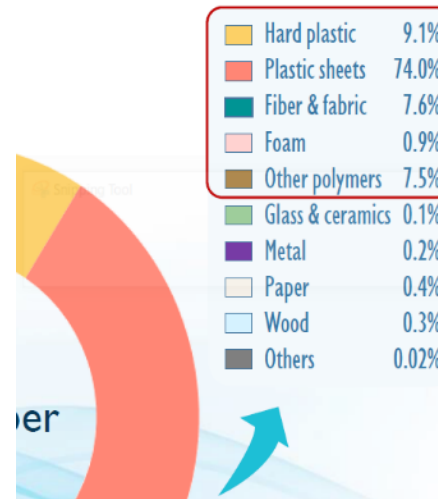


The collections are set at 3-month interval, 24 hours at a time.
The floating debris was classified and analyzed for data analysis.

Thai National Action Plan	CCTV (GIC/AIT)
Plastic bottles (all types)	Plastic beverage bottles
Plastic bags	Garbage bags
Bottle caps	N.A.
Monolayer plastic film packaging (HDPE, LL, LDPE)	N.A.
Plastic cups	N.A.
N.A.	Plastic straws
N.A.	Foam food containers
N.A.	Miscellaneous plastic



Debris sorted by Material Types
from 5 Major Rivers of Thailand



Model Predictions

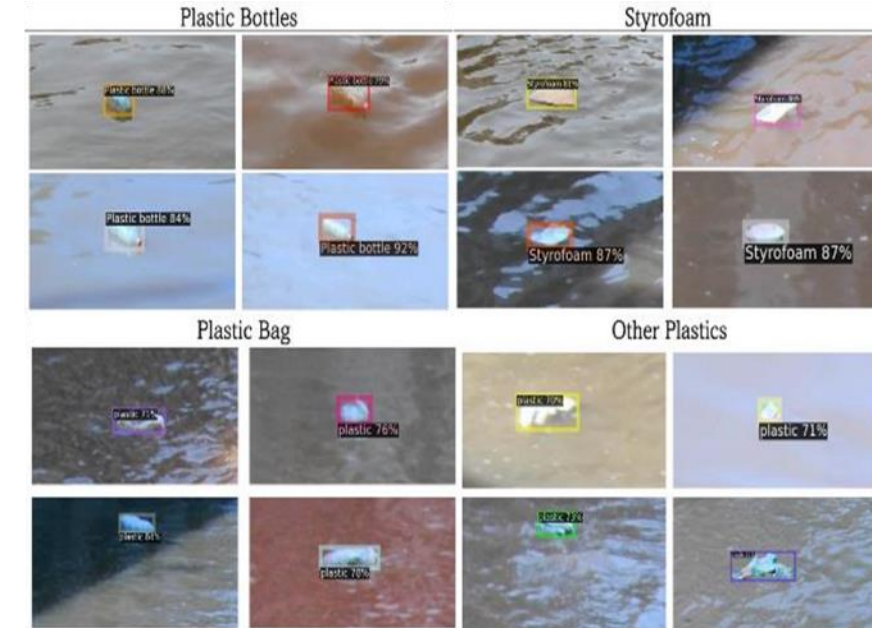


Image Annotations

Category	No. of Instances (15 Nov- 04 Jan)
Plastic (General)	6491
Plastic bottle	5310
Other	2771
Styrofoam	4590
Trash bag	554
Glass bottle	434

Reference. Amount of plastic waste with potential leakage into the sea

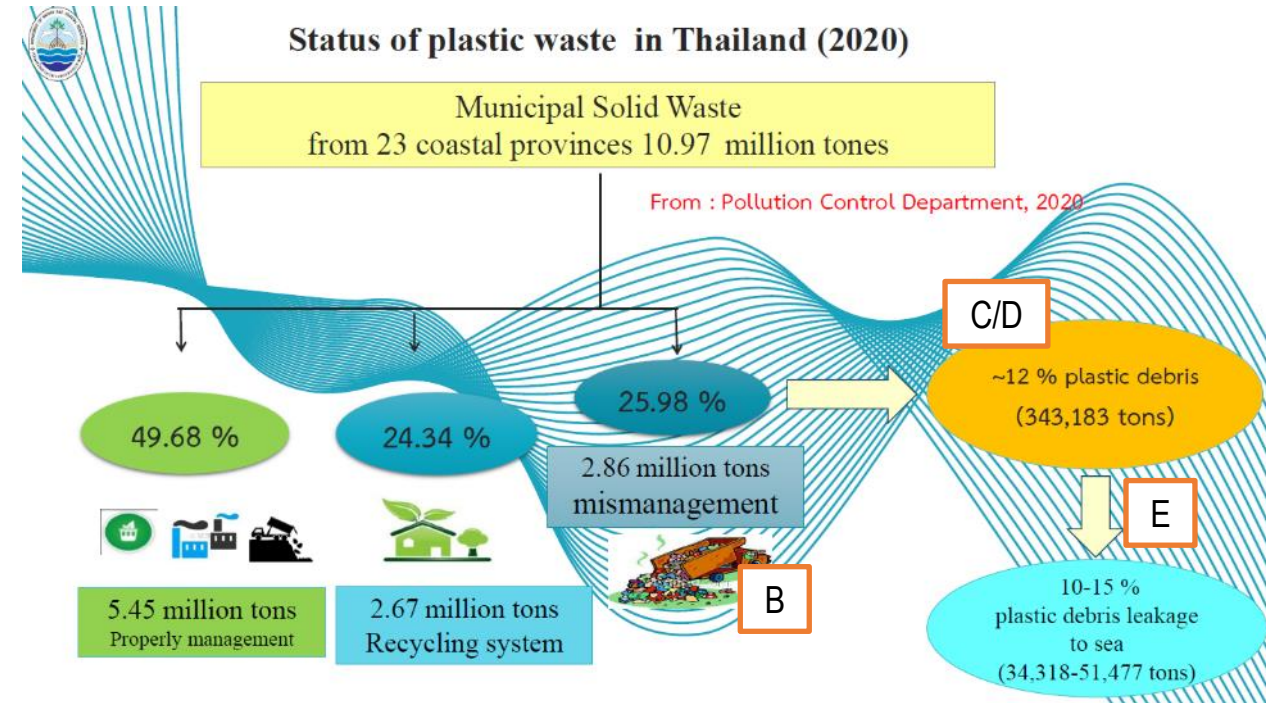
Indicator / Action Plan on Plastic Waste Management Phase II (2023 –2027)

Indicator 3. Amount of plastic waste with potential leakage into the sea reduced:

- Baseline: 0.02million (20,000tons/year)*
- 50% Reduction by 2027

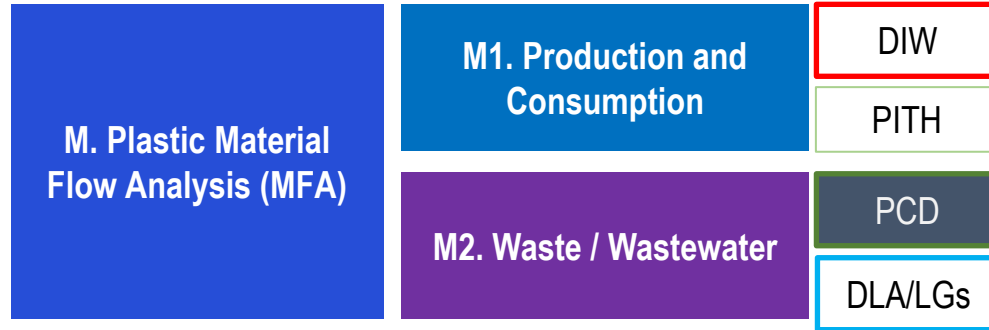
* Calculated from amount of **improperly disposed plastic waste** with potential leakage into the seas in 23 coastal provinces using the following formular: Equation: $A = B \times C \times D \times E / 100$

- A) Amount of plastic waste from disposal sites with potential leakage into the seas (tons/year)
- B) Amount of waste entering to mismanaged disposal sites with a distance of 50 km from the coast in 23 coastal provinces (tons/year)
- C) Composition of plastic waste in landfills in each province, and average number of plastic waste (28.13% or 0.2813)
- D) Average moisture of municipal solid waste (40% or 0.40)
- E) Probability of plastic waste leakage (5% or 0.05) by information from a study by World Bank



Reference. Reference. Gap of Plastic Leakage Estimation Method

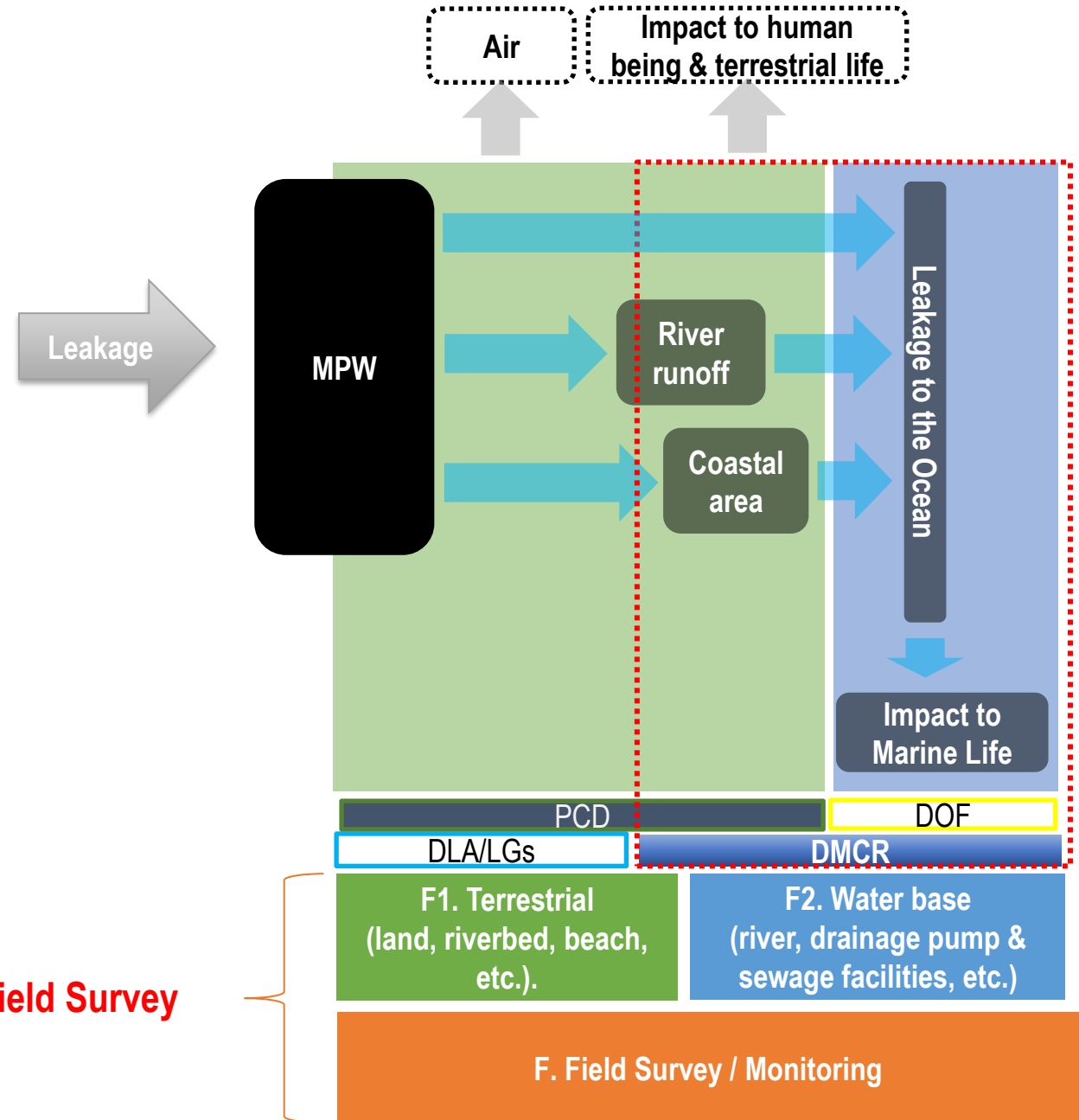
1. Estimation based on Statistic or Secondary Survey



To pave the gap

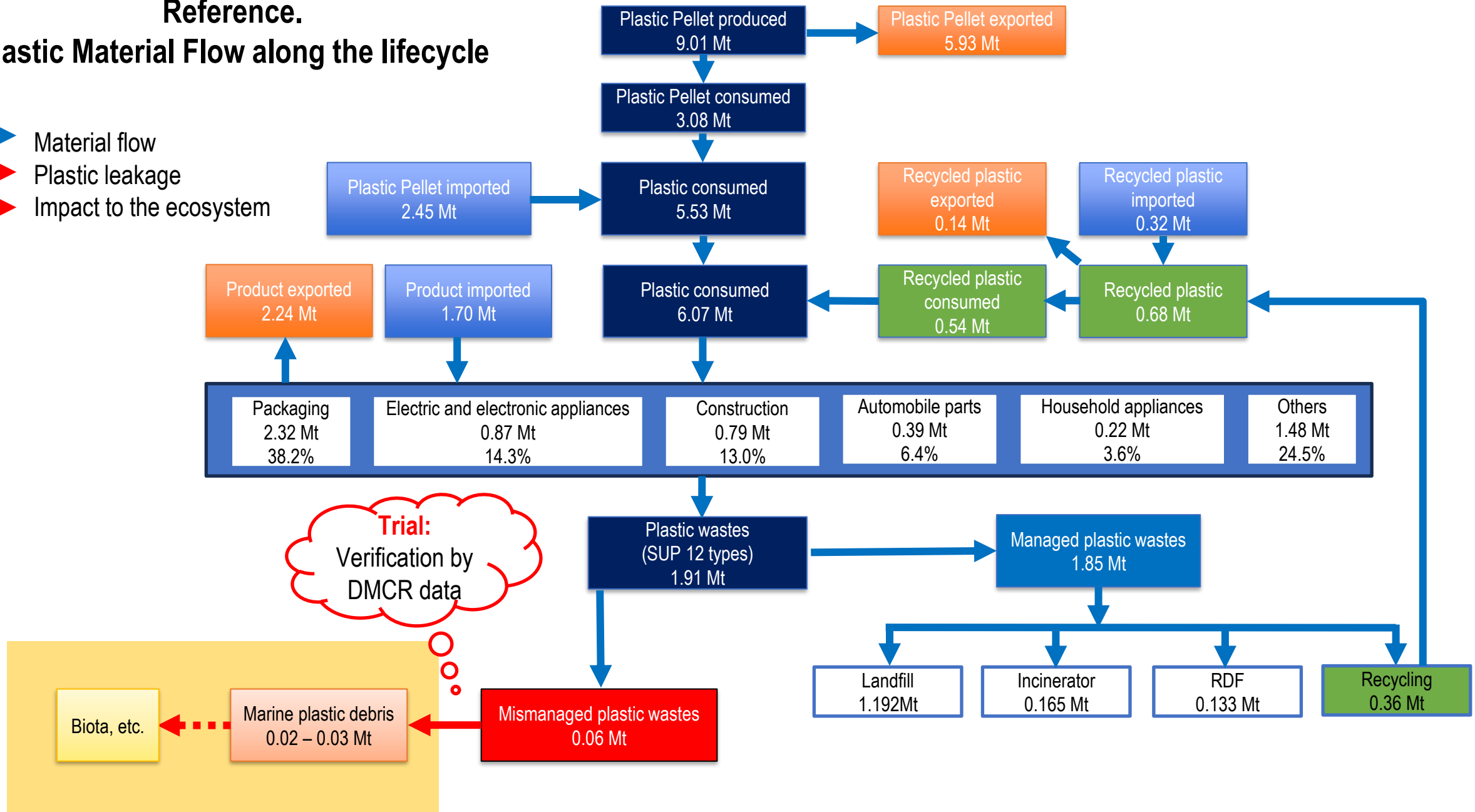
- Harmonization
- Verification

2. Estimation based on Field Survey



Reference. Plastic Material Flow along the lifecycle

- ➡ Material flow
- ➡ Plastic leakage
- ⋯➡ Impact to the ecosystem



2.1 Status and Challenges: The puzzle pieces are scattered!

➤ Existing national, regional and global issues, policies and initiatives

- Global Issue of plastic pollution / INC Discussion (Plastic Pollution Treaty)
- Regional Frameworks (Bangkok Declaration, ASEAN Framework on Plastic Pollution, COBSEA RAPML, ASEAN RAP, Mekong riverine protocols, etc.)
- Thailand Road Map on PWM followed by Action Plan (Phase-I and II), Action Plan on Marine Debris Management

➤ Existing stakeholders (Plastic Lifecycle Approach)

- **Value chain:** Monitoring of Material Flow – DIW, PCD, DLA, BMA, LGs, Academia, Private sector, NGOs
- **Leakage:** Monitoring of plastic leakage (source, pathway, hotspots and fate) – PCD, BMA, LGs, DMCR, DOF, MD, Academia, Private sector, NGOs
- **Impact:** Assessing ecological impacts – DMCR, MOPH, Academia, NGOs

Marine Debris related monitoring activities by DMCR Research Centers

1. Floating marine debris from river mouths
2. Marine debris survey on coral reef
3. Plume of debris from coastal observation of macro debris (Manta tow)
4. Entanglement/ingestion of debris to marine species
5. Branding investigation from beach area
6. Drifted debris at beach and coastal areas (by DMCR regional office)
7. MP monitoring along the coastal area (10 stations of sandy beach)
8. Near shore MP monitoring (30 stations of sea surface)
9. Impact of MP to green mussel and zooplankton
10. Ingestion of MP to marine species

➤ Status of DMCR Marine Debris related activities

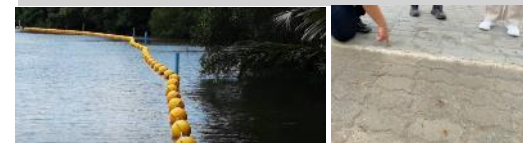
Donor-driven projects
Global/Regional initiatives



Academia, PS and
NGOs led project



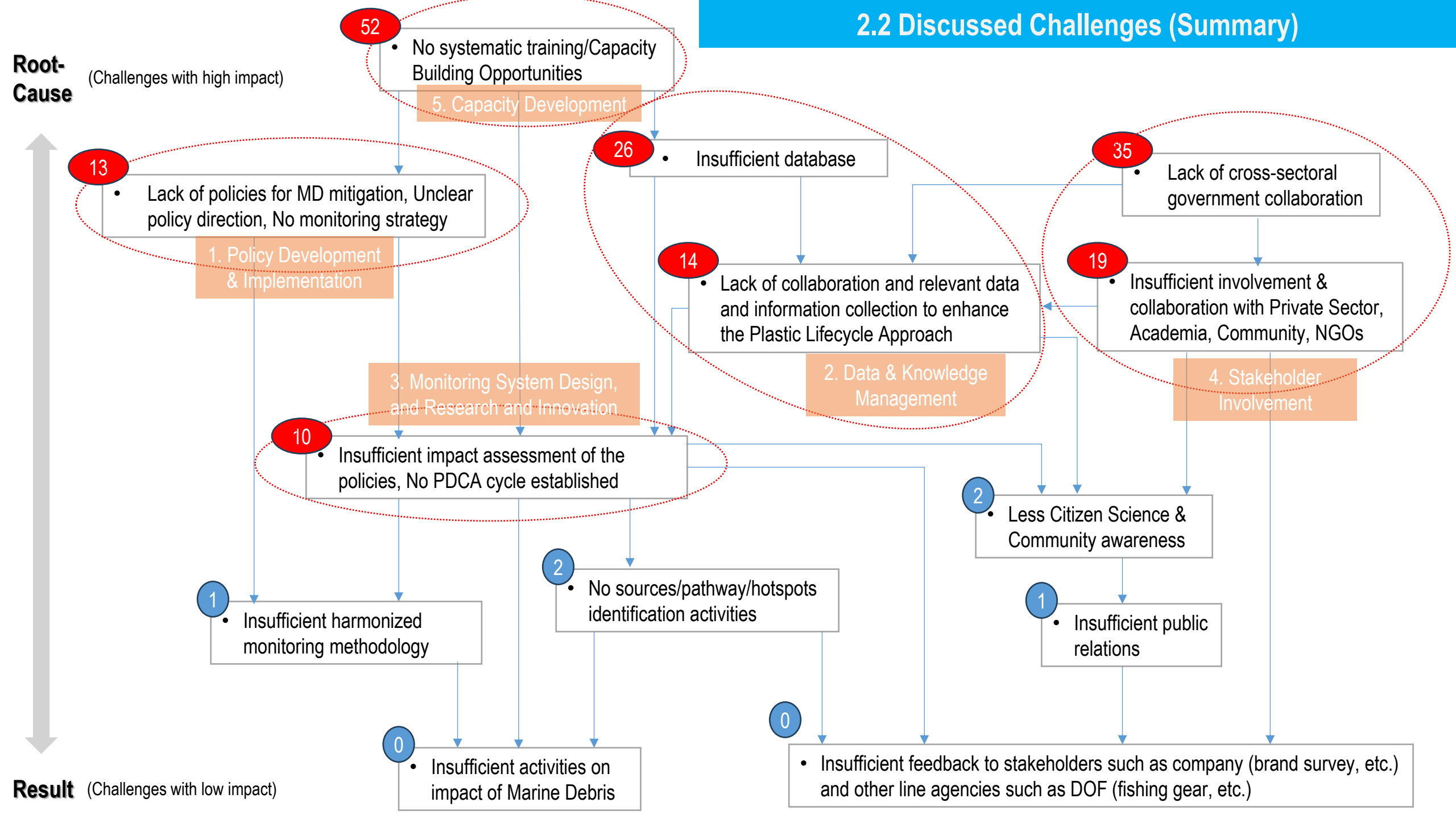
Collaboration among Regional
Offices and LGs/PS



Clean-up Initiatives at 72
beaches

(LGs/PS: Local Governments & Private Sector)

2.2 Discussed Challenges (Summary)



2.3 Status and Challenges: Development of MDC Plan

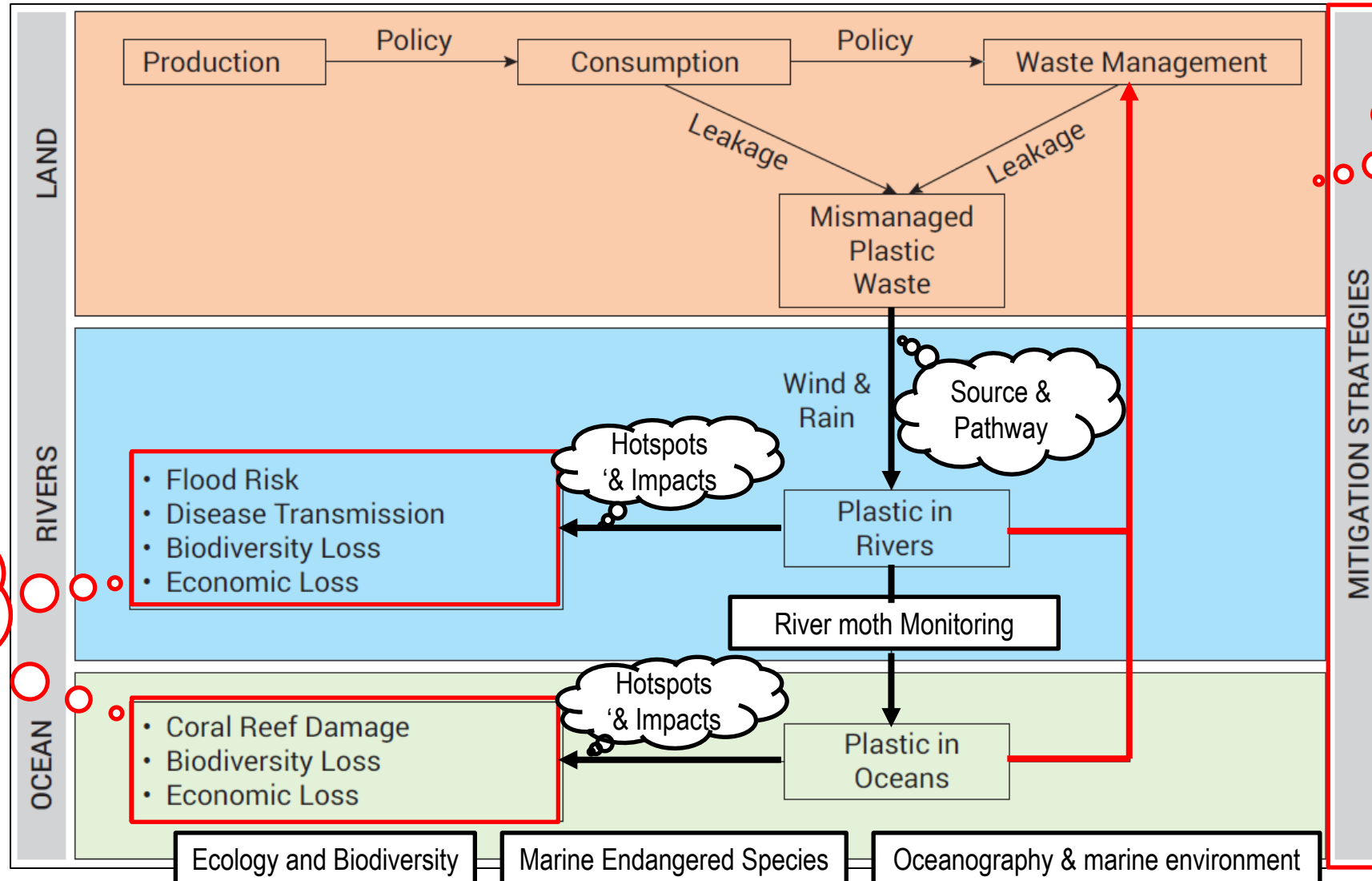
- Why do we need MDC?
- What are the impacts/improvements are expected though MDC?

- ◆ Data Management, Outreach & national/global Networking
- ◆ Capacity Development Opportunity
- ◆ Stakeholder Collaboration & Involvement

Monitoring parts

- ❑ Enough to identify the Environmental & Economic Impacts?
- ❑ Enough to provide scientific evidence for intervention measures?
- ❑ Enough to evaluate the impacts of intervention measures?

Science-based Interventions

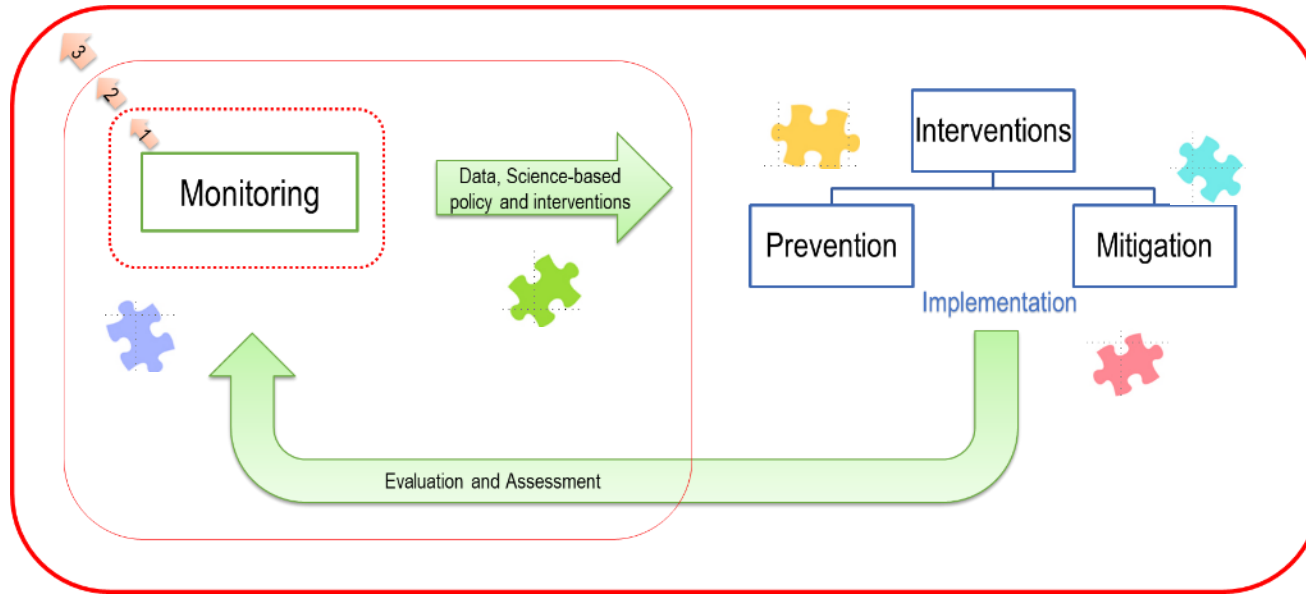


Intervention parts

- ❑ Conduct interventions to mitigate Environment & Economic damages?
- ❑ Support line agencies and stakeholders to conduct interventions?
- ❑ Conduct the effective outreach and awareness activities?
- ❑ Coordinate national resources, stakeholders & initiatives to optimize the effectiveness and impact of MDM efforts?

Provide recommendations

3.1 Strategic Framework of MDC: Guiding to Putting the scattered puzzle pieces in place



1. Lifecycle-Aligned Monitoring

Conduct monitoring activities that are integrated across all stages of the plastic lifecycle, from production to disposal as well as its leakage and fate, to address plastic pollution comprehensively.

2. Harmonized Methodologies

Employ globally, regionally, and nationally standardized and harmonized methodologies to ensure consistency, comparability, and integration of data across different contexts.

3. Science-Based Interventions

Develop and implement interventions based on robust scientific research and evidence to maximize impact and efficacy.

4. PDCA Cycle

Utilize the Plan-Do-Check-Act (PDCA) cycle to ensure continuous improvement and adaptive management of marine debris initiatives.

5. Research and Innovation

Promote and support research and innovative approaches to address emerging challenges in marine plastic pollution.

6. Capacity Development

Strengthen the skills and expertise of stakeholders through training, education, and knowledge transfer to foster long-term sustainability.

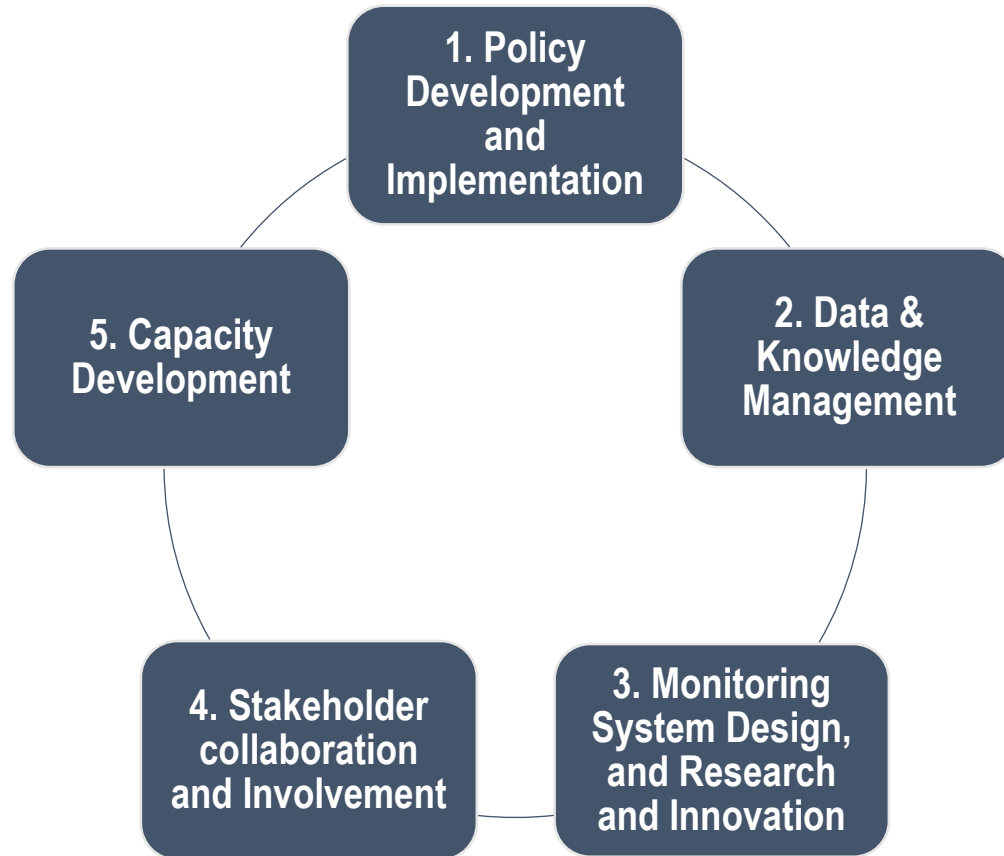
7. Stakeholder Engagement

Engage a wide range of stakeholders, including governments, industries, academia, and communities, to foster collaborative action and shared responsibility.

8. Outreach and Public Awareness

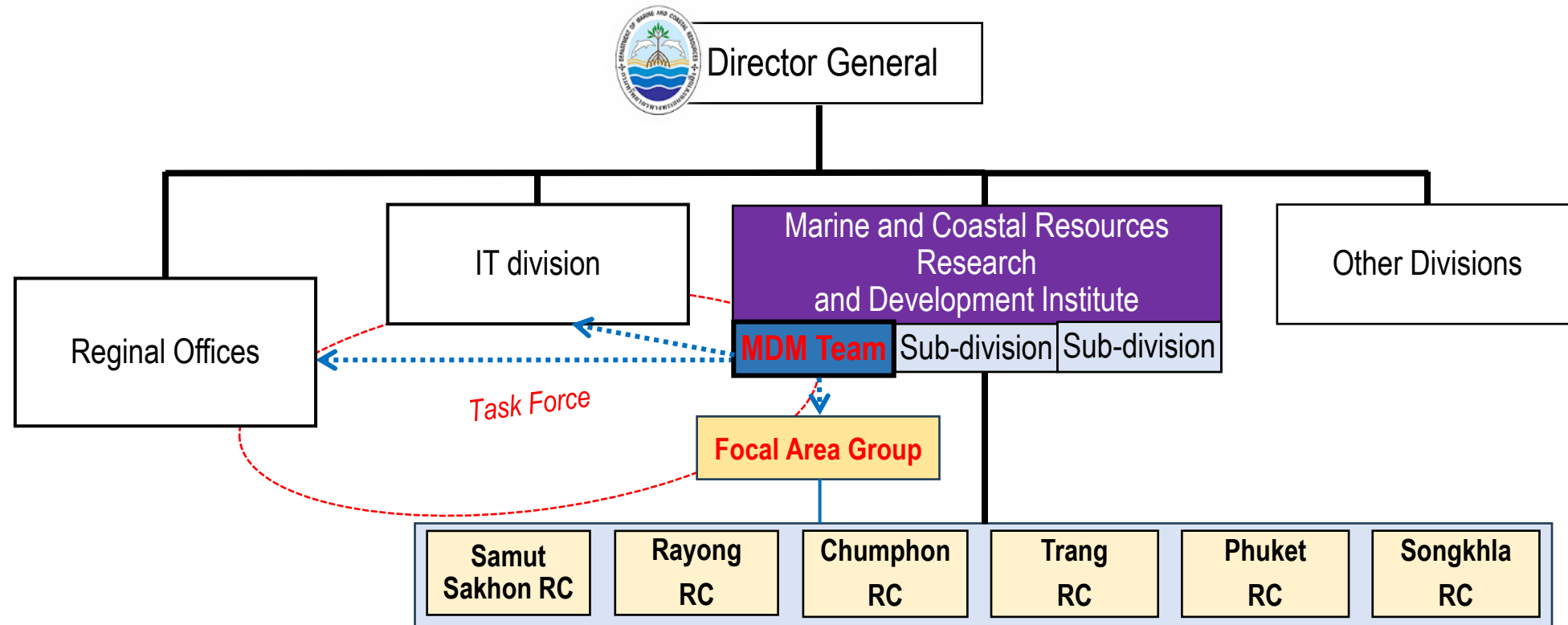
Conduct outreach activities to raise public awareness about plastic pollution and encourage behavior change through education and communication strategies.

3.2 Towards completing the puzzle (Marine Debris Center)



No	Target	Output/Indicator
1	Policy Development and Implementation	Marine Debris Management Strategy Annual plan with securing the budget and Implementation & Assessment
2	Data & Knowledge Management	MD Data Management Hub for Thailand Enhance the Hub through networking and harmonizing with other national and international Data Management Hub
3	Monitoring System Design, and Research and Innovation	MD Monitoring & Research Roadmap & Strategy Enhance the Research Capacities for Research Centers
4	Stakeholder collaboration and Involvement	Support for Solution Design and Implementation Promote collaboration with private sectors, academia, NGOs, and communities (e.g., citizen science, research support, clean-ups) as well as the international societies
5	Capacity Development	ToT training programme for Research Centers Regional Training Programme to be delivered by Research Centers

3.3 Structure of MDC (Initial Phase: Apr. 2025 – Mar. 2027)



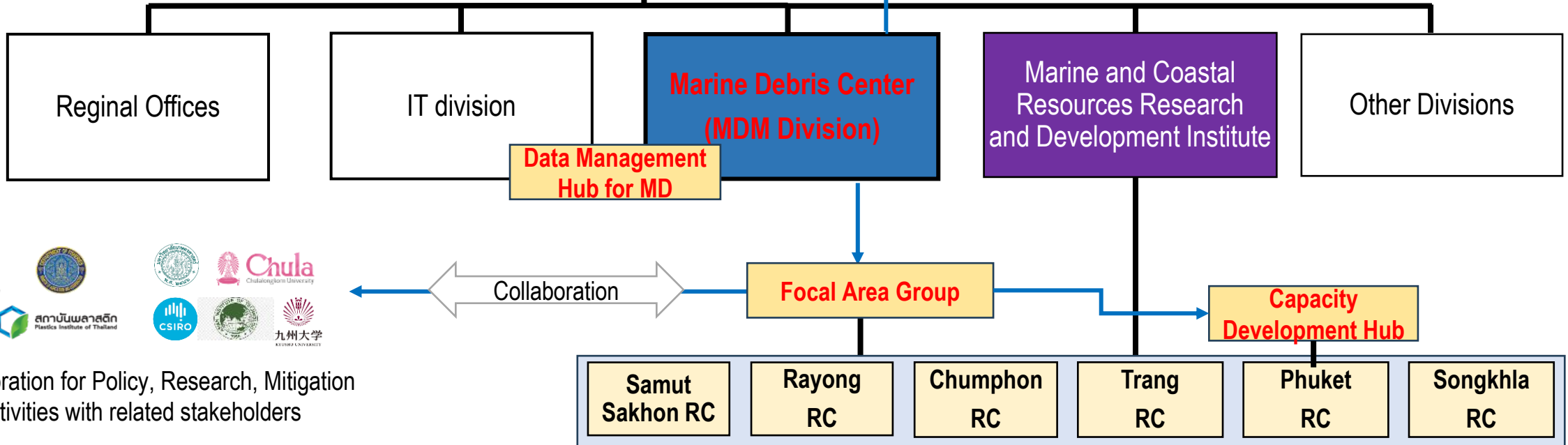
- Establish Marine Debris Management Team under the institute
- Organize the **Task Force** for Marine Debris Management (MDM)
- Develop the framework of Marine Debris Management Strategy in line with the Roadmap/NAP and Plastic Treaty
- Develop the budget plan and proposals for the implementation of the strategy (Annual budget, NRCT and JICA Technical Cooperation, etc.)
- Initiate the activities according to the Strategic Goals

3.4 Structure of MDC (Foundation Phase: Apr. 2025 – Mar. 2027)



Director General

DM/CD Regional hub



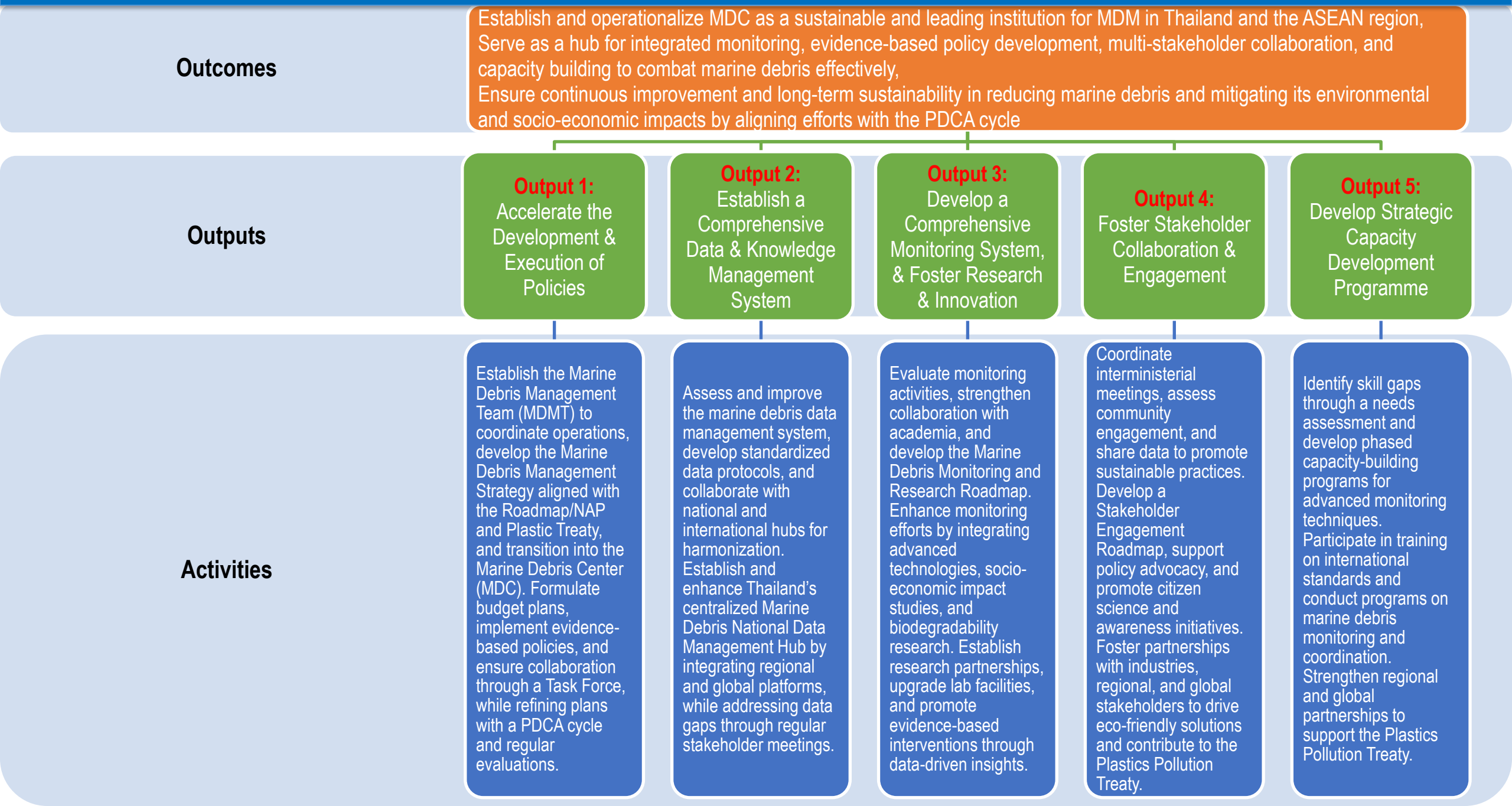
Collaboration for Policy, Research, Mitigation activities with related stakeholders

- Establish MDC (MDM Division) including a new staff assignment
- Conduct activities in line with Strategic Goals inc. CD/TOT programme
- Develop the Marine Debris Management Strategy (2028 -) with the breakdown of the annual action plan
- Develop Marine Debris Monitoring & Research Roadmap & Strategy
- Strengthen a partnership with national stakeholders (Line ministries, Academia, Privet Sector, and NGOs, etc.)

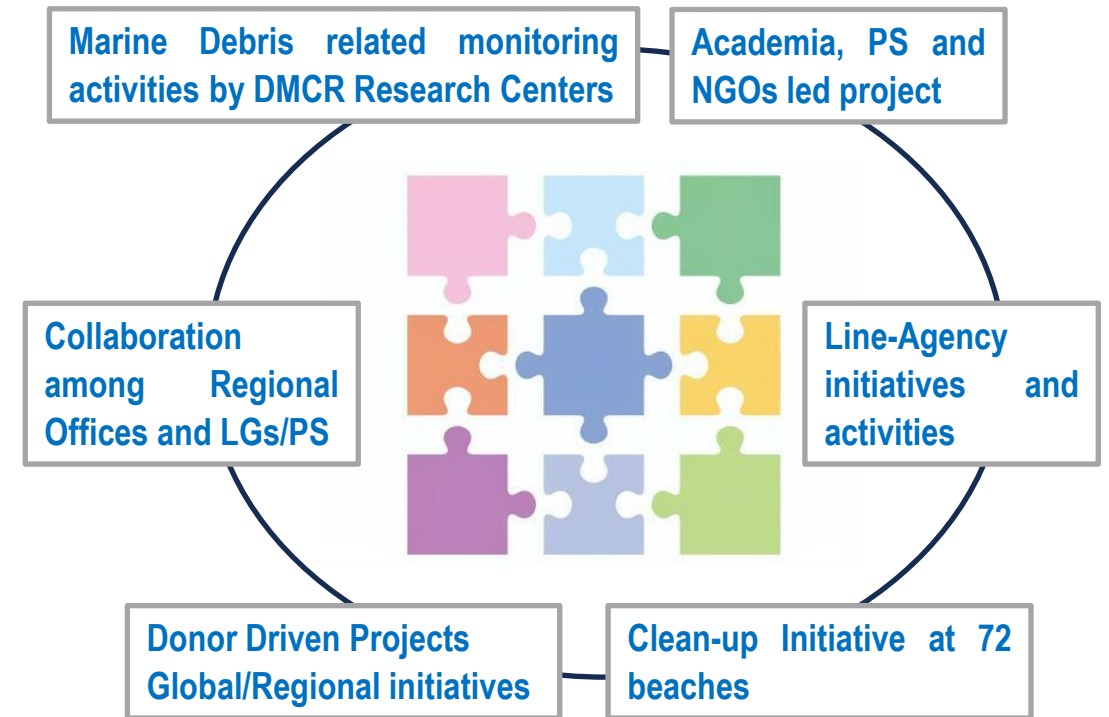
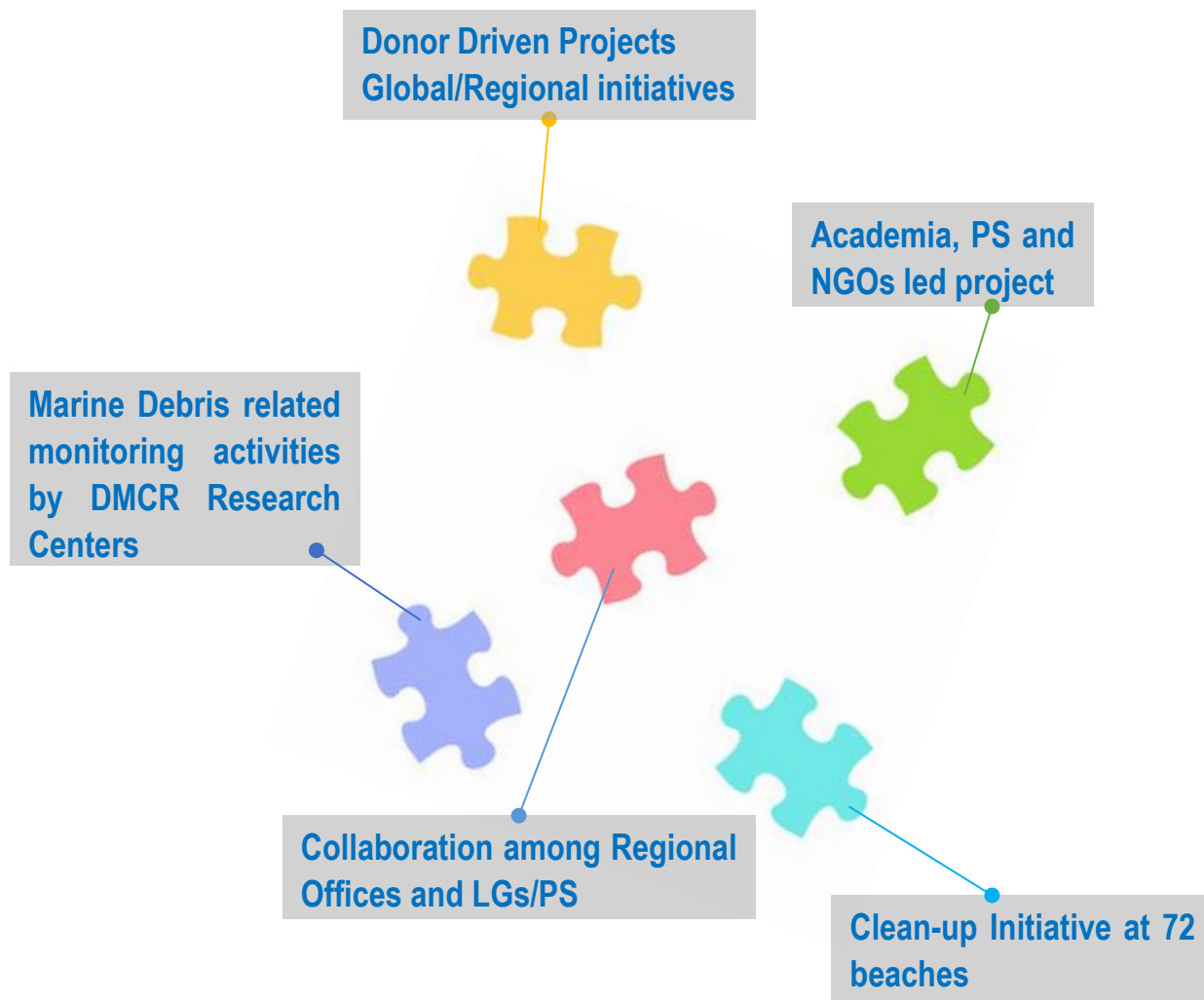
- Enhance MDC (MDM Division) including additional staff assignment
- Enhance activities in line with the Strategic Goals inc. regional trainings
- Implement the Marine Debris Management Strategy (2028 -)
- Establish the National Data Management Hub for MD
- Strengthen a partnership with regional and global stakeholders (ASEAN, UN organizations and Development Partners, etc.)

Refer to "Roadmap for DMCR MDC Establishment"

3.5 Theory of Change for Establishment of MRC (under discussion)



3.6 Impact of MDC



- 1. Governance Alignment and Efficiency**
 - Enhanced Policy Implementation / Clear Role Definition.
- 2. Centralized Data and Knowledge Management**
 - Unified Data Governance / Promotion of Technological Advancements
- 3. Alignment with International and Regional Frameworks**
 - Leadership in ASEAN / Integration with Global Initiatives
- 4. Strengthened Stakeholder Collaboration**
 - Multi-Sectoral Engagement / Enhanced Public Participation
- 5. Economic and Financial Impact**
 - Improved Funding Access / Long-Term Cost Efficiency