LME 31 – Somali Coastal Current

Bordering countries: Kenya, Somali, United Republic of Tanzania.
LME Total area: 844,524 km²

List of indicators

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LME overall risk
This LME falls in the cluster of LMEs that exhibit high percentages of rural coastal population, high numbers of collapsed and overexploited fish stocks, as well as high proportions of catch from bottom impacting gear.

Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very high.

<table>
<thead>
<tr>
<th>Very low</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Very high</th>
</tr>
</thead>
</table>

Productivity

Chlorophyll-A
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.306 mg.m\(^{-3}\)) in August and a minimum (0.107 mg.m\(^{-3}\)) during April. The average CHL is 0.193 mg.m\(^{-3}\). Maximum primary productivity (336 g.C.m\(^{-2}.y\(^{-1}\)) occurred during 2003 and minimum primary productivity (225 g.C.m\(^{-2}.y\(^{-1}\)) during 2011. There is a statistically insignificant decreasing trend in Chlorophyll of -31.7% from 2003 through 2013. The average primary productivity is 277 g.C.m\(^{-2}.y\(^{-1}\), which places this LME in Group 3 of 5 categories (with 1 = lowest and 5= highest).
Primary productivity

Sea Surface Temperature

From 1957 to 2012, the Somali Coastal Current LME #31 has warmed by 0.55°C, thus belonging to Category 3 (moderate warming LME). The Somali Current warmed rather steadily since 1957 until present. During the warm event of 1998, SST peaked at the all-time maximum of 27.7°C. Cold/warm events at the southern periphery of the Somali Current likely affected the Agulhas Current LME #30 through sporadic southbound leakages. On the northern end, the Somali LME has no LME neighbor and its connection to the Arabian Sea LME #32 is tenuous at best. Yet the all-time maximum of 1998 (El Niño year) occurred simultaneously in both LMEs and was observed more or less synchronously around the entire Indian Ocean. This synchronism could only have resulted from large-scale forcing such as the El Niño 1997-1998.
Fish and Fisheries

Over half of the reported landings in the Somali Coastal Current LME consist of "mixed groups". This LME notably contains a high level of subsistence and artisanal fisheries, which are confined to its inshore areas. Consequently, oceanic fisheries in the LME are dominated by distant-water fishing fleets from Europe and East Asia. Due to the poor quality of the available landings statistics in the region, the majority of the landings in the LME can only be classified as 'unidentified marine fish', making interpretation of the status of marine fisheries in the LME extremely difficult.

Annual Catch

Total reported landings in the LME showed a general increase over the reported period, but with marked fluctuations, recording 50,000 t in 2004.

Catch value

The value of the reported landings peaked in 2001 at around 100 million US$ (in 2005 real US$), and in the last 10 years between 38-50 million US$.

Marine Trophic Index and Fishing-in-Balance index

Due to the high proportion of unidentified catches in the underlying statistics, the MTI and the FiB index of the reported landings estimated for this LME should not be viewed as good indicators of the state of its fisheries, i.e., the increase in the MTI from 1950 to the mid-1970 is likely a result of the improvement in the taxonomic details of the reported landings; the increase in the FiB index during this period seems to be informative, as it suggest the spatial expansion of fisheries in the region.
decrease in FiB index from mid-1990 indicates that the ecosystem is impaired by the removal of excessive levels of biomass.

Stock status
The Stock-Catch Status Plots show that the number of overexploited stocks is higher than that of collapsed or fully exploited stocks, and the overexploited stocks contribute almost half of the total catch biomass.

Catch from bottom impacting gear
The percentage of catch from the bottom gear type to the total catch reached its first peak at 15% in 1980 and then declined. In the recent decade, this percentage fluctuated around 4%.
Fishing effort
The total effective effort increased from around 3 million kW in the 1950s to its peak at 72 million kW in the early 2000s. In the recent few years, the fishing effort kept declining.

Primary Production Required
The primary production required (PPR) to sustain the reported landings in the LME is low, reaching 2.5% only in recent years.
Pollution and Ecosystem Health

**Nutrient ratio, Nitrogen load and Merged Indicator**

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans. An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

**Nitrogen load**

The Nitrogen Load risk level for contemporary (2000) conditions was very low (level 1 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a “current trends” scenario (Global Orchestration), this increased to low in 2030 and remained low in 2050.

**Nutrient ratio**

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was low (2). According to the Global Orchestration scenario, this remained the same in 2030 and increased to moderate in 2050.

**Merged nutrient indicator**

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this increased to low in 2030 and remained low in 2050.
POPs
Four samples at four locations, mainly from Kenya, are available. This LME shows low average concentrations (ng.g\(^{-1}\) of pellets) of 25 (range 1-42 ng.g\(^{-1}\)) for PCBs and 10.5 (range 2-16 ng.g\(^{-1}\)) for DDTs, both corresponding to risk category 2, while trace average concentration of 0.6 (range 0.1-0.9 ng.g\(^{-1}\)) for HCHs corresponding to risk category 1, of the five risk categories (1 = lowest risk; 5 = highest risk). All locations in Kenya had higher concentrations of PCBs (15 – 42 ng.g\(^{-1}\)) and DDTs (11 – 16 ng.g\(^{-1}\)) than background levels (10 and 4, respectively). Current emission of PCBs from e-waste or old equipment may occur and the application of DDT pesticide for Malaria control may contribute. More locations should be monitored in this LME.

<table>
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<tr>
<th>Locations</th>
<th>Avg. (ng/g)</th>
<th>Risk</th>
<th>Avg. (ng/g)</th>
<th>Risk</th>
<th>Avg. (ng/g)</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCBs</td>
<td>25</td>
<td>2</td>
<td>10</td>
<td>2</td>
<td>0.6</td>
<td>1</td>
</tr>
<tr>
<td>DDTs</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>HCHs</td>
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</tbody>
</table>

Legend:
- Very low
- Low
- Medium
- High
- Very high

Plastic debris
Modelled estimates of floating plastic abundance (items km\(^{-2}\)), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with relatively moderate levels of plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The high values are due to the relative importance of these sources in this LME. The abundance of floating plastic in this category is estimated to be on average over 12 times lower that those LMEs with lowest values. There is very limited evidence from sea-based direct observations and towed nets to support this conclusion.

Ecosystem Health

Mangrove and coral cover
0.15% of this LME is covered by mangroves (US Geological Survey, 2011) and 0.46% by coral reefs (Global Distribution of Coral Reefs, 2010).
Reefs at risk
This LME has a present (2011) integrated threat index (combining threat from overfishing and destructive fishing, watershed-based and marine-based pollution and damage) of 282. 23% of coral reefs cover is under very high threat, and 40% under high threat (of the 5 possible threat categories, from low to critical). When combined with past thermal stress (between 1998 and 2007), these values increase to 51% and 37% for very high and high threat categories respectively. By year 2030, 29% of coral cover in this LME is predicted to be under very high to critical level of threat from warming and acidification; this proportion increases to 63% by 2050.

Marine Protected Area change
The Somali Coastal Current LME experienced an increase in MPA coverage from 544 km$^2$ prior to 1983 to 5,489 km$^2$ by 2014. This represents an increase of 910%, within the low category of MPA change.

Cumulative Human Impact
The Somali Coastal Current LME experiences an average overall cumulative human impact (score 3.44; maximum LME score 5.22), but which is still well above the LME with the least cumulative impact. It falls in risk category 2 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (1.04; maximum in other LMEs was 1.20), UV radiation (0.52; maximum in other LMEs was 0.76), and sea surface temperature (1.67; maximum in other LMEs was 2.16). Other key stressors include sea level rise and ocean based pollution.
Ocean Health Index

The Somali Coastal Current LME scores below average on the Ocean Health Index (score 61 out of 100; range for other LMEs was 57 to 82). This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 decreased 5 points compared to the previous year, due in large part to changes in the scores for natural products and clean waters. This LME scores lowest on mariculture, natural products, coastal protection, carbon storage, tourism & recreation, sense of place, and clean waters goals and highest on artisanal fishing opportunities and coastal livelihoods & economies goals. It falls in risk category 5 of the five risk categories, which is the highest level of risk (1 = lowest risk; 5 = highest risk).
Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 298 926 km$^2$. A current population of 15 672 thousand in 2010 is projected to increase to 92 037 thousand in 2100, with a density of 52 persons per km$^2$ in 2010 increasing to 308 per km$^2$ by 2100. About 64% of coastal population lives in rural areas, and is projected to decrease in share to 63% in 2100.

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<th></th>
<th>Total population</th>
<th>Rural population</th>
</tr>
</thead>
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<td>2010</td>
<td>15,671,779</td>
<td>9,996,331</td>
</tr>
<tr>
<td>2100</td>
<td>92,037,170</td>
<td>57,816,834</td>
</tr>
</tbody>
</table>

Legend:
- Very low
- Low
- Medium
- High
- Very high

Coastal poor

The indigent population makes up 49% of the LME’s coastal dwellers. This LME places in the very high-risk category based on percentage and in the high-risk category using absolute number of coastal poor (present day estimate).

Coastal poor

7,675,312

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the very low-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $103 million for the period 2001-2010. Fish protein accounts for 13% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013
$944 million places it in the very low-revenue category. On average, LME-based tourism income contributes 12% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with very high risk.

<table>
<thead>
<tr>
<th>Fisheries Annual Landed Value</th>
<th>% Fish Protein Contribution</th>
<th>Tourism Annual Revenues</th>
<th>% Tourism Contribution to GDP</th>
<th>NLDI</th>
</tr>
</thead>
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<tr>
<td>102,869,730</td>
<td>13.2</td>
<td>943,984,859</td>
<td>12.2</td>
<td>0.9097</td>
</tr>
</tbody>
</table>

**Legend:**

- Very low
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- Very high

**Human Development Index**

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the very low HDI and very high-risk category. Based on an HDI of 0.337, this LME has an HDI Gap of 0.663, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks. HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the medium risk category (high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a very high-risk category (very low HDI) because of reduced income levels and increased population values from those estimated in a sustainable development scenario.

<table>
<thead>
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<th>HDI 2100</th>
<th>HDI SSP1</th>
<th>HDI SSP3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3370</td>
<td>0.7468</td>
<td>0.2570</td>
</tr>
</tbody>
</table>

**Climate-Related Threat Indices**

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure. The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (e.g. overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m² in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.
Present day climate threat index of this LME is within the very high-risk (very high threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is very high. In a sustainable development scenario, the risk index from sea level rise in 2100 is medium, and increases to very high risk under a fragmented world development pathway.

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2100</th>
<th>SSP1</th>
<th>SSP3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate Threat</td>
<td>0.7870</td>
<td>0.5404</td>
<td>0.5143</td>
<td>0.7791</td>
</tr>
<tr>
<td>Contemporary Threat</td>
<td>0.5143</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
</tbody>
</table>

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