



# The Adaptive Management and Resilience–Building Strategies to Address Future Uncertainties

Focus on fisheries and aquaculture

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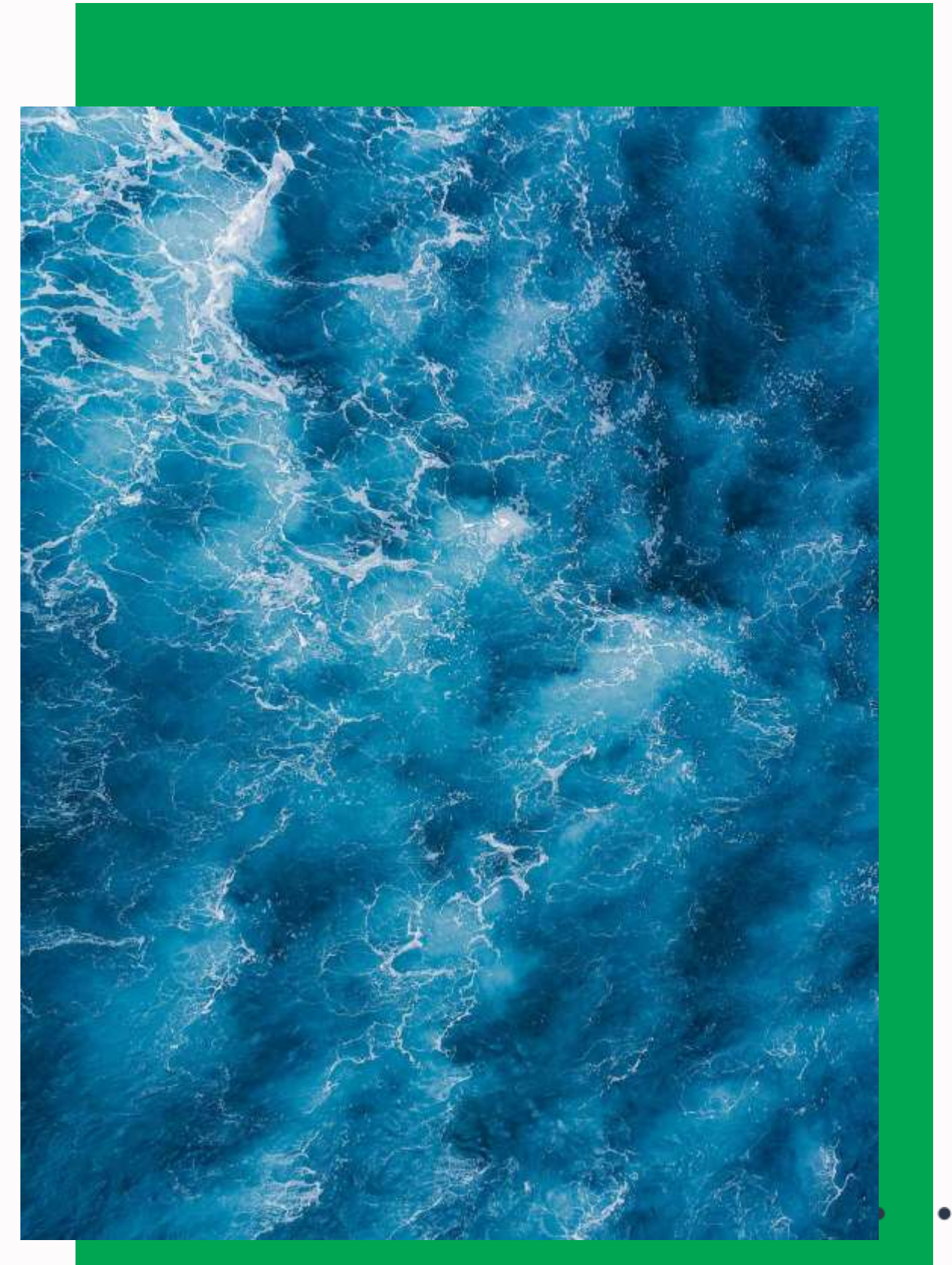
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# Introduction

The adaptive management and resilience-building strategies are crucial for the sustainability of fisheries social-ecological systems in the face of future uncertainties, particularly those arising from climate change.

This sub-topic relates to traditional fisheries management models, which are often inadequate to address continuous changes, including the extreme impacts of climate change. Therefore, adaptive management is a necessary solution.

Furthermore, it is necessary to understand strategies for building resilience, including a holistic socio-economic perspective, stakeholder participation, a preventative approach, governance flexibility, and diversification.

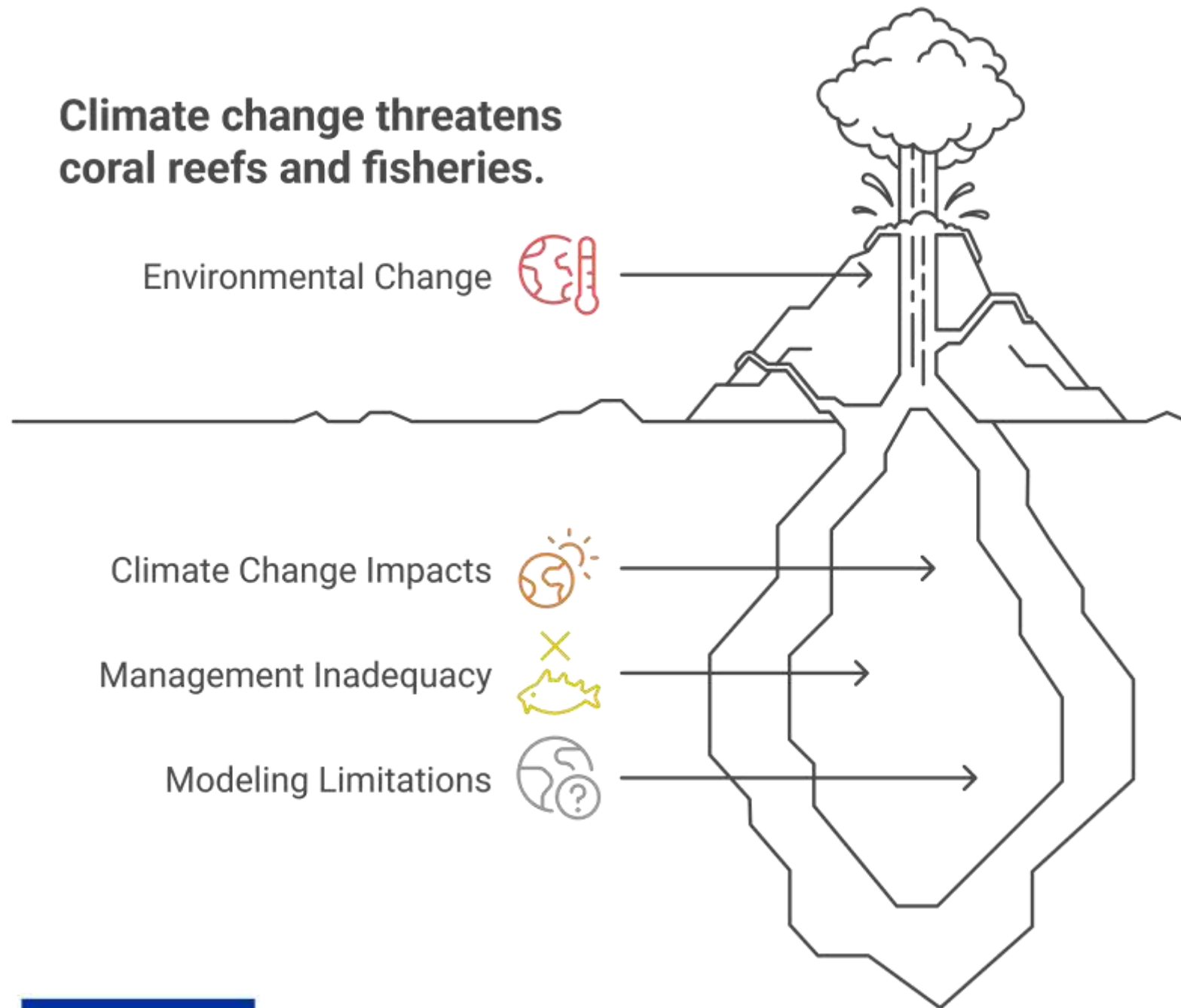
While implementation faces challenges, including a lack of political will, governance capacity, and resources, adaptive management and resilience-building strategies are indispensable for ensuring the sustainability and robustness of global fisheries in a continuously changing environment.





# Global Environmental Change (Bahri et al., 2021)

Climate change threatens coral reefs and fisheries.



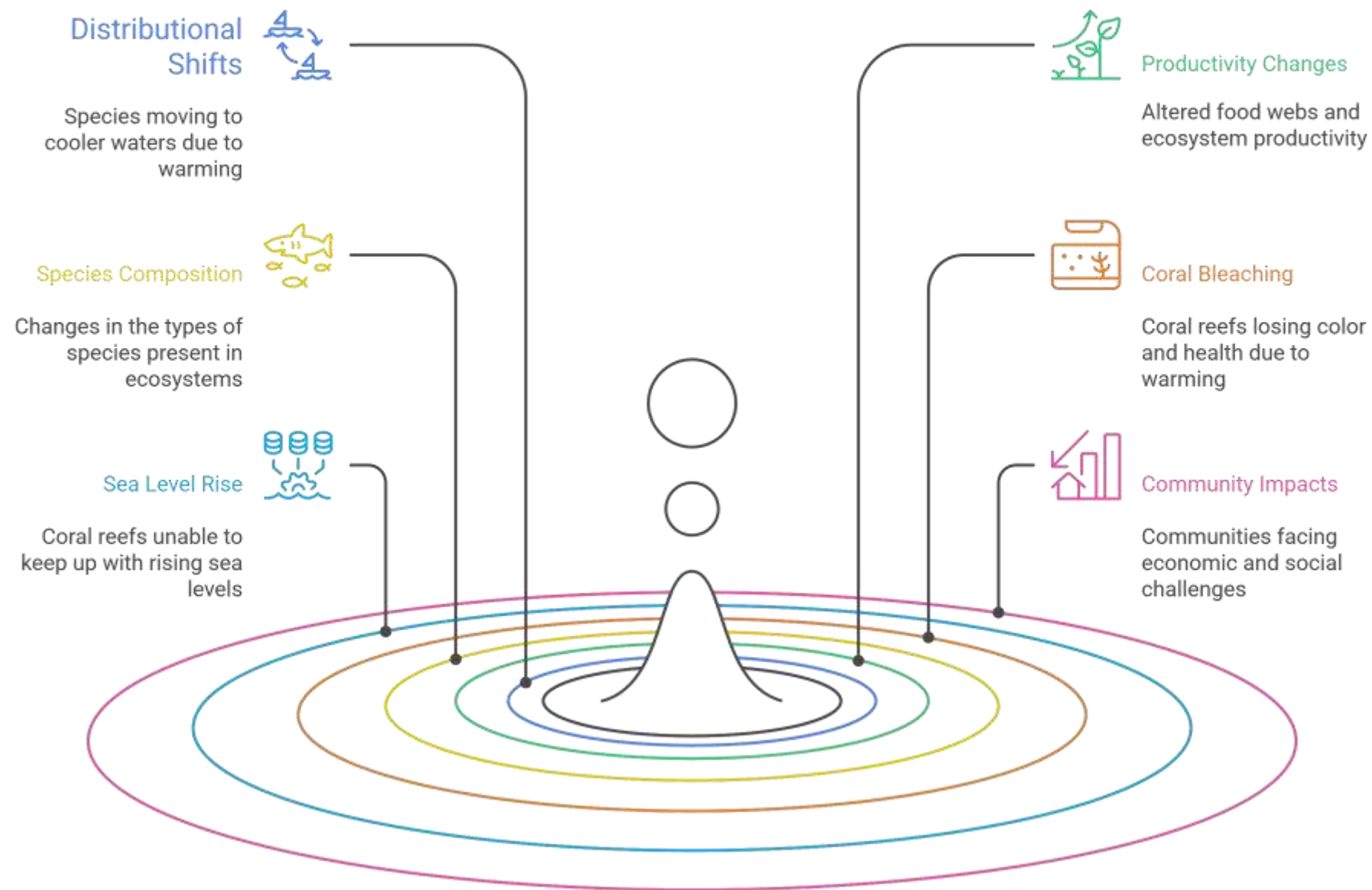
## The Challenge: Global Environmental Change & Uncertainty

- **Coral reefs** and their dependent coastal communities are threatened by global environmental change and site-specific pressures like overfishing and pollution.
- **Fisheries worldwide** face significant challenges from global climate change, impacting resource distribution, abundance, and fishing locations and timing.
- **Traditional fisheries management** approaches may be insufficient for addressing the fundamentally new elements introduced by climate change, such as continuous directional changes in species distributions.
- Uncertainty is rooted in our **limited ability to model and predict the state of nature**, particularly temporal variations in populations and spatial variations across trophic levels.

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# Global Environmental Change (Bahri et al., 2021)

## Climate Change Impacts on Marine Ecosystems



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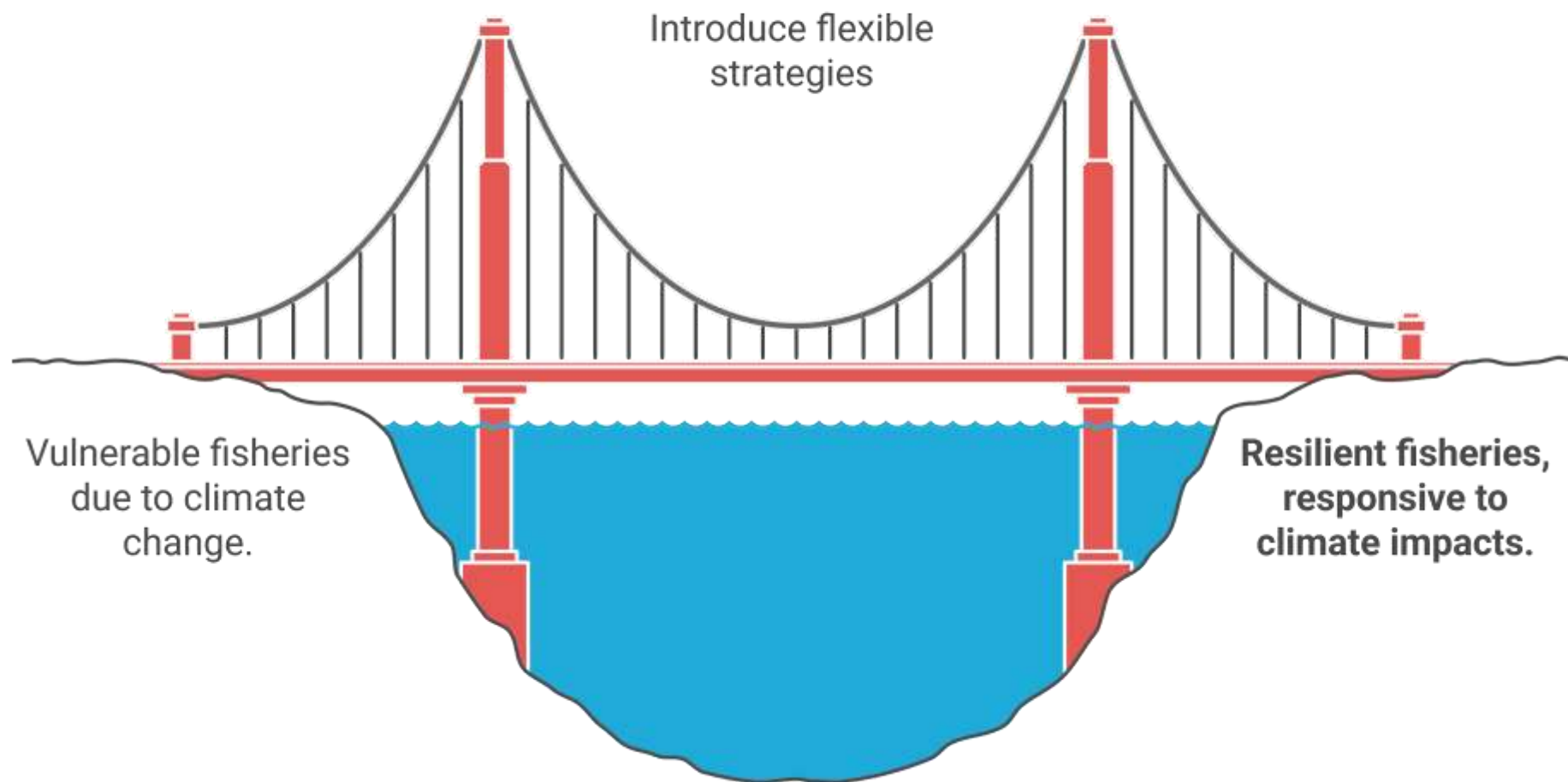


## Pervasive Impacts on Marine Ecosystems and Fisheries

- Climate change effects include **rising ocean temperatures, acidification**, and altered upwelling and mixing processes.
- These changes lead to distributional shifts, **productivity changes**, and alterations in species composition.
- The Western Indian Ocean (WIO) coral reefs are highly vulnerable, with **severe annual bleaching** predicted by 2033.
- Reefs in the Indian Ocean region show diminished capacity to keep pace with **rising sea levels**.
- Such significant changes are potentially devastating to communities highly dependent on these ecosystems.

# Why New Approaches are Imperative? (Bahri et al., 2021)

Adapting fisheries management to climate change impacts.



- There is a critical need to **introduce flexibility into the fisheries management cycle** to foster adaptation and strengthen resilience to climate change.
- Most current fisheries management strategies **rely on static population dynamics**, failing to account for climate-related impacts like altered productivity and distribution of aquatic species.

The goal is to **improve the resilience of fisheries, reduce their vulnerability to climate change**, and **enable managers** to respond in a timely manner to projected changes in marine resources and ecosystems.





# Understanding Adaptive Management (AM)

(Edmondson and Fanning., 2022)

- . **Definition:** AM is a systematic process for continually improving management policies and practices by learning from the outcomes of previously employed policies and practices.
- . It **treats management options as deliberate experiments**, acknowledging a limited ability to know or control all factors, to increase knowledge and reduce uncertainty.
- . AM distinguishes itself from conventional management through its explicit focus on learning.
- . It involves a comprehensive process of **active learning, planning, evaluation, and judgment** about the socio-economic-ecological environment and the effects of key decision variables.

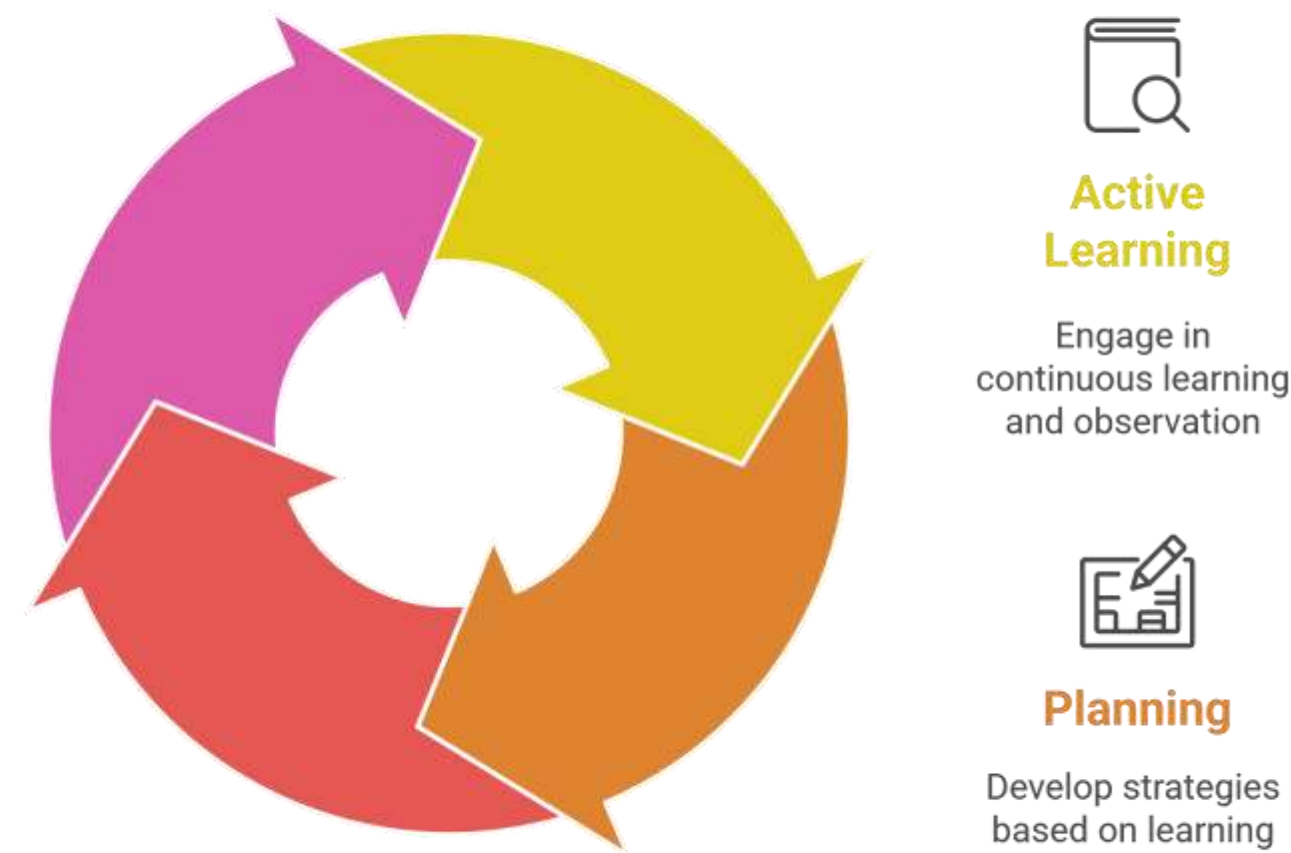




# Adaptive Management Cycle (AMC)

(Bahri et al., 2021; Edmondson And Fanning., 2022; Grafton & Kompas., 2005; Smith and Walters., 2011)

## Adaptive Management Cycle



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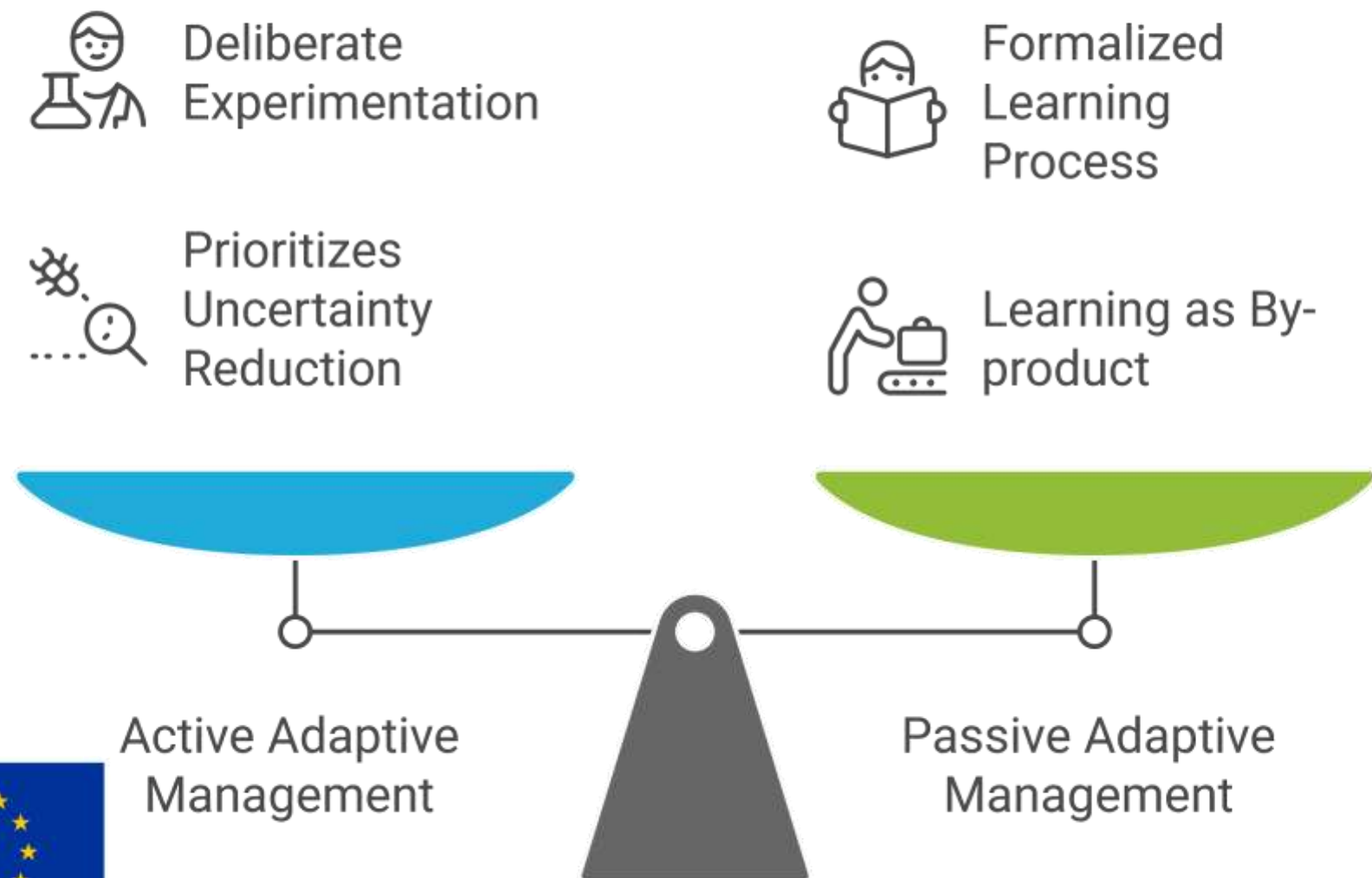
- AM is an **iterative process** that typically involves continuous cycles of **Planning, Implementation, Monitoring, Review/Learning, and Adjustment**.
- **Feedback from the fishery system**, collected through monitoring (e.g., using status indicators), is crucial for evaluating successes or failures and for **revising planning and implementation decisions**.
- This cycle often includes **Management Strategy Evaluation (MSE)**, a framework used to simulate a fisheries system and test alternative management actions against desired objectives, ensuring robustness to uncertainty and variability.



# Type of Adaptive Management Approaches

(Edmondson and Fanning., 2022; Smith and Walters., 2011)

Compare active and passive adaptive management approaches.



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## . Active Adaptive Management (AAM):

- Involves deliberate, large-scale experiments where management options are treated as hypotheses to be tested.
- It prioritizes the reduction of uncertainty through learning-focused decision-making.
- **Example:** Deliberately varying salmon escapements to obtain better information for future management, which becomes increasingly important as natural informative variation is eliminated.

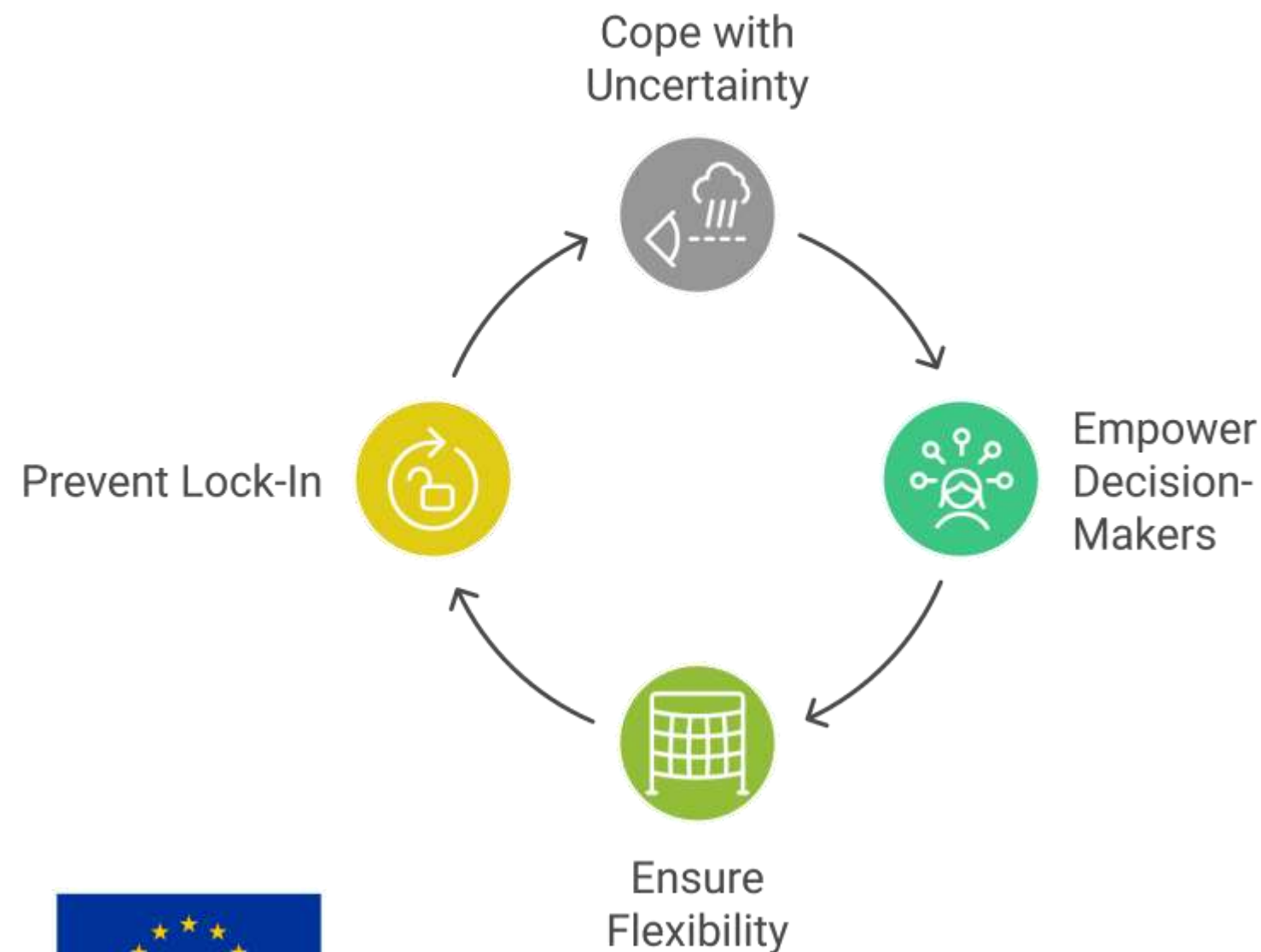
## . Passive Adaptive Management (PAM):

- Relies on formalized learning as a process underlying the adjustment of management decisions, but without explicit experimentation.
- Learning is a by-product of decision-making, with a focus on implementing a single course of action based on past experiences and refining it as new experience grows.

# Key Benefit of Adaptive Management

(Bahri et al., 2021; Edmondson & Fanning., 2022; Smith & Walter., 2011; Grafton & Kompas., 2005)

## Adaptive Management Cycle



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- **Effectively copes with uncertainty and complexity** in socio-ecological systems, providing a structured approach for learning and necessary adjustments.
- **Empowers decision-makers, industries, and local communities to react and adapt** to changes as they occur.
- Provides **flexibility and robustness** in strategies, enabling better long-term outcomes for fisheries.
- **Prevents "lock-in" to suboptimal management** situations where a single suboptimal action is repeated due to lack of information on its true suboptimality.



# Enduring Challenges in Implementing Adaptive Management

(Edmondson & Fanning., 2022; de Young et al., 2012)

Barriers to adaptive management implementation, from specific to systemic



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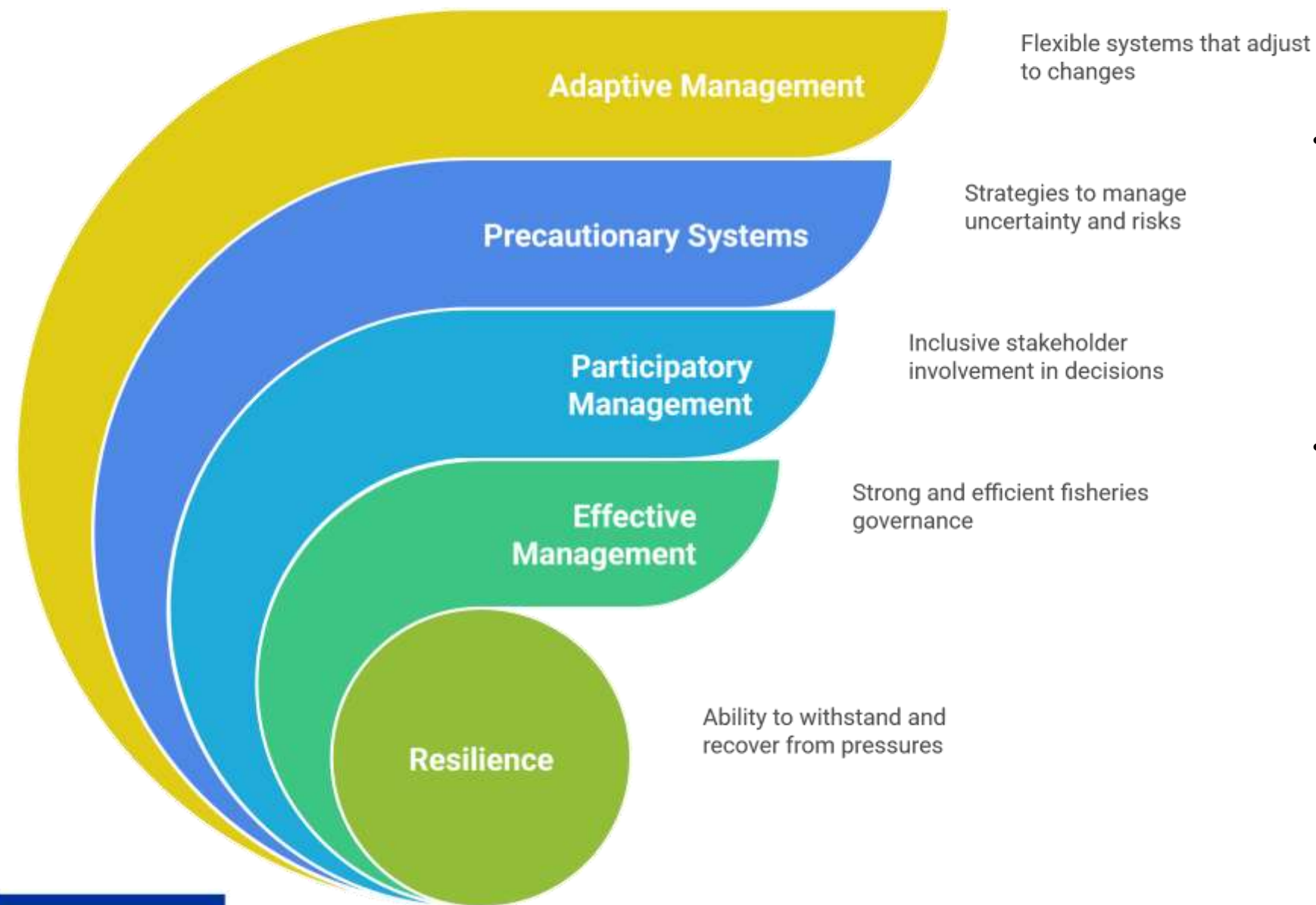


- Persistent challenges include **lack of clarity in definition and approach**, and a limited number of documented success stories.
- **Traditional management, policy, and funding paradigms often favor reactive approaches** over proactive adaptive ones.
- **Unwillingness to embrace uncertainty**, lack of leadership, and insufficient management resources for expanded monitoring activities are significant barriers.
- **Difficulty in detecting the effects of management actions against a broader background of change** limits learning and effective adaptation.
- Broader systemic issues like **lack of political will, insufficient governance capacity and structures, and inflexible legal frameworks** impede effective implementation.

# Understanding Resilience-Building Strategies

(Hattam et al., 2020)

## Fisheries Resilience Foundations



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- Building the **resilience of coral reef ecosystems and the coastal communities dependent on them is an issue of international concern** (e.g., SDG 14).
- Resilience is conceptualized as the **ability of a system to resist, recover, adapt, and bounce back from any kind of pressure**, though not necessarily to the exact same prior state.
- For fisheries, building resilience involves strengthening four key "foundations":
  1. Effective fisheries management systems.
  2. Participatory fisheries management systems.
  3. Precautionary systems dealing with uncertainty and risks.
  4. Adaptive fisheries management systems.



# Pillars of Climate-Resilient Fisheries

(de Young et al., 2012)

## Foundations of Climate-Resilient Fisheries



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### Effective Management Systems

Ensures sustainable resource use through planning, implementation, and review.



### Participatory Processes

Adapts management plans through stakeholder engagement and local knowledge.



### Precautionary Approach

Proactively assesses risks and sets conservative targets to mitigate climate impacts.

- **1. Effective Management Systems:** A foundational element, ensuring sustainable resource use through a cycle of planning, implementation, monitoring, and review.
- **2. Participatory Processes:** Essential for adapting management plans to climate change, involving various forms of stakeholder engagement from information sharing to co-management. This capitalizes on local knowledge and adaptive capacity.
- **3. Precautionary Approach:** Key for dealing with the high uncertainty of climate impacts; the principle states that "lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat". This requires proactive risk assessment and conservative target settings.



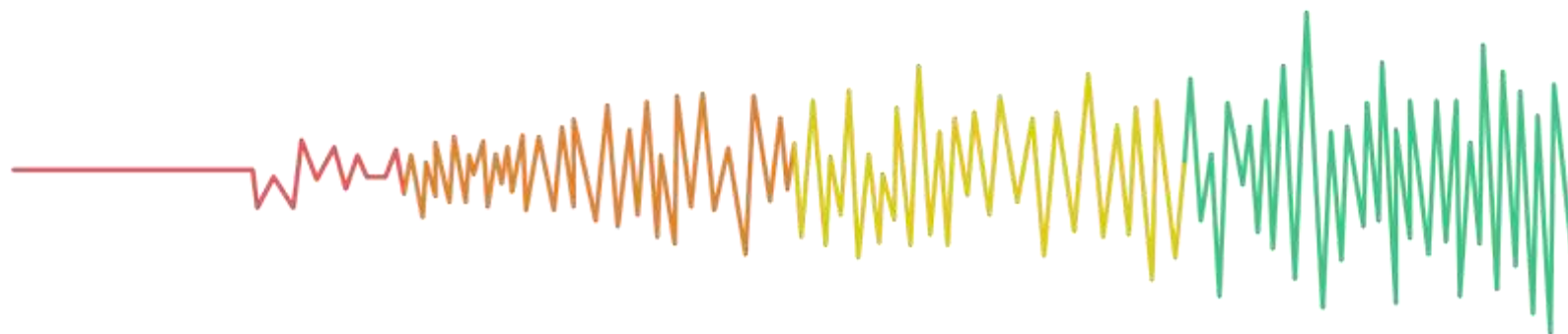


# Examples of Ecological Resilience Strategies

(Hattam et al., 2020; de Young et al., 2012; Bahri et al., 2021)

Ecological resilience strategies ranked by proactive vs reactive approach.

Reactive < > Proactive



## Coral Reef Restoration

Directly repairs damaged ecosystems

## Rebuilding Overfished Stocks

Reduces vulnerability to climate stressors

## Conserving Keystone Species

Avoids ecological tipping points

## Maintaining System Properties

Supports inherent resilience factors

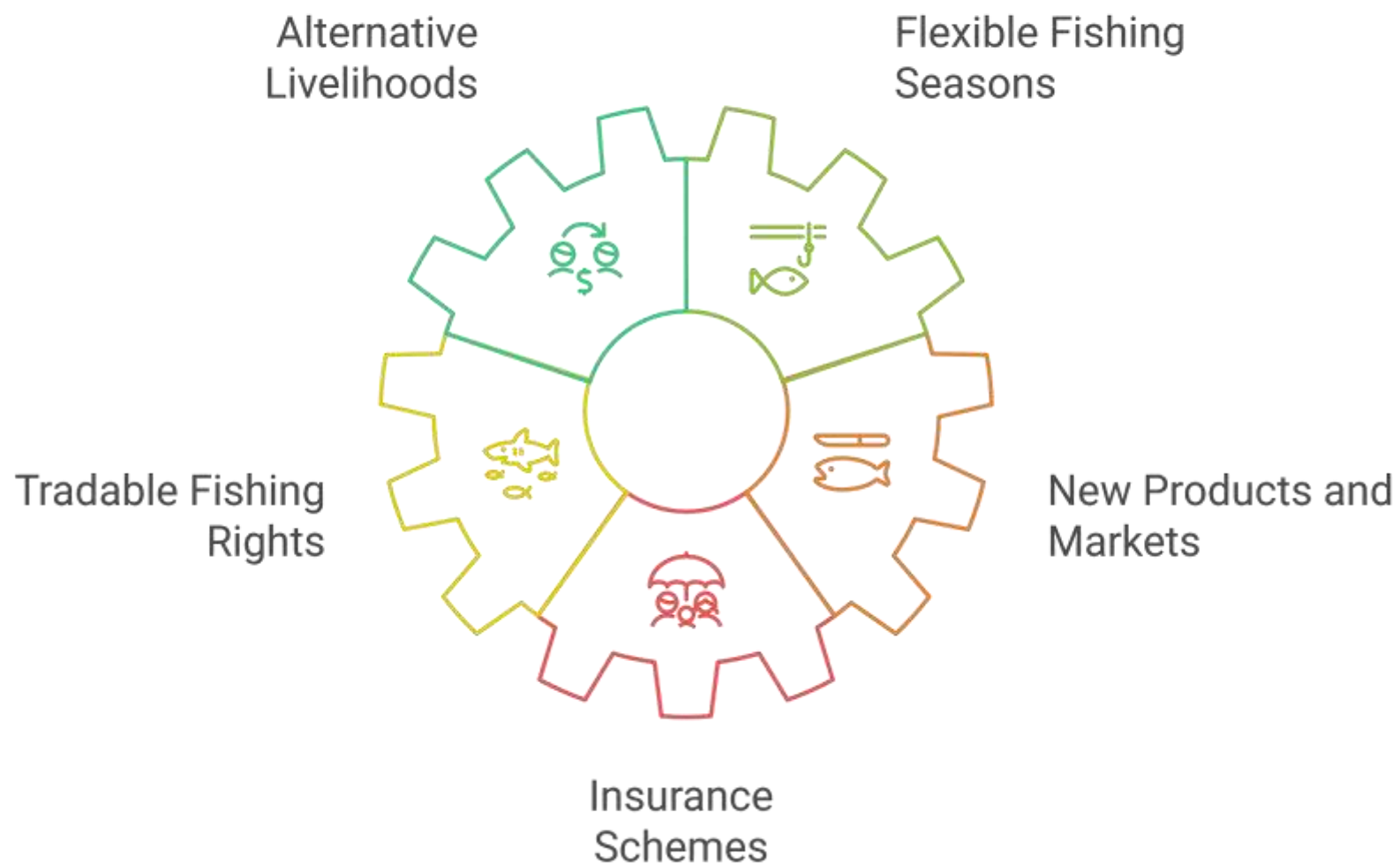
- **Coral Reef Restoration:** Efforts like coral gardening primarily support ecological resilience.
- **Conserving Keystone Species Complexes:** Aims to avoid ecological tipping points and related undesirable changes in target species abundance and ecosystem function.
- **Rebuilding Overfished Stocks:** A high priority to ensure the underlying resilience of the fishery system is supported, making it less vulnerable to additional climate stressors.
- **Maintaining System Properties:** Recognizing and supporting inherent resilience factors such as genetic or biological diversity and habitat complexity minimizes disruption to these properties.



# Examples of Social & Economic Resilience Strategies

(de Young et al., 2012; Bahri et al., 2021; Hattam et al., 2020)

## Enhancing Coastal Community Resilience



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- **Alternative Livelihoods:** Developing diverse income sources can reduce the vulnerability of coastal communities to declines in traditional fisheries. Micro-finance schemes can support such transitions.
- **Flexible Fishing Seasons:** Adjusting seasons to align with market demand can maintain economic viability even with reduced catch limits or changing environmental conditions.
- **Tradable Fishing Rights/Allocations:** Mechanisms like the Vessel Day Scheme (VDS) allow for equitable distribution of benefits despite climate-driven redistribution of fish stocks, avoiding conflicts.
- **Developing New Products and Markets:** Innovation in product development and marketing maximizes fishery value as traditional catches decline, promoting diversification and economic yield.
- **Insurance Schemes:** Offer crucial protection for fishers against financial losses and damages caused by climate events or forced practice changes.



# The Holistic View: Social-Ecological Resilience

(de Young et al., 2012; Bahri et al., 2021; Hattam et al., 2020)

## Where Nature and Society Meet in Fisheries



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- Fisheries are inherently **complex social-ecological systems**; therefore, resilience building must holistically consider the intricate interactions between the ecosystem and the human communities dependent on it.
- Achieving resilience requires **nuanced policy interventions**, recognizing that adaptive capacities can vary significantly even within communities facing similar climate impacts.
- Effective strategies necessitate **matching the appropriate scales**—physical environment, biological system, and human social and cultural systems—across both time and space.
- The concept highlights that a fishery is an **interplay of an ecosystem, human economic activity, and the system of social control (management)**, all inextricably intertwined and influencing each other.





# The Current Status and Gaps in Implementation

(Hattam et al., 2020; Edmondson & Fanning., 2022; de Young et al., 2012)

**Building resilience through robust evaluation and data integration.**

Resilience-building programs lack robust evaluation.

Implement robust evaluations and integrate climate information.

Strategies build social and ecological resilience.

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- The effectiveness of many resilience-building programs and strategies remains largely unknown due to a lack of robust evaluation.
- There is limited evidence evaluating the impacts of different strategies in regions like the WIO, with available information often relying on global literature rather than local evaluation.
- A general absence of long-term monitoring and evaluation data severely hampers the ability to articulate the success of strategies in building social and ecological resilience.
- A disaggregated understanding of resilience is often missing, particularly regarding gender equity and individual agency, which has implications for policy design.
- Globally, there has been a slow uptake of climate information into fisheries management systems, with few examples of demonstrated success.



# "Latest News Update": Real-World Adaptive Strategies

(Bahri et al., 2021; de Young et al., 2012)

- **Uruguay Yellow Clam Fishery:** Reopened with institutionalized monitoring by fishers and co-management, leading to precautionary low TACs and restricted seasons. This built resilience to warming seas.
- **Peruvian Anchoveta Fishery:** Operates with **a flexible and adaptive management system** incorporating near real-time observational data. This allows swift responses to rapid spatio-temporal environmental changes and protects juvenile populations.
- **Parties to the Nauru Agreement (PNA) Vessel Day Scheme (VDS):** A cooperative fishery management mechanism that helps member countries adapt to climate variability (e.g., El Niño Southern Oscillation) impacting tuna distribution, ensuring equitable distribution of economic benefits.
- **South African Small Pelagic Fishery:** Conducted vulnerability assessments and utilizes Operational Management Procedures (OMPs) developed with stakeholder consultation. Challenges remain in fully integrating future climate scenarios into OMPs.
- **Tasmanian Fisheries:** Demonstrate flexible management that allows for relatively quick adjustments (within months) to observed environmental changes. Includes strategies like "green" infrastructure and the use of citizen science (Redmap) for early detection of species range shifts.



## “Latest News Update”: Real-World Adaptive Strategies-02

(Bahri et al., 2021; de Young et al., 2012)

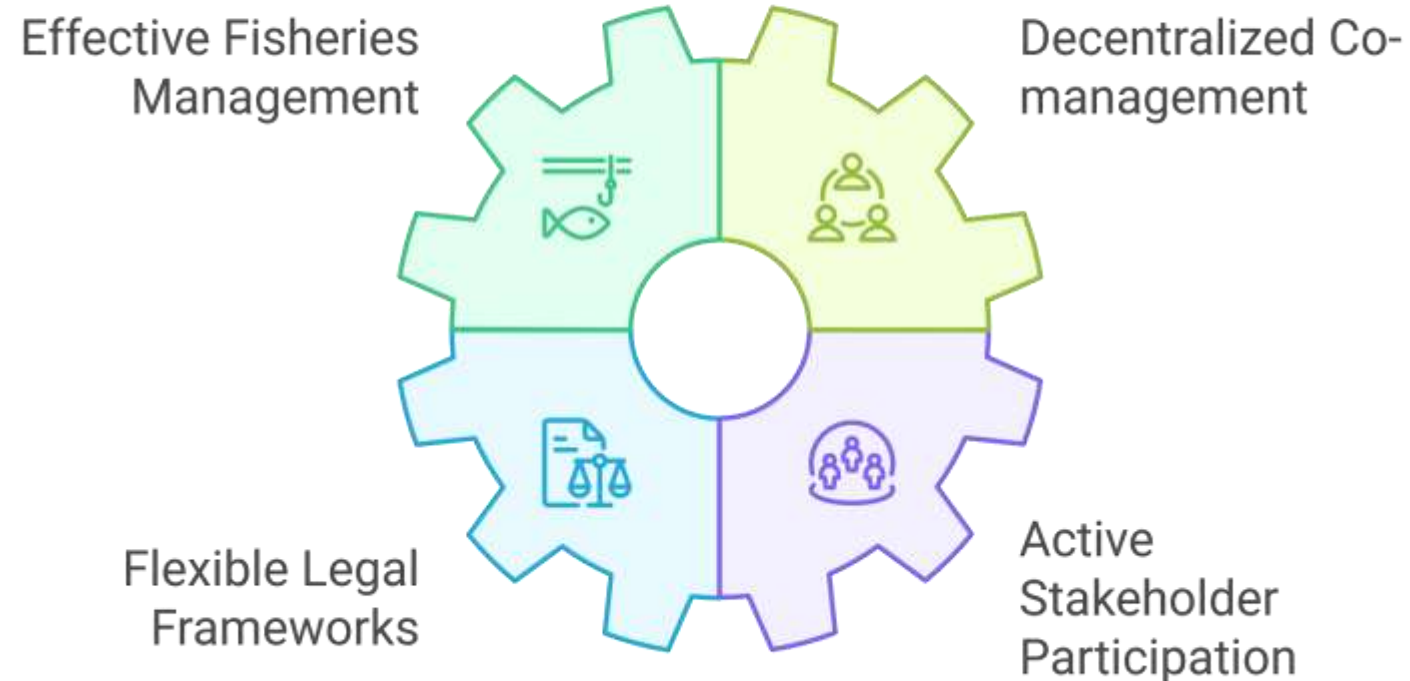
- **Myanmar Marine Fisheries:** Despite capacity constraints, efforts focus on building "general resilience" through biodiversity conservation via co-management areas (LMMAs). This enhances the adaptive capacity of fisher groups.
- **Belize Managed Access Program:** Links Marine Protected Area (MPA) networks with rights-based fisheries management. This system provides secure fishing rights, reduces illegal fishing, improves reporting, and incentivizes compliance, using an "Adaptive Management Framework" for continuous improvement.
- **Canadian Greenland Halibut Fishery:** Utilizes empirical modeling to provide climate-conditioned management advice. This has shown that previously sustainable exploitation rates may be too high under rapid warming scenarios, necessitating adjustments.
- **Philippine Sardine Fisheries:** Currently prioritizing addressing overexploitation to improve resource sustainability and build resilience to future climate changes. Emphasizes the need for better governance and enhanced understanding of fish-environment interactions.





# Offered Solutions: Strengthening Governance & Participation (de Young et al., 2012; Bahri et al., 2021)

## Enhancing Governance and Participation in Fisheries



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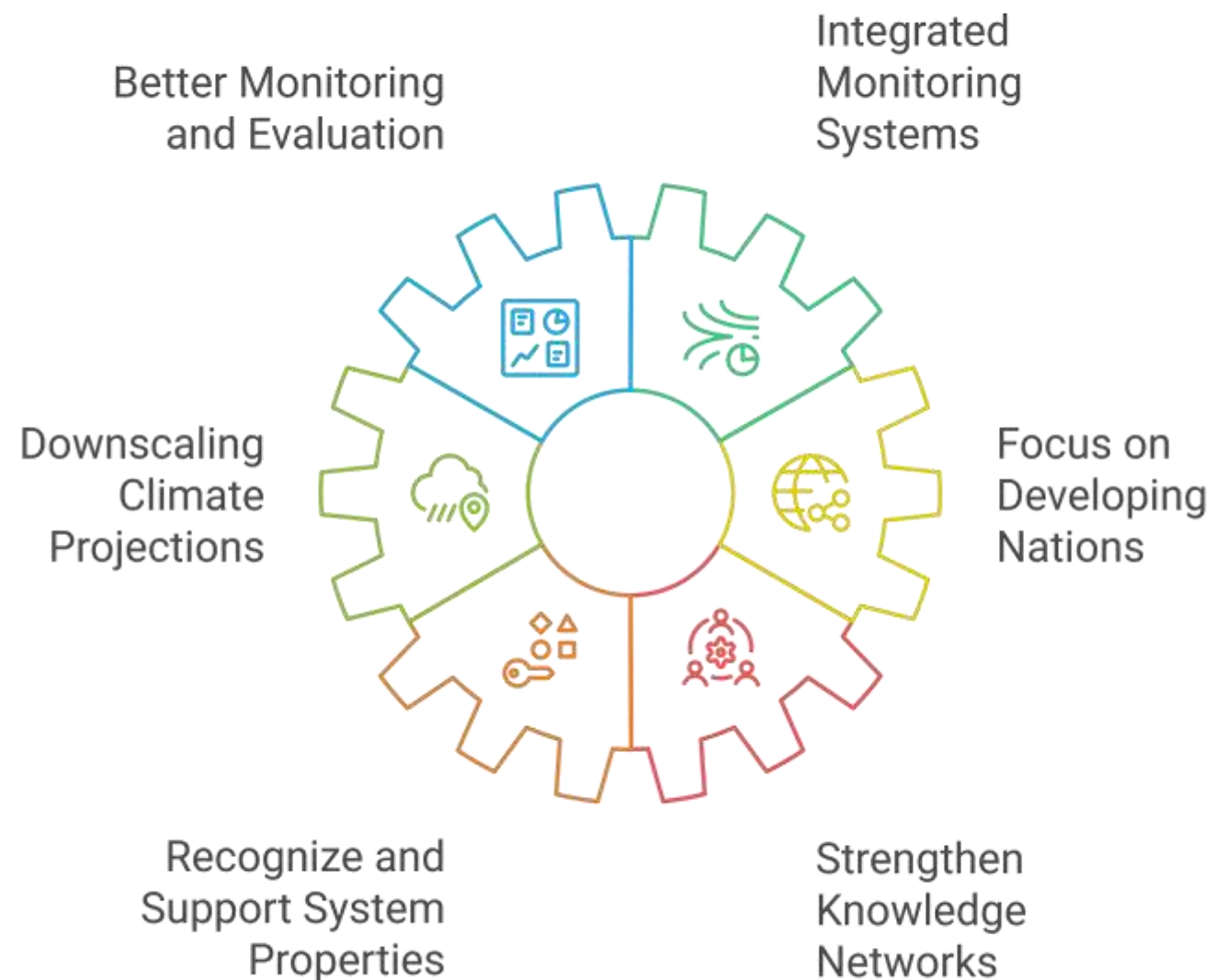
- **Effective Fisheries Management as the Foundation:** It is the primary need to ensure that management frameworks are implemented effectively. For regions with limited resources, focusing on the basics is crucial.
- **Decentralized Co-management Structures:** Empowering stakeholders and decentralizing management responsibilities increases responsiveness and adaptiveness compared to centralized structures. It fosters greater participation and tailors rules to local contexts, improving enforcement.
- **Flexible Legal Frameworks:** Legal and governance structures must be flexible and supportive of adaptive approaches, with decentralization and co-management being key to success.
- **Active and Ongoing Stakeholder Participation:** Crucial throughout the adaptive management process to inform objective setting, reinforce relationships, support social cohesion, ensure compliance, and integrate various forms of knowledge.



# Offered Solutions: Improving Data, Knowledge & Capacity

(Hattam et al., 2020; Bahri et al., 2021; de Young et al., 2012)

## Enhancing Climate Resilience



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- **Better Monitoring and Evaluation:** Long-term monitoring and evaluation data are urgently needed to support effective decision-making. This should include collecting both social and ecological data, ideally with community involvement.
- **Integrated Monitoring Systems:** Promote systems that incorporate both scientific and local/traditional knowledge to provide higher-resolution data and early detection of climate impacts.
- **Downscaling Climate Projections:** Translate regional climate change projections into local-scale impacts and associated socio-economic scenarios to inform localized adaptation.
- **Focus on Developing Nations:** Address the urgent need for understanding and meeting the specific needs of low-capacity regions for climate-adaptive fisheries management.
- **Recognize and Support System Properties:** Ensure management measures minimize disruption to inherent resilience factors like genetic/biological diversity and habitat complexity.
- **Strengthen Knowledge Networks:** Foster interactions and lesson sharing among practitioners and experts across regions to develop best practices.

## Conclusion: A Path Forward Amidst Uncertainty

(Bahri et al., 2021; de Young et al., 2012; Edmondson & Fanning et al., 2022; Hattam et al., 2020)

- . Adaptive management and resilience-building strategies are indispensable for ensuring the sustainability and robustness of global fisheries in a continuously changing environment.
- . Achieving this requires enhancing the fundamentals of traditional best-practice management while also embracing new approaches for novel, directional changes introduced by climate change.
- . A successful path forward will likely involve a combination of adaptive and dynamic management approaches alongside fixed long-term measures.
- . Critically, it means treating "crises" or unexpected events as opportunities for learning through practical experiments, rather than mere reactions.

The ultimate objective is to **manage stocks and fisheries sustainably for long-term yield and sustained economic benefits**, requiring continuous adaptation to system changes and ongoing uncertainties.





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