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Large Marine Ecosystems Status and Trends

Sherry Heileman (Component coordinator)

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IOC-UNESCO

On behalf of the LMEs Working Group

UNEP

gef

UNEP-DHI PARTNERSHIP
Centre on Water and Environment

United Nations Educational, Scientific and Cultural Organization

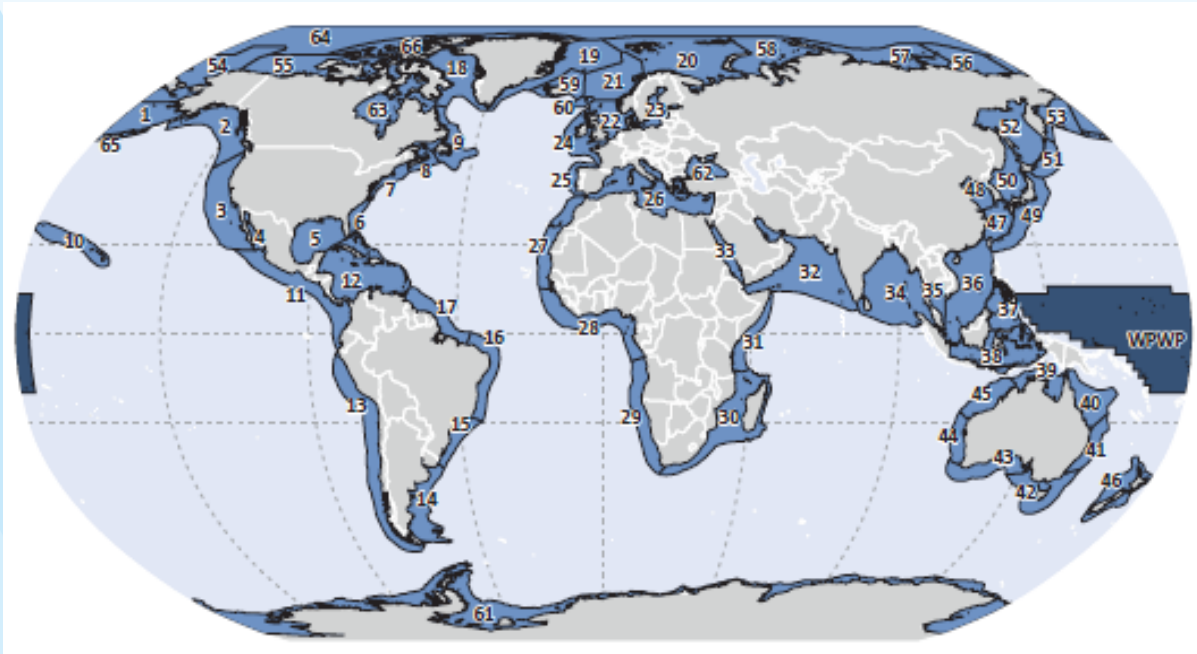
International Hydrological Programme

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

ILEC

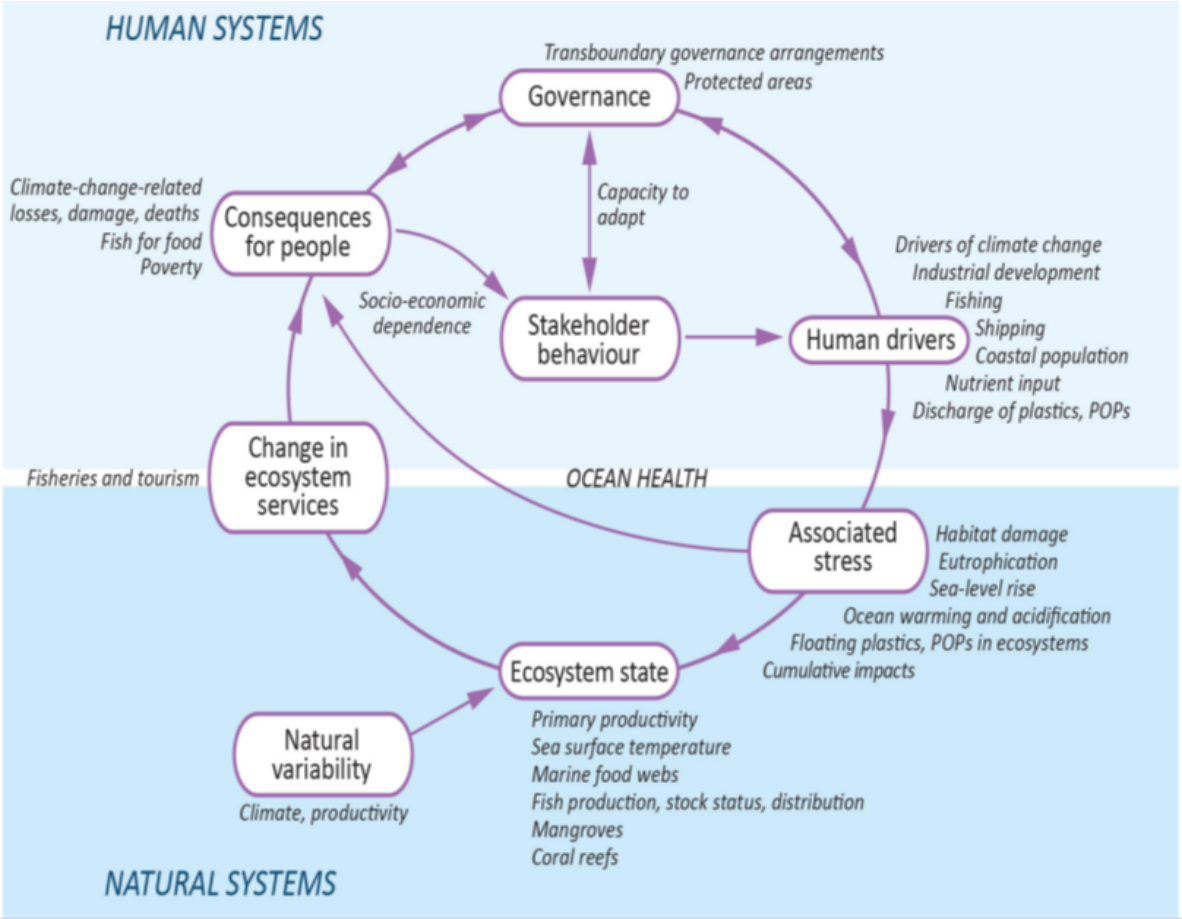
Large marine ecosystems



- 66 LMEs cover the world's coastal areas from shoreline to outer edge of continental shelf or major ocean current
- Each 200,000 square km or greater
- Highly productive; intense impacts from human activities

Western Pacific Warm Pool also assessed (subset of indicators)

Conceptual framework



Builds on the 5 LME modules: **Productivity, Fish & Fisheries, Pollution & Ecosystem Health, Socio-economics & Governance**

DPSIR framework

Links between human and natural systems

Incorporates natural variability

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Assessment questions

- What are the current trends (& projections) in LME state with respect to fisheries, pollution, habitats?
- Which LMEs are at the highest relative risk?
- What are the implications for humans?

  - *Where is human dependency greatest on LME ecosystem services?*

  - *Where are humans most vulnerable to changes in LME condition?*

- What is the status of governance arrangements in transboundary LMEs to address the priority issues (fisheries overexploitation, pollution, habitat/biodiversity loss)

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Indicators by LME modules (relevance to SDG Goals & Targets)

Productivity	Fish & Fisheries (14.4)	Pollution & Ecosystem Health
•Chlorophyl	•Fishing subsidies (14.6)	•Nutrient loads (6.3, 14.1)
•Primary productivity	•Catch from bottom gear	•Coastal Eutrophication Potential (6.3, 14.1)
•SST	•Fishing effort (14.4)	•POPs in plastic pellets (6.3, 12.4, 14.1)
	•MTI & FIB	•Micro & macro-plastic debris (6.3, 12.5, 14.1)
	•Ecological footprint	•MPA coverage (14.2, 14.5)
	•Stock status	•Reefs at Risk Index (14.2)
	•Catch potential under global warming	•Mangrove extent (14.2)

Indicators cont'd (and relevance to SDG Goals & Targets)

Socio-economics	Governance
•% fish protein (2.1, 2.2, 14.7) •% GDP tourism (8.9, 14.7) •Coastal population •Human Development Index •Night light Development index •Climate risk (11.5, 13.1) •Contemporary treat index (1.5, 11.5)	•Governance architecture- Completeness, Engagement, Integration (multi-country LMEs)

Relative risk

- Concept of risk: the likelihood of failure to sustain the ecosystem services that transboundary waters provide.
- Grouping of LMEs into 5 colour-coded categories of relative risk based on indicator values

- Ideally, the cut-off points for the five categories should be based on set targets or reference points, but globally these do not exist for most of the indicators
- Experts decided on the cut off points
- Values are averages at the LME scale and do not reflect the situation of any particular country

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Results: Global patterns of risk

Single biophysical indicators

(drivers and environmental state)

Examples

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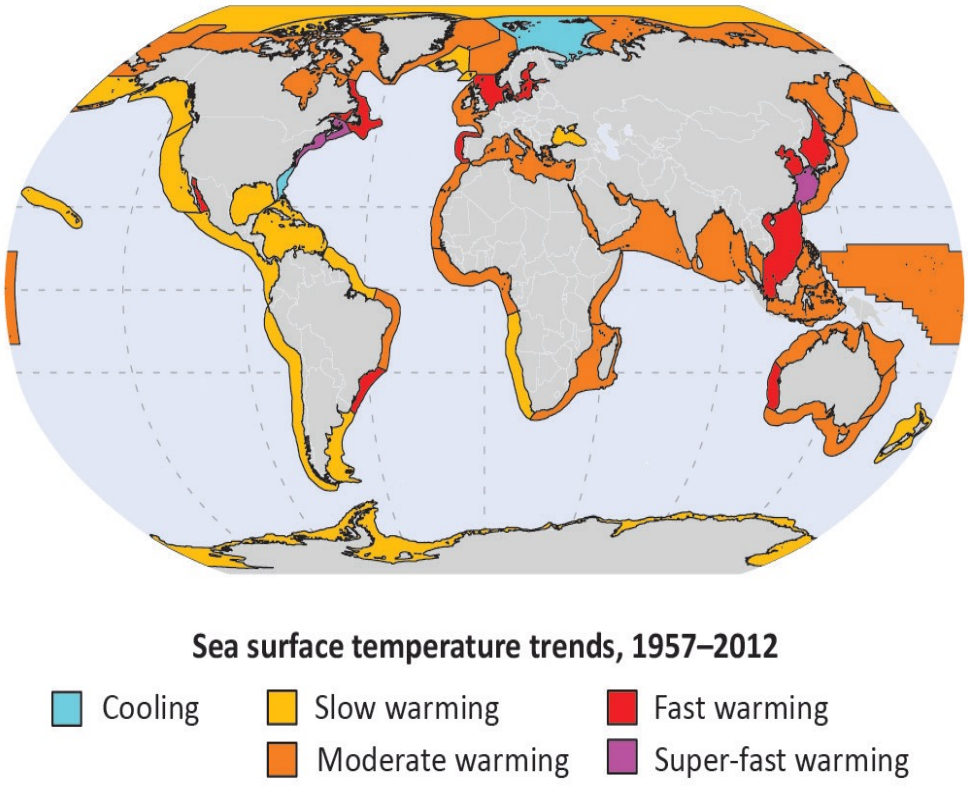
Productivity: Sea surface temperature (1957-2012)



- SSTs have increased in all but two LMEs since 1957.
- Three LMEs show 'super-fast' warming (increase of up to 1.6°C): East China Sea, Scotian Shelf, and Northeast US Continental Shelf.
- Warming seas are already affecting LME productivity and biodiversity (e.g., fish catch potential, coral reefs) and exacerbating human impacts in certain LMEs.

I. Belkin, URI

D. Pauly & V. Lam, Sea Around Us (UBC)

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Fish & Fisheries

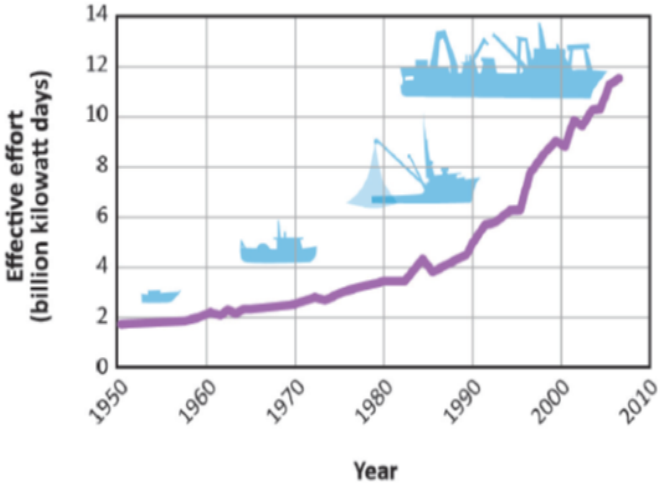
Overfishing identified as a priority issue in most LMEs.

What drives unsustainable fishing?

- Excessive fishing effort
- Harmful fishing subsidies
- Other factors such as illegal, unreported and unregulated fishing (IUU), etc

Effective fishing effort:

Steady increase since 1950



Fishing subsidies:

Value of fishing subsidies in some LMEs amount to up to 80% of catch value!

D. Pauly & V. Lam, Sea Around Us (UBC)

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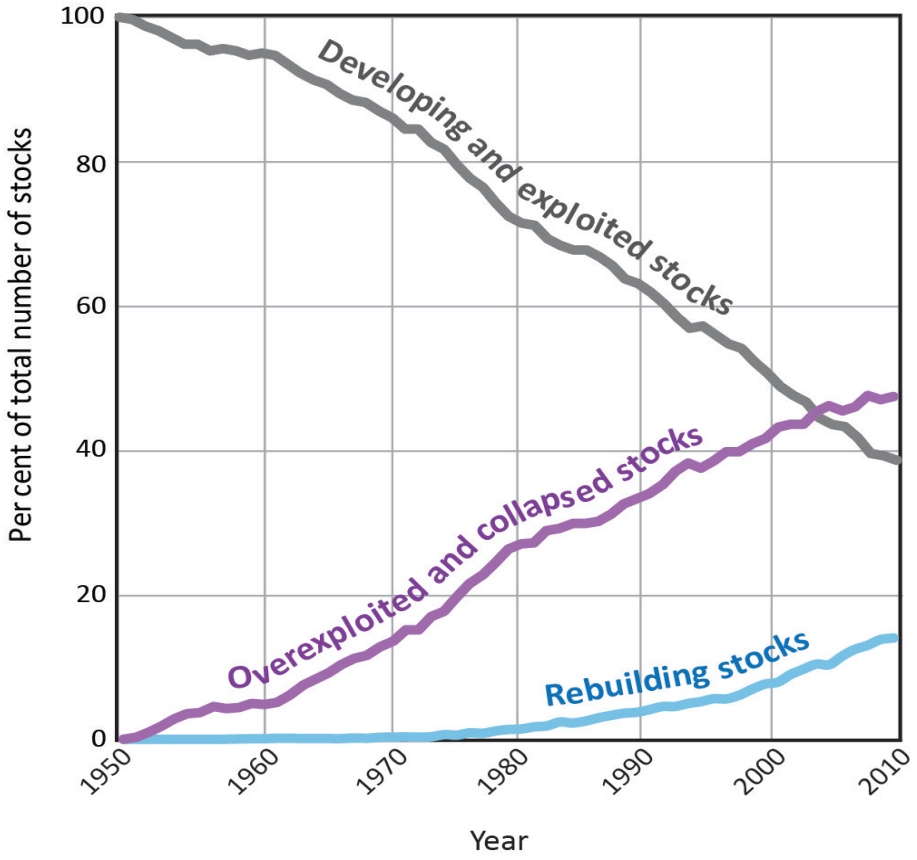
Fish & Fisheries



- One symptom of unsustainable fishing- collapsed and overfished stocks.
- Sources of pressure and degree of risk vary among LMEs → need for tailored solutions.
- Nearly all GEF-eligible LMEs have more than 50% of the indicators at medium/high/highest risk levels.

D. Pauly & V. Lam, Sea Around Us (UBC)

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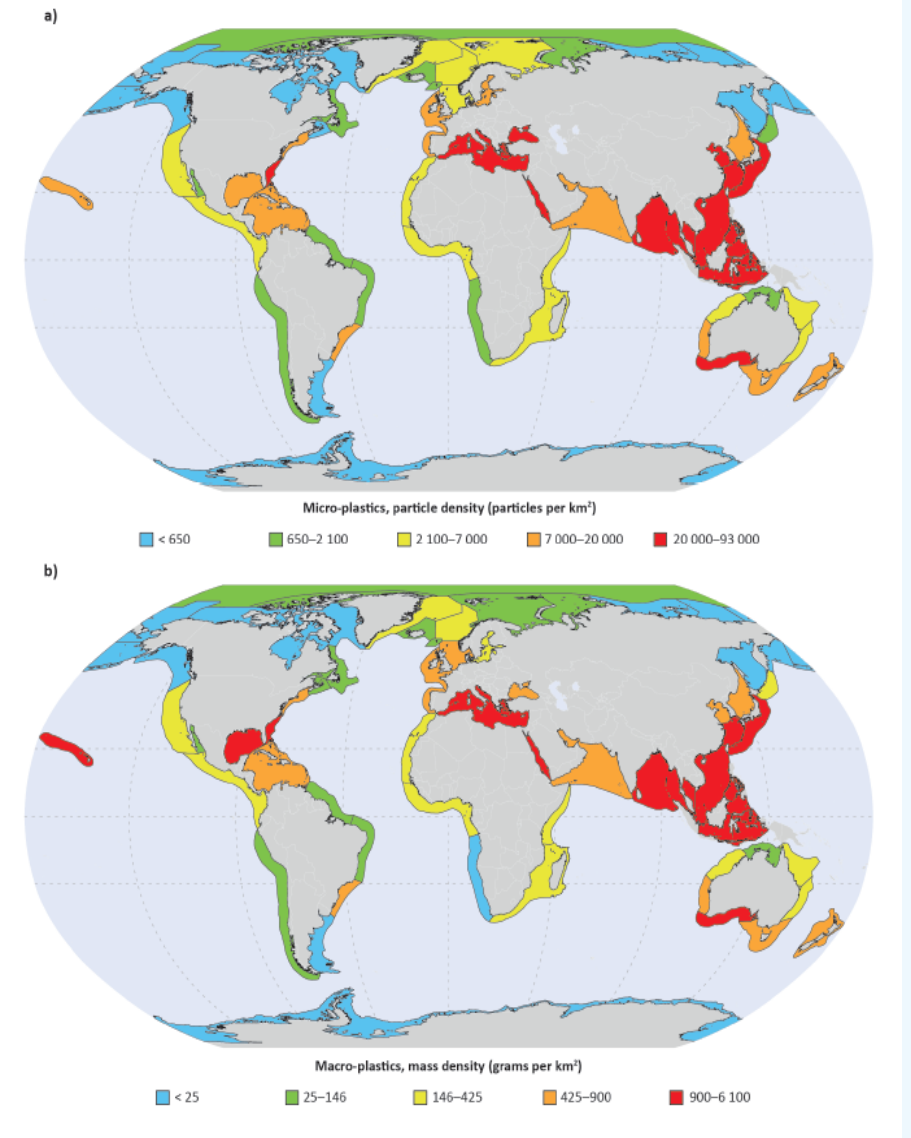
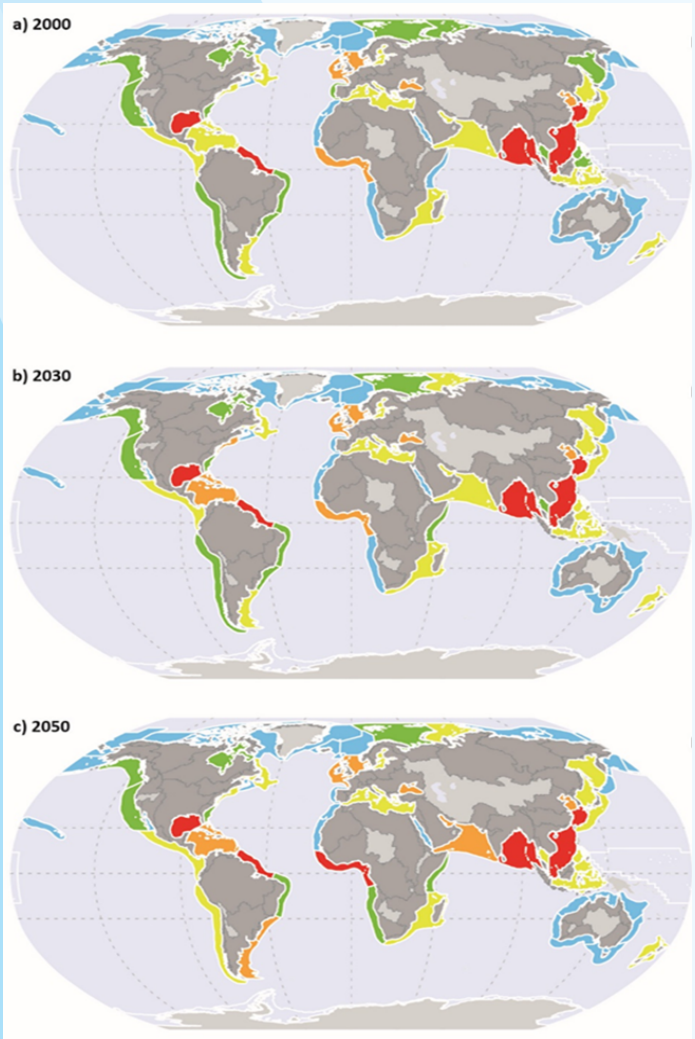
Pollution: Relative abundance of floating micro-plastics (upper) & macro-plastics (lower), from model estimates

- The model uses three proxies to represent sources of marine litter: *coastal population density, proportion of urbanized catchment (more rapid run-off),and shipping density*.
- Estimated levels are highest in East and Southeast Asia, the Mediterranean, and the Black Sea.



P. Kershaw (GESAMP) & L. Lebreton

Nutrient inputs & Coastal Eutrophication Potential

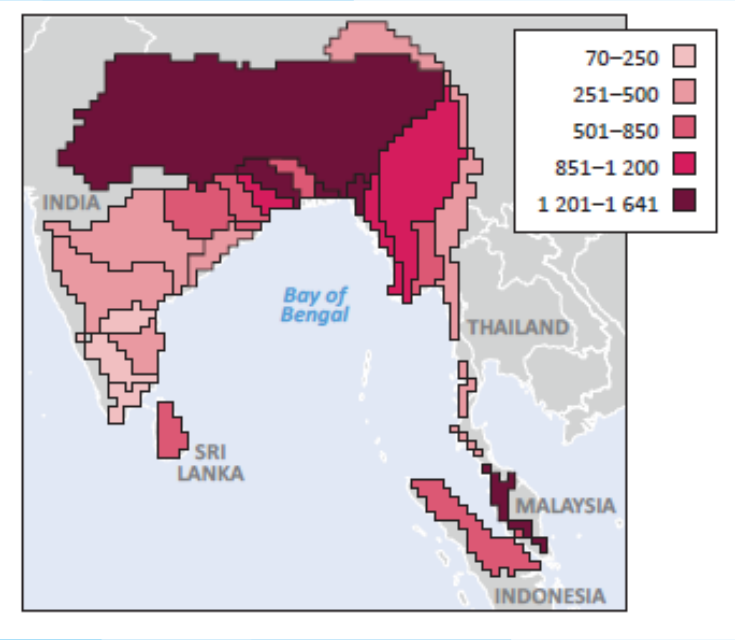


- Global NEWS model- indicator of coastal eutrophication based on the amount of nitrogen input in rivers, and nutrient ratios (dissolved Si to N or P).
- 16% of LMEs are at high risk from nutrients (sewage and agriculture)
- *Based on current trends, by 2050, coastal eutrophication risk will increase in 21% of LMEs, mainly in southern and eastern Asia, South America and Africa*.
- Iberian Coastal & Northeast US Continental Shelf are projected to lower their eutrophication risk by 2050.

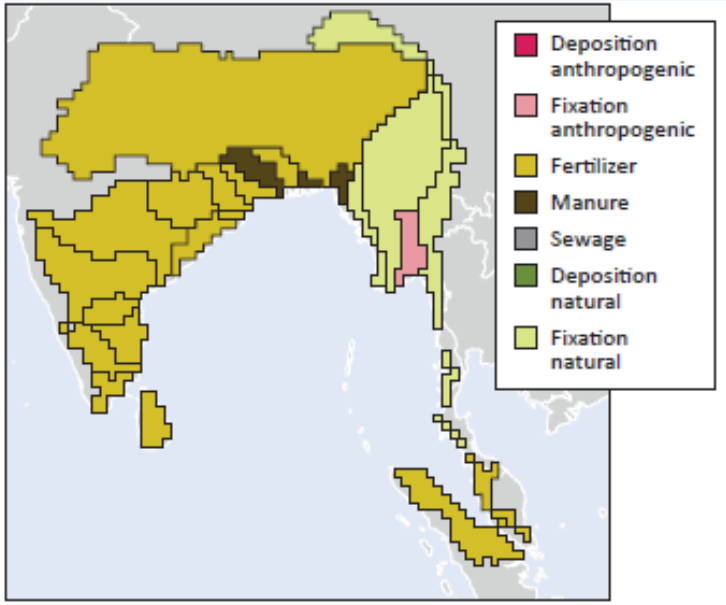
S. Seitzinger (IGBP) &
E. Mayorga (Univ. Wash)

Spatial variation of nutrient loads and sources within LMEs- Bay of Bengal LME

Dissolved Inorganic Nitrogen (DIN) yield (kg/sq.km/yr)

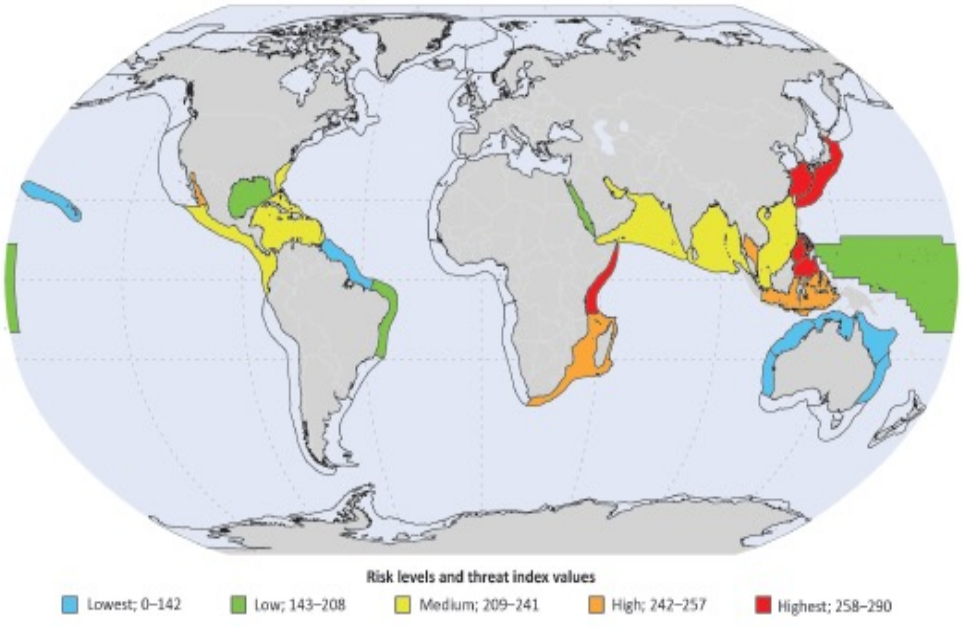


Primary DIN sources



- Illustration of variability at sub-LME scale and why it is important to consider smaller scales
- Shows which basins in the LME are the most affected and the major sources of nutrients – important for management interventions

Ecosystem health: Reefs at risk index



When integrated local threat is combined with past thermal stress (1998 -2007)- the proportion of LMEs with 50 per cent or more of their coral reef area at 'high' or 'highest' threat almost doubles.

For the WPWP, the extent of area under 'high' to 'highest' threat increases to between 11 - 26.4 %.

- By 2030 due to ocean warming and acidification most LMEs will have more than 50% coral reef area at high and critical threat levels

C. McOwen & M. Jones (UNEP-WCMC)

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Global patterns of risk

Integrating multiple indicators:

Cumulative Human Impacts

Ocean Health Index

Multivariate analysis (biophysical indicators & HDI)

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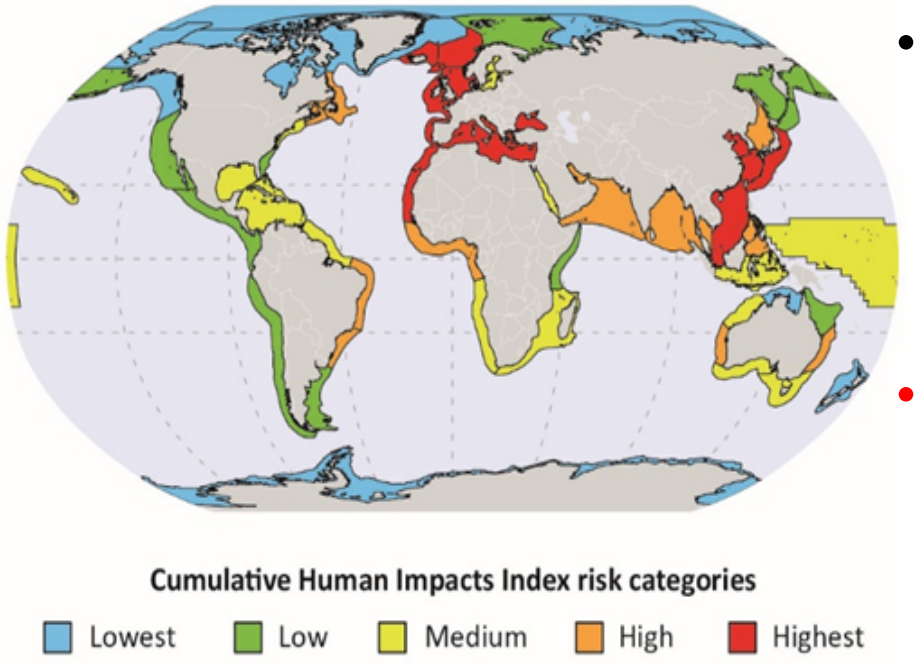
Cumulative Human Impacts

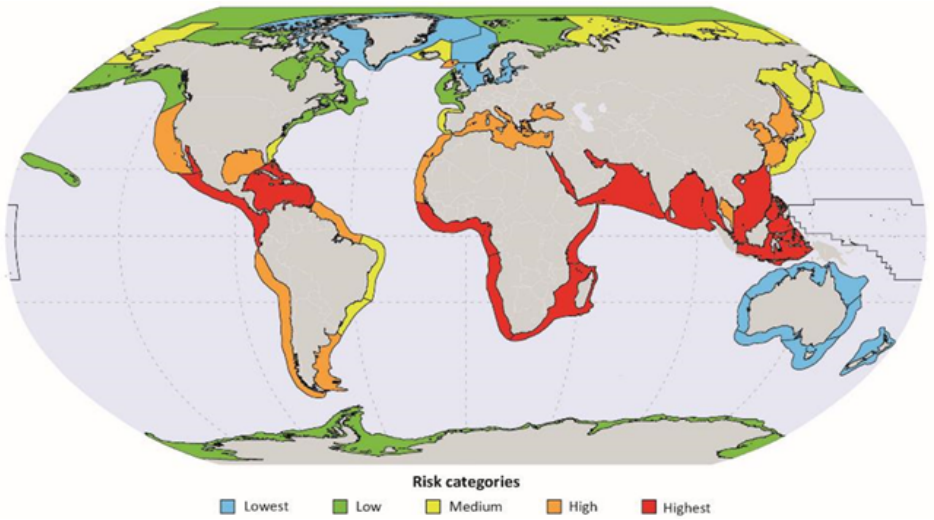


The CHI Index combines 19 measures of impacts related to: climate change, fishing, land-based pollution, and commercial activities.

B. Halpern & M. Frazier (UCSB)

- In general, LMEs adjacent to heavily populated coastlines, particularly in developed countries that encompass large watersheds, have the highest impact scores.
- The top sources of impact for nearly every LME are associated with ocean acidification and high water temperatures.
- Commercial shipping and demersal commercial fishing are the other two main stressors at the LME scale.
- At smaller scales, esp. along coastlines, stressors such as land-based pollution and fishing play a dominant role.

Ocean Health Index



The OHI measures progress towards achievement of ten widely-agreed public goals for healthy oceans, including food provision, carbon storage, coastal livelihoods and economies, and biodiversity.

- The LMEs with the lowest OHI scores are long the equator, suggesting that priority should be given to improving LME health in tropical regions.
- The highest scoring LMEs are around Australia and in the sub-polar North Atlantic.
- Ocean health tends to score lower where coastal habitats are degraded or destroyed. Habitat restoration and protection is therefore a key strategy for improving ocean health.

B. Halpern et al (UCSB)

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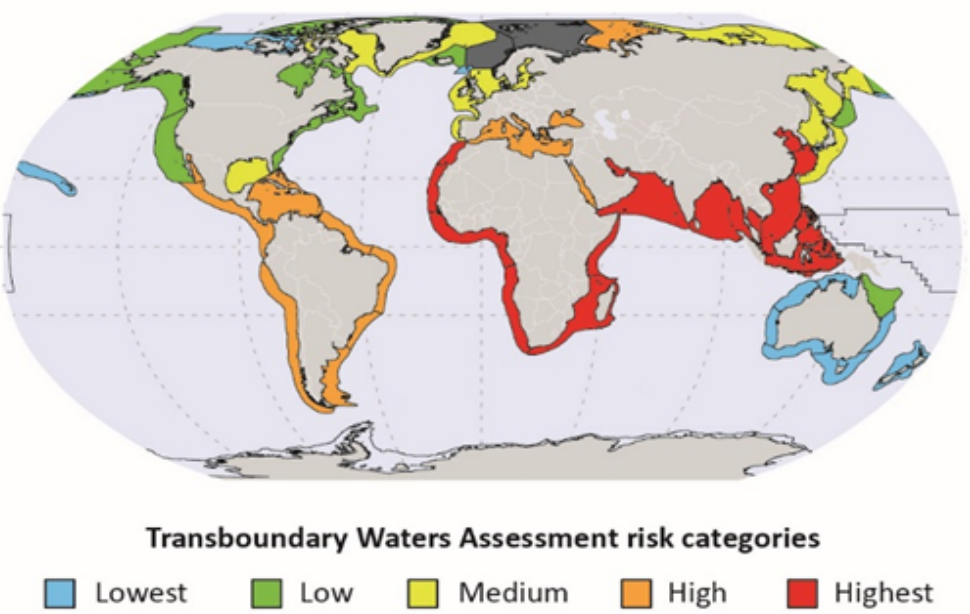
Overall patterns of risk- multiple indicators

- An overall risk score produced based on selected fisheries, pollution, and ecosystem health indicators .
- Score adjusted using the Human Development Index, to rank LMEs (ONE of MANY WAYs to rank LMEs)



Lowest risk: the Australian and New Zealand Shelf LMEs

Low risk: the coastal waters of the US and Canadian LMEs

Medium risk: LMEs with largely rural coastal areas of developed countries, such as the East Siberian Sea, or LMEs surrounded by developed countries with frequented shipping routes

High risk: includes the Mediterranean and LMEs in South and Central America

Highest risk: LMEs fringed by developing countries in Africa and Asia

K. Kleisner & L. McManus et al

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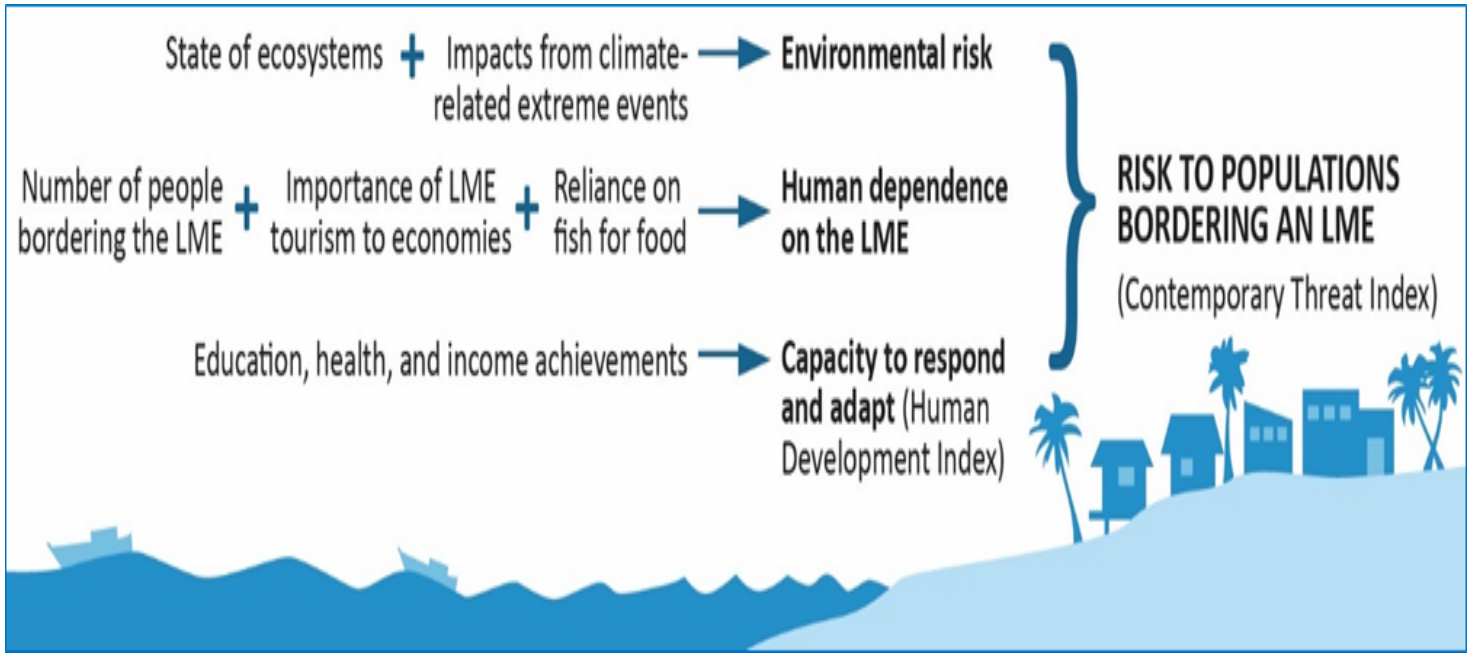
Socio-economics: Consequences for humans- Human dependence and vulnerability

Contemporary Threat Index: Incorporates measures of:

- Environmental risk (environmental degradation & climate change)
- Dependence on LME resources (coastal population, tourism, fisheries)
- Capacity to respond/adapt to threats (HDI)



L. McManus & M. Estevanez

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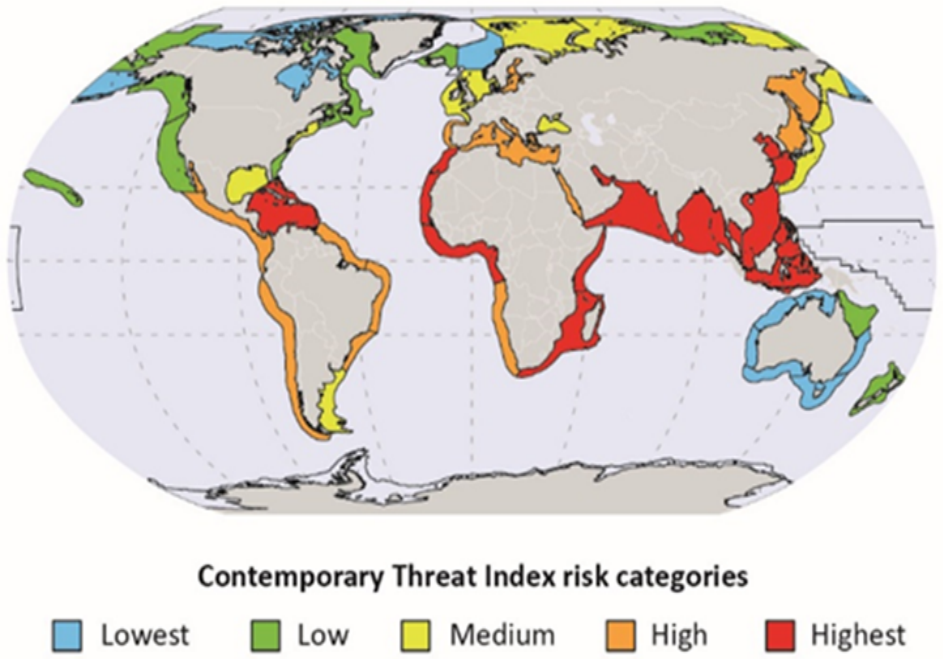
Contemporary Threat Index



- Coastal populations in highly populated tropical regions are the most at risk.
- Populations with the highest risk levels border the Bay of Bengal, Canary Current, Gulf of Thailand, South China Sea, Sulu-Celebes Sea, and Somali Coastal Current LMEs.

Sustainability targets: Enhanced human wellbeing within limits of healthy ecosystems.

L. McManus & M. Estevanez

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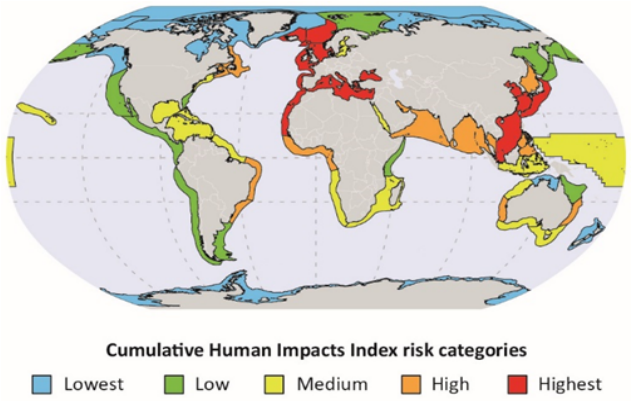
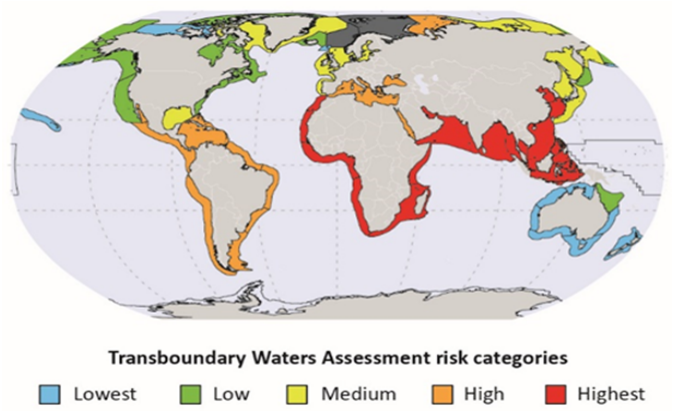
Global patterns of risk- 4 different lenses, similar story

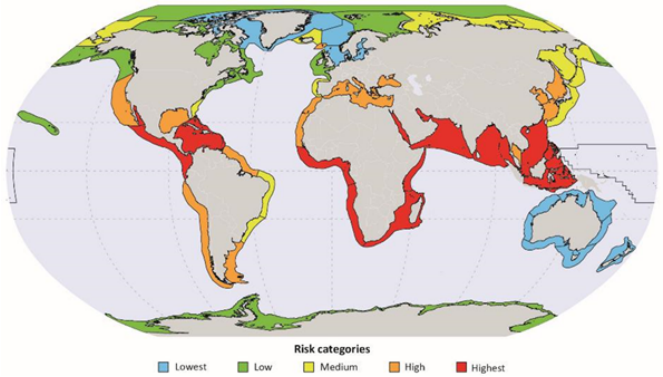
Cumulative Human Impact



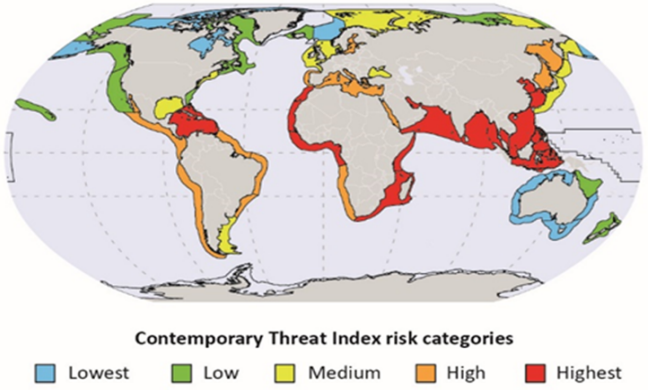
Overall risk – biophysical indicators & HDI



Ocean Health Index



Contemporary Threat Index



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Governance: Transboundary governance arrangements

Formal governance arrangements for transboundary agreements on fisheries, pollution, and habitat destruction/biodiversity in the 49 multi-country LMEs and the Western Pacific Warm Pool were assessed using three indicators:

1. **Integration** of institutions in addressing transboundary issues is generally poor, with over 60 per cent of LMEs being in the highest risk category. Greater emphasis needs to be placed on collaboration in transboundary governance. Specifically, organizations involved with fisheries governance in many LMEs are currently disconnected from those involved with pollution and biodiversity.
2. **Engagement** of countries in governance arrangements is generally good, reflecting a high level of commitment on transboundary issues.
3. **Completeness** of governance arrangements is moderate overall. Current and new agreements should cover all stages of the policy cycle. Strong, knowledge-based arrangements that include measures for accountability, monitoring, and evaluation are needed for adaptive management.

L. Fanning (Univ. Dal), R. Mahon (CERMES) et al

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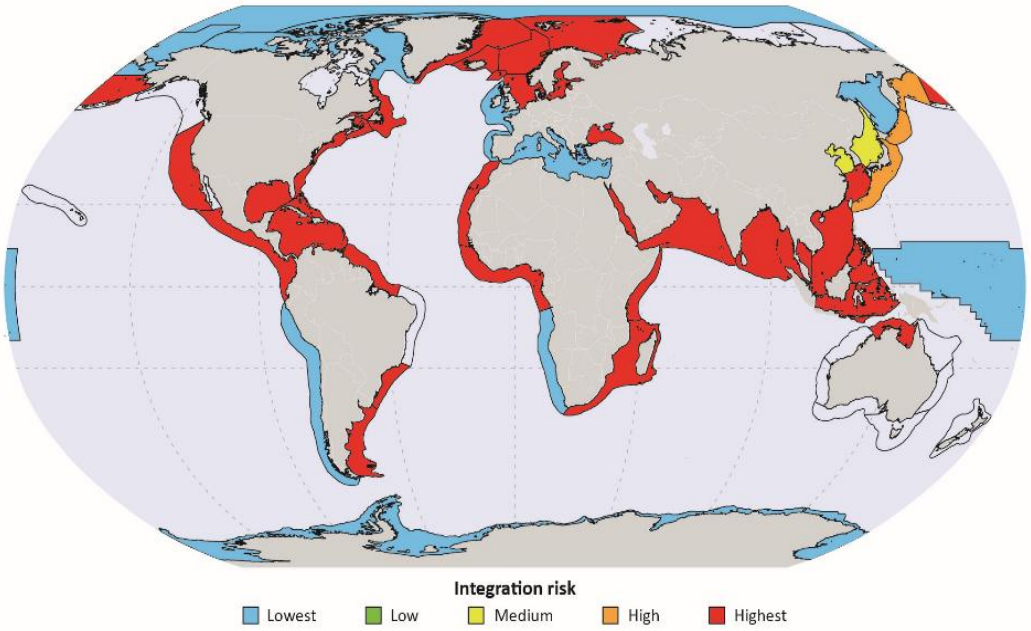
Governance arrangements: Integration

Global distribution of levels of integration and perceived risk for 49 transboundary LMEs and the Western Pacific Warm Pool (WPWP)



- Lowest level of risk: 6 LMEs in the North Polar region; the Antarctic, Benguela Current, Humboldt Current, and Mediterranean LMEs; LMEs adjacent to countries in the European Union; and the WPWP.
- 31 LMEs were assigned the highest risk level indicating that a sectoral approach to developing and implementing issue-specific agreements may be in place.
- The Mediterranean has the lowest risk across the three governance indicators. It has an overarching integrating mechanism to address transboundary issues.

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Key messages

- LMEs in developing regions (GEF-eligible) are at highest potential risk.
- LMEs experience a range of stressors that are largely anthropogenic, and local and regional in scale. But global threats (warming seas and acidification) are projected to play an increasing role in determining LME condition.
- Under a business as usual scenario, risks levels in a number of LMEs are projected to rise in the future due to factors such as increasing nutrients inputs from watersheds, warming seas, and increasing coastal populations.
- There is much room for improvement in transboundary governance arrangements in LMEs.
- Data availability constraints need to be addressed.

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Key messages (cont'd)

- Degraded LMEs have potentially severe consequences for dependent human communities. Degrading LME conditions and climate related risks are **additional** burdens for socioeconomically compromised coastal populations of mostly tropical LMEs. Coastal populations in developing regions are most at risk.
- Maintaining LME health is critical in helping countries to achieve SDG targets esp. those related to hunger (SDG #2), poverty reduction (SDG#1), and sustainable use of the oceans, seas, and marine resources for sustainable development (SDG #14). Regular assessment of LMEs can contribute to evaluating progress towards these targets.

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Data challenges

- Global data sets are needed for a global comparative assessment
- Global datasets were available only for a limited number of indicators
- Where available, there can be significant level of uncertainty in the reliability for certain indicators as well as spatial and temporal gaps
- Model estimates were relied on for a number of the indicators assessed
- Need for validation (ground-truthing) of modelled estimates and remotely sensed data, and improvement in quality of empirical data.

Downscaling of LME indicators

- The TWAP LMEs assessment was a global assessment at the scale of the entire LME, using global datasets

- But there can be within-LME variations, as illustrated by the spatial variation in nutrient inputs and sources from different watersheds in the Bay of Bengal LME

- Therefore, downscaling to sub-LME scale (e.g., country scale) will be necessary to develop management interventions at the appropriate scale and to support SDG reporting by countries

- All the indicators can be assessed at smaller (or bigger) geographic scales, if data are available at these scales

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One Shared Ocean

Search for an LME or click on the map

Click here to choose an LME

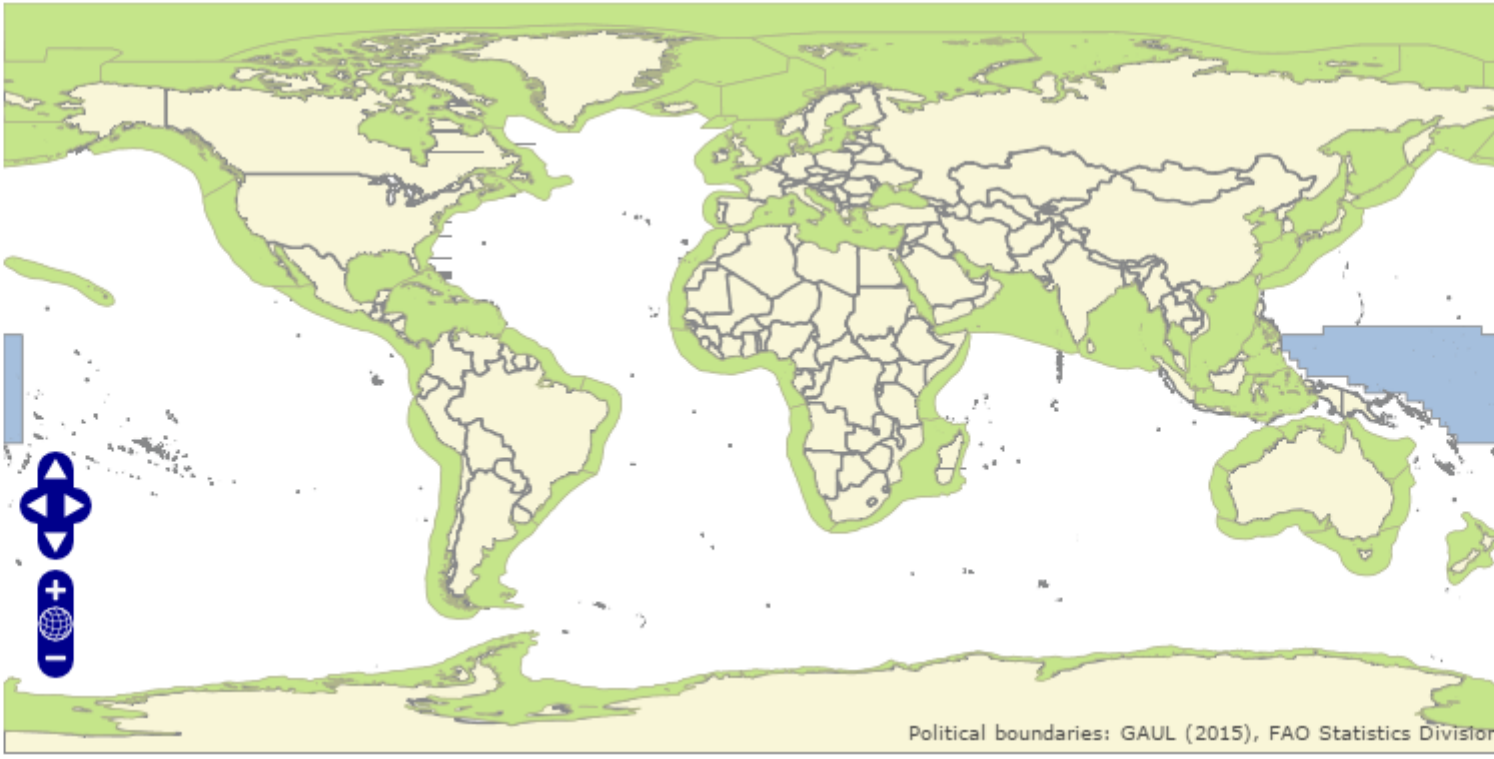
Read about LMEs

Assessment methodology

- LMEs
- Productivity
- Fish & Fisheries
- Pollution
- Ecosystem health
- Socio-economics
- Governance

Patterns of risk among LMEs

Western Pacific Warm Pool



Information on the status of the Large Marine Ecosystems (LMEs), based on the TWAP LMEs assessment is represented through a series of indicators and indices, arranged according to the five LME modules Productivity, Fish and Fisheries, Pollution and Ecosystem Health, Socio-economics and Governance. In addition, patterns of risk among LMEs from human activities are explored by integrating multiple indicators. Some of the indicators are also presented for the Western Pacific Warm Pool (WPWP). The 66 LMEs are displayed in green on the above map, and the WPWP is displayed in blue.

PDF

Download all factsheets

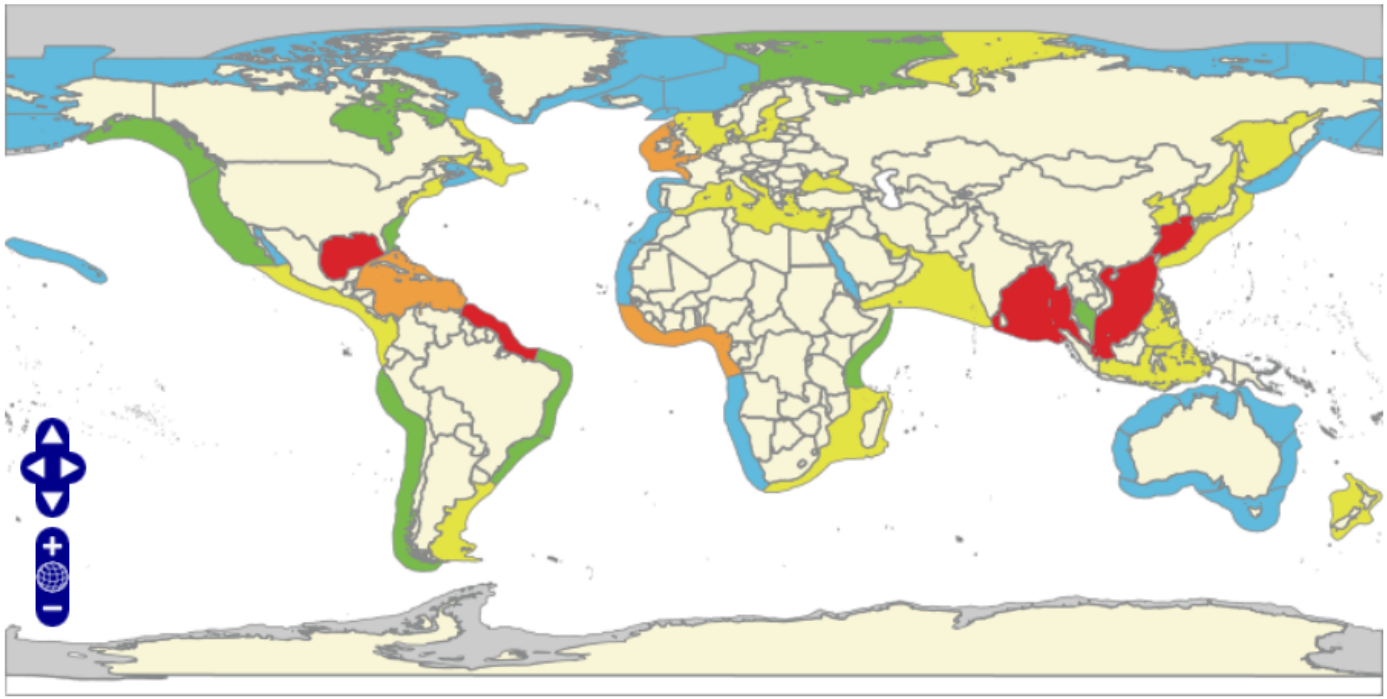
(get individual factsheets from each LME page)

Presentation of results: Global view

Read more about LMEs

- **LMEs**
- **Productivity**
- **Fish & Fisheries**
- **Pollution**
  - **Nutrients**
    - ICEP
    - ICEP (2030)
    - ICEP (2050)
    - DIN loading
    - DIN loading (2030)
    - DIN loading (2050)
    - Merged indicator
    - Merged indicator (2030)
    - Merged indicator (2050)
  - **Plastics**
  - **POPs**
- **Ecosystem health**
- **Socio-economics**
- **Governance**

Global Comparative Assessment



Projection of DIN loading to 2030, categorized from the lowest (1) to the highest (5) values

Source: E. Mayorga. Get data and metainformation.

Map as an image (click to display, right-click to save to a file).

Risk level:

1: Very low | 2: Low | 3: Medium | 4: High | 5: Very high | No data

Presentation of results: Individual LMEs

Gulf of Mexico

Click here to choose an LME

LME 5: Gulf of Mexico
Bordering countries:
Mexico, United States of America
LME total area:
1,530,387 km²

LME overall risk:

More information and data

- Productivity
- Fish and Fisheries
- Pollution and Ecosystem Health
  - Pollution
  - Ecosystem Health
- Socio-economics
- Governance

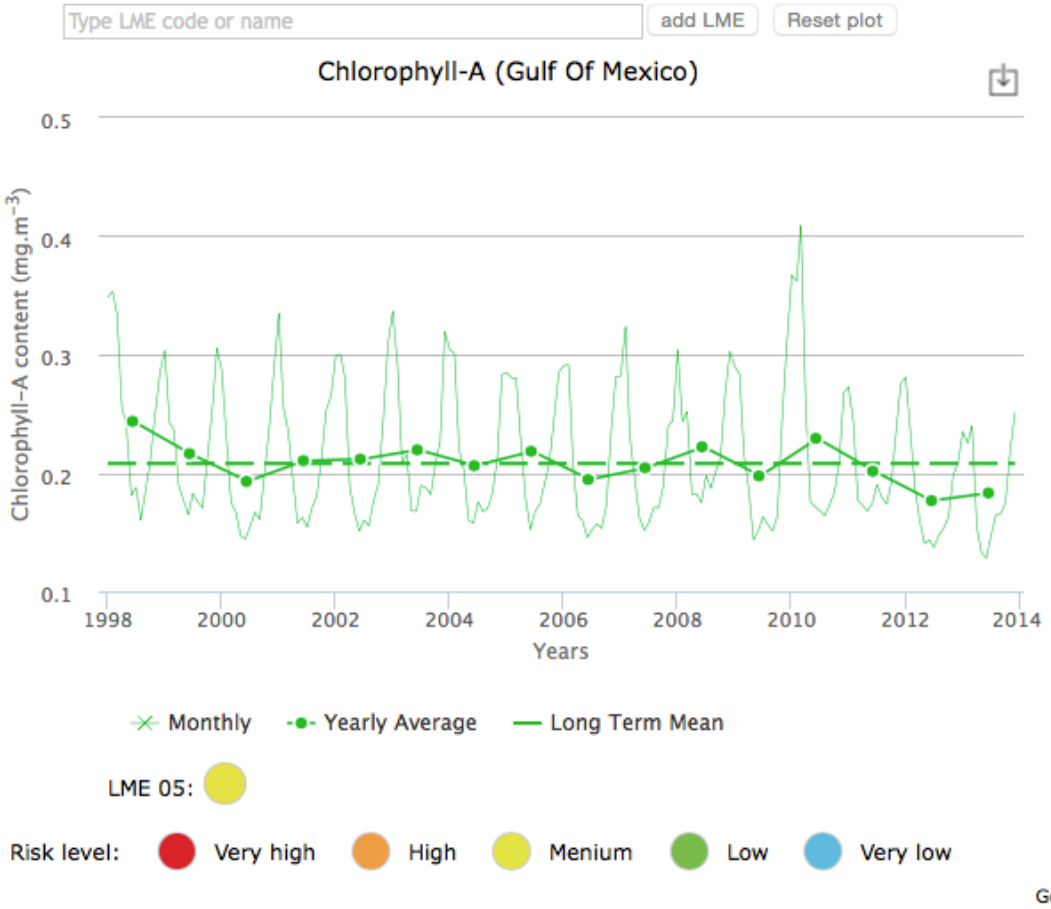
go to the LME portal

Gulf of Alaska ›

Productivity

Chlorophyll-A:

The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.297 $mg.m^{-3}$) in January and a minimum (0.159 $mg.m^{-3}$) during June. The average CHL is 0.208 $mg.m^{-3}$. Maximum primary productivity (317 $g.C.m^{-2}.y^{-1}$) occurred during 1998 and minimum primary productivity (227 $g.C.m^{-2}.y^{-1}$) during 2012. There is a statistically insignificant decreasing trend in Chlorophyll of -0.221 % from 2003 through 2013. The average primary productivity is 270 $g.C.m^{-2}.y^{-1}$, which places this LME in Group 3 of 5 categories (with 1 = lowest and 5= highest).



Productivity

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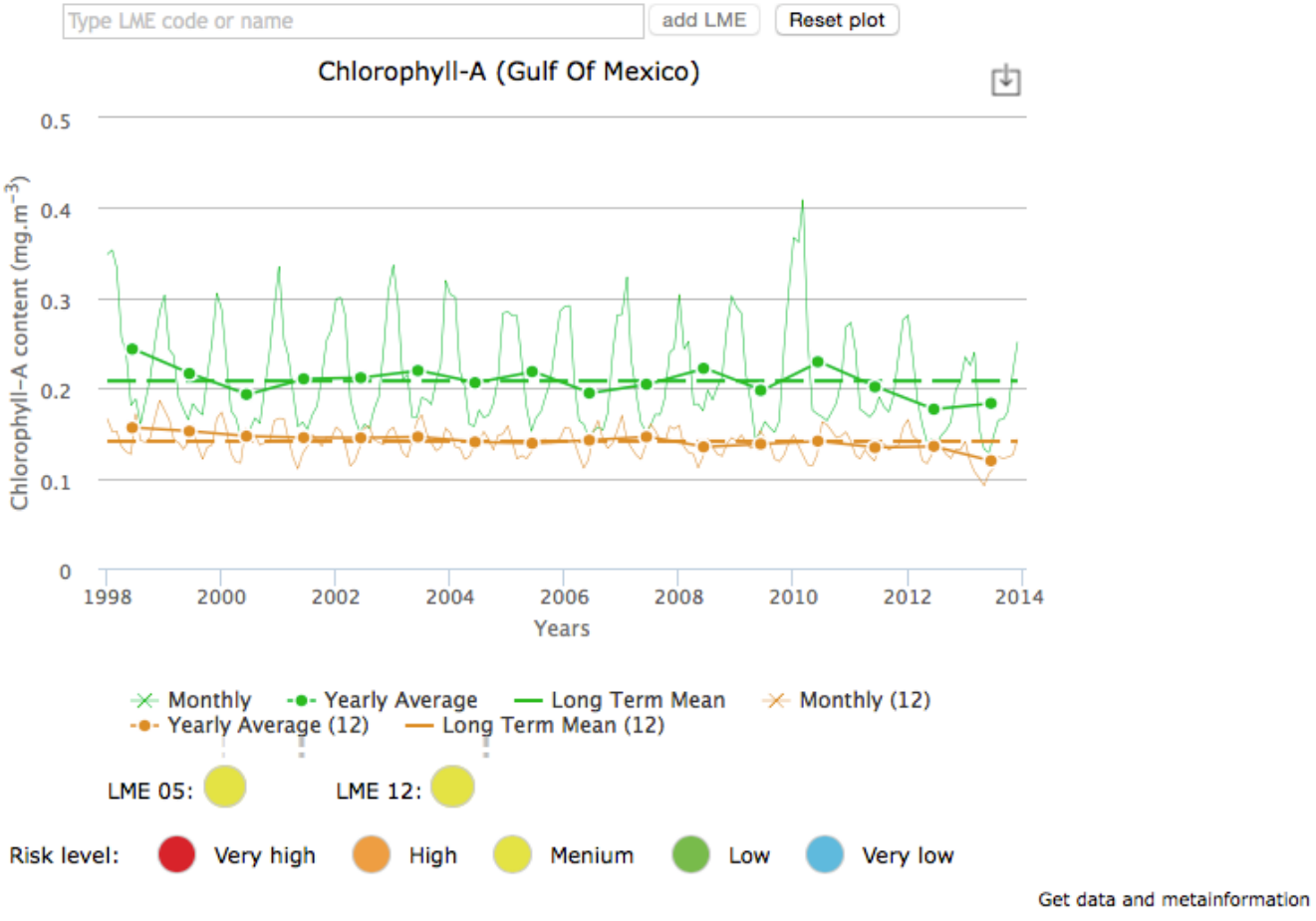
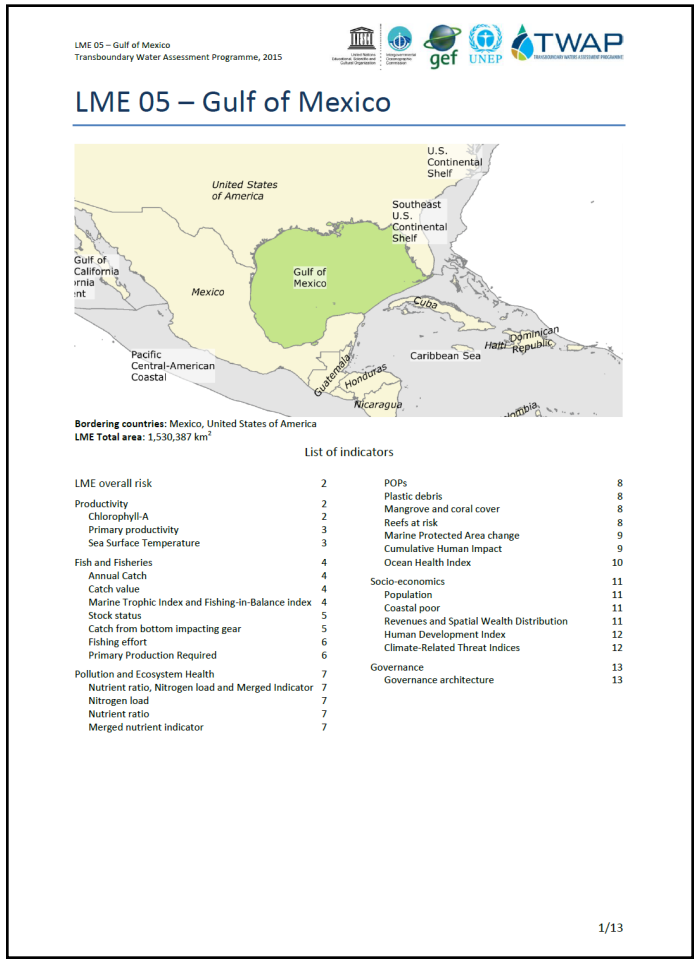


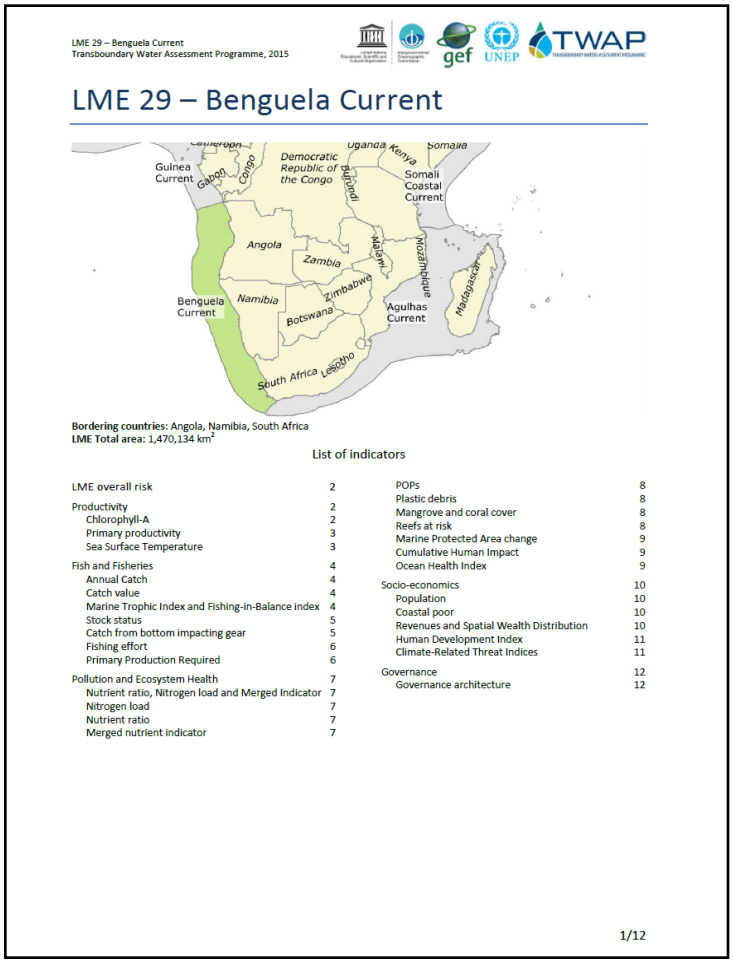
LME Factsheets- downloadable as pdf



LME 05 – Gulf of Mexico

Bordering countries: Mexico, United States of America
LME Total area: 1,530,387 km^2

List of indicators



LME 29 – Benguela Current

Bordering countries: Angola, Namibia, South Africa
LME Total area: 1,470,134 km^2

List of indicators

Sustaining TWAP LME assessment: Linkages with other assessment processes and programmes

Julian Barbiere, IOC-UNESCO

TWAP
TRANSBOUNDARY WATERS ASSESSMENT PROGRAMME

TWAP LMEs Working Group

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TWAP

TRANSBOUNDARY WATERS ASSESSMENT PROGRAMME

Thank you





UNEP

gef

UNEP-DHI CENTRE for Water and Environment

UNEP DHI

UNESCO United Nations Educational, Scientific and Cultural Organization

International Hydrological Programme

UNESCO United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

ILEC