❖Red Sea: LME

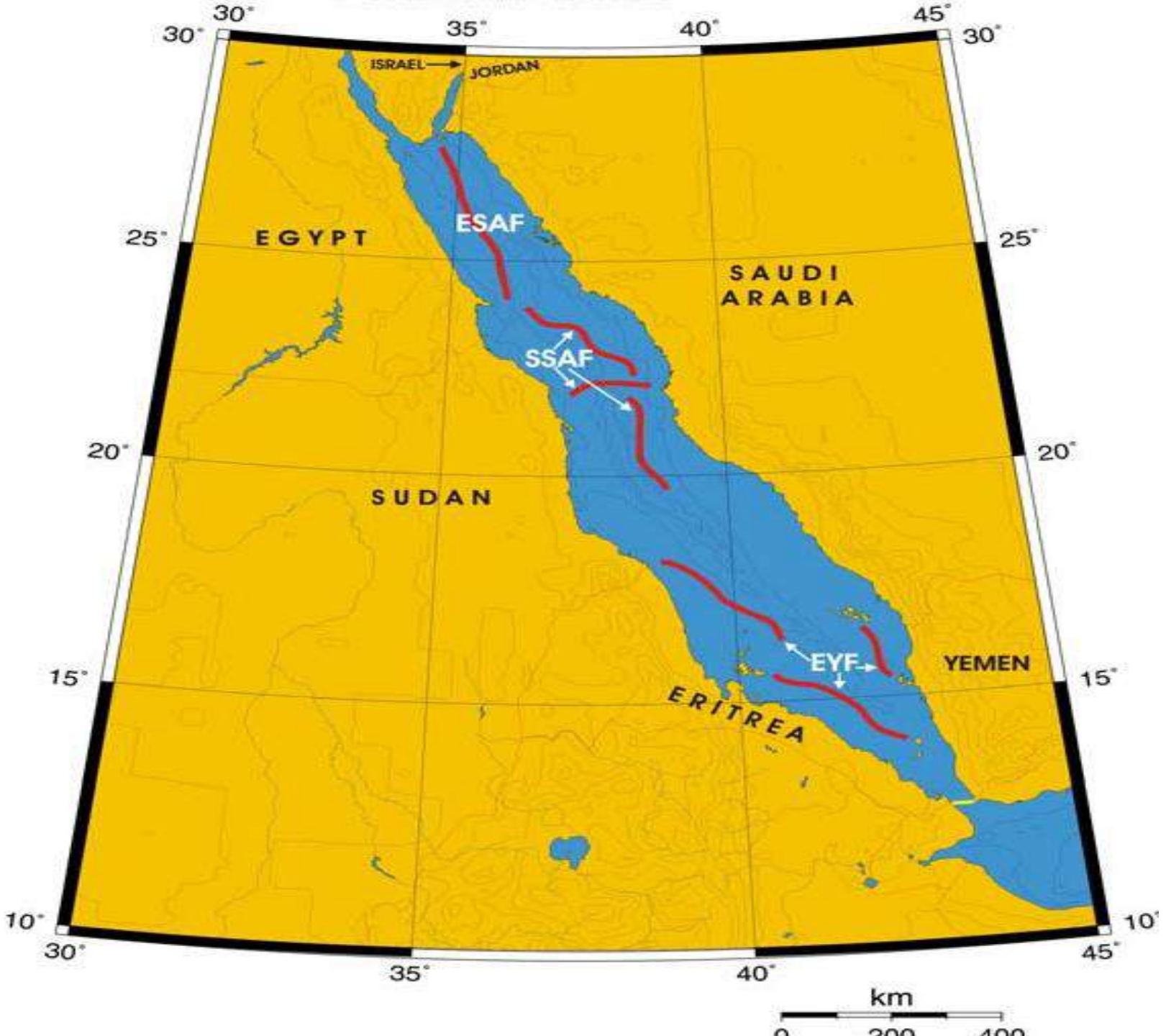
- The Red Sea LME is bordered by Djibouti, Egypt, Eritrea, Palestine, Jordan, Saudi Arabia, Sudan and Yemen. It has a surface area of 458,620 km^2, of which **2.33% is protected** and includes **3.8% of the world's coral reefs** .

- It is characterised by **dense**, **salty** water formed by **net evaporation** with rates up to 1.4 - 2.0 m yr^{-1} .

- **High evaporation** and **low precipitation** maintain the Red Sea LME as one of the **most saline** water masses of the world oceans, with a mean surface salinity of **42.5 ppt** and a mean temperature of **30°** C during the summer.

- Three **depressions greater** than **2,000** m in depth occur in the axial trough of the LME.
- Here the water is **heated** by **mineral-rich thermal vents** (**hot brine** regions), reaching up to **62** °C and being enriched with **various heavy metals** such as **manganese**, **iron**, **zinc**, **cadmium** and **copper**.

- A dominant phenomenon affecting the oceanography and meteorology of the region is the **Arabian monsoon**.
- In **winter**, northeast monsoon winds extend well into the Gulf of Aden and the southern Red Sea, causing a seasonal reversal in the winds over this entire region.


30°
35°
40°
45°
30°
25°
20°
15°
10°
ISRAEL
JORDAN
EGYPT
ESAF
SAUDI
ARABIA
SSAF
SUDAN
EYF
YEMEN
ERITREA
km
0
200
400

✓Productivity

- The Red Sea LME, at **>300** g Cm^{-2} year, can be considered a Class **I**, **highly productive ecosystem**.

- Seasonal **fluctuations** in plankton **biomass** and **productivity** in the **southern** Red Sea.

- During **spring** and **summer**, the LME is **oligotrophic**,
- while in **winter** (northeast monsoon) **productivity** is **higher** in the upper layers of the **southern** Red Sea.

- During this **monsoon** period, **diatom blooms** occur and mesozooplankton biomass increases, attributed to the entrainment of nutrients from below the **thermocline** due to wind-induced mixing and winter cooling.

- The **phytoplankton** community is dominated by the **dinoflagellate** are frequent in the **open parts** of the Red Sea LME.

- The Red Sea is a net **importer** of **zooplankton** from the **Indian Ocean**, though many species do not survive the **extreme conditions** of this LME.

- The phytoplankton, zooplankton and **fish fauna** bear more **similarity** to the **Indian Ocean biota** than to the **Mediterranean** Sea.

- Its **complex reefs**, together with **extensive mangroves**, **seagrass** and **macro-algal beds** form highly productive habitats for **unique species assemblages**.

- Endemism is very high, especially among reef fishes and invertebrates, the latter including a number of dinoflagellates and euphausiids.

- Several species of marine mammals, as well as turtles and seabirds also occur in the LME.

➢ *Oceanic fronts*

- The Red Sea LME has the highest temperatures and salinities observed in the World Ocean. The extremely **high evaporation** rate leads to formation of **salinity fronts**, on which **temperature fronts** tend to develop.

- Despite the relative **uniformity** of **meteorological** conditions over the Red Sea, **fronts emerge** owing to **wind-induced upwelling**.

- Three groups of fronts are distinguished north to south:

  (1) Egypt-Saudi Arabia Front (ESSF).
  (2) Sudan-Saudi Arabia fronts (SSAF).
  (3) Eritrea-Yemen fronts (EYF).

- ***Red Sea LME SST***

- **Linear** SST **trend** since 1957: **0.29°C**. Linear SST trend since **1982**: **0.74°C**.

- The **long-term warming** of the Red Sea is modulated by **moderate-to-strong decadal** variability while **interannual variability** is relatively **small**.

- The warming event peaked in 1969 at >**28.5°C**. This mark has not been surpassed since, even in 1998- 1999, during and after the **strongest El-Niño** of the last 50 years, when **SST** reached **28.5°C** in 1999.

- The **coolest** event bottomed out in **1975** at <**27.5°C**.

- the **present period** can be considered as a **warm one**.

- The Red Sea **circulation** features a series of **eddies** or **sub-gyres** that vary spatially and temporally **depending** mostly on **wind forcing** .

- **The Red Sea response to wind forcing strongly depends on wind direction:**

✓ Along-axis winds do not interact with the surrounding topography.

✓ whereas cross-axis winds interact with high, steep mountains surrounding the Red Sea, resulting in a highly structured wind field conducive to oceanic eddy formation, oceanic eddies modulate SST.

✓ long-term variability of the Indian monsoon could strongly affect SST field in the Red Sea.

❖Fish and Fisheries

- ✓ About **1,200** species of **fish** are known to occur in the **Red Sea LME**.
- ✓ Marked **differences occur** in **fish species richness**, **assemblage compositions** and species **abundance** in **different parts** of the Red Sea, **reflecting** the **heterogeneous nature** of its **environment** .
- ✓ **Fishing** occurs mainly at the **subsistenceor artisanal levels**, although **commercial trawling** and **purse seining** are also carried out in **Egypt**, **Saudi Arabia** and **Yemen**.
- ✓ Total reported **landings** from this LME have increased **steadily**, recording over **130,000 tonnes** in **2004**, most of it in the '**mixed group**'.
- ✓ The **primary production** required to sustain the reported landing in this LME is increasing in recent years, but has yet to **reach 10%** of the observed primary production .
- ✓ A large share of the **ecological footprint** in the region is accounted for by the **countries bordering** the LME, namely **Yemen, Egypt and Saudi Arabia**.
- ✓ The fisheries of the Red Sea LME are still expanding, and therefore, they show **high and stable mean trophic levels, with a increase in the FiB index.**

❖Threat to the LME's

- ✓ **Overexploitation**, **destruction** of **spawning**, **nursery** and **inadequate resource management** and **regulations**, in conjunction with a lack of **enforcement**, are main **barriers** to the sustainable **development** of the LME's **fisheries resources**.

- ✓ The absence of effective control has also resulted in **widespread illegal fishing** and **habitat destruction** by both **national** and **foreign vessels**. these factors may pose a serious threat to the **LME's biological diversity** and **productivity**.

- ✓ The **lack** of **stock assessments** and **incomplete fisheries statistics** causes major **uncertainties** in the **status** of the LME's **fish stocks**.

- ✓ Reported **declines** in **catches** and in the **average size** of fish **landed** are indicators of **overfishing** and may **illustrate** the **incomplete nature** of the official reported landings data.

- ✓ most **fish stocks** are **assumed** to be **overexploited**. These include **finfish** and **shark** at the ecosystem scale and **mollusc** (*Strombus*), **lobster** and **shrimp** in the southern areas.

- ✓ **Overexploitation** of **shark species** is severe especially in Sudan, Djibouti and Yemen as a result of a large-scale illegal fishery for the East Asian shark fin market .

- ✓ Where such fishing practices do occur, they involve the use of small meshed nets and **dynamite** fishing.

- ✓ These practices **remove** many **reef herbivores**, resulting in **increased algal** growth with **reduced grazing pressure** on **algae** .

- ✓ **Trawl fisheries** using very **small meshes** take a wide **variety** of **small perciform fishes**.

- ✓ **By catch** from net fishing also includes **turtles**, **dugong** and **dolphins**, which almost invariably, are **discarded dead**.

- ✓ The **fisheries resources** of the Red Sea are also **stressed** by the **destruction of coastal habitats** resulting from **uncontrolled land-filling** and **land-based pollution** .

- **Pollution and Ecosystem Health**

- ***Pollution:***

✓ **sewage** is a major source of **coastal contamination** throughout the LME. Because of **rapid population growth** and **inadequate treatment** and **disposal facilities**, **poorly treated** or **untreated sewage** is dumped in coastal areas.

✓ The **input** of **nutrient-rich sewage** water also results in **eutrophication** of the coastal waters around some population centres, major **ports** and **tourist** facilities.

✓ Pollution from **solid waste** is a major problem in, although it is limited to small areas around urban centres, **coastal villages**, large tourist developments and major **shipping lanes** .

✓ **Chemical pollution** is limited to the vicinity of industrial zones and facilities, which usually discharge their effluents directly into the sea. These industries include phosphate mines, desalination plants, chemical industrial installations and oil production and transportation facilities.

- ✓ **Routine operational leaks and spills** from **oil and gas exploration** and **production** in the **Gulf** of **Suez** and the **northern** and **southern Red Sea** have resulted in **contamination** of **beaches** and water by **tar balls** and oil slicks in localised areas throughout the LME.

- ✓ The risks of **oil well blowouts**, spills and other production accidents associated with the offshore oil industry in the **northern Red Sea** constitute another significant potential environmental threat to this LME .

- ✓ **Petroleum hydrocarbon levels** are relatively high in the Gulf of Suez, with substantial oil and tar on the shores

- ✓ maritime pollution caused by **international shipping**. The Red Sea-Suez Canal is one of the world's busiest industrial shipping routes. About **25,000-30,000** ship transits occur **annually** in the Red Sea, mostly involving the transport of **petrochemical products**, including more than **100 million tonnes of oil.**

✓ *Habitat and community modification*:

- ✓ The Red Sea LME is globally renowned for its **unique** and **attractive marine** and **coastal habitats** with **high species diversity**.

- ✓ For example, the **coral community** of the Red **Sea/Gulf of Aden** is composed of more than **250 species** of **stony corals**. This is the highest diversity in any part of the Indian Ocean .

- ✓ Of these, **6%** are believed to be **endemic**. These habitats are under variable **anthropogenic pressures**, especially adjacent to **urban** and **industrial** areas, **port facilities**, major **shipping lanes** and in the vicinity of coastal **tourist** developments .

- ✓ **Mangrove degradation** is severe and **widespread** throughout the LME . Urban and tourist development in coastal areas and **extensive land filling** have contributed to the **decline** of the **region's mangroves** .

- ✓ The **combined effects** of **grazing** by **domesticated animals** and **cutting** of **mangroves** for **firewood**, **charcoal** production and construction **material** have accelerated the **degradation** of **mangroves** near major human settlements .

- ✓ **Mass mortality of mangrove trees appears** to be a serious problem along the **southern coasts of Yemen** and **Sudan**, attributed to construction activities involving **dredging** and **sediment dumping on the shore, diversion of tidal water**.
- ✓ The recently emerging and **growing shrimp** farming industry also poses a serious threat to the region's **mangroves**.

- ✓ **Mangroves** already exist near their **upper limits of temperature** and **salinity tolerance** in the Red Sea LME, which makes them very sensitive to disturbance.

❑ Red Sea coral reefs

- Recent declines have been reported in various locations

➢ Major threats to the region's coral reefs include:

- land filling and dredging for urban and **tourism developments**
- **sedimentation**
- destructive **fishing methods**
- discharge of **sewage** and other **pollutants**
- direct **damage** by **tourists** and boats in high-use areas .
- Anchor damage to corals and re-suspension of sediments and subsequent siltation caused by **passing ships** has also been implicated in the **degradation** of **coral reefs** in this LME.
- Several outbreaks of the **crown-of-thorns starfish** (**COTS**) (*Acanthaster planci*) and an increase in bio-eroding organisms such as the **urchin** *Diadema setosum* and the **coral-eating gastropods** *Drupella* and *Coralliophila* have also damaged coral reefs in some localised areas, for example, in Yemen and Djibouti.

- A **decline** of **20-30% in coral cover**, corresponding with COTS outbreaks, has been recorded at most sites surveyed in the Egyptian sector of the LME.

✓ Socioeconomic Conditions

- The Red Sea is of major socioeconomic importance to the bordering countries. Much of the urban and industrial expansion, as well as the development of tourism has occurred in the coastal zone.

- The population along the shores of the LME and the Gulf of Aden has been estimated at five million. Coastal urbanisation has been driven mainly by oil discoveries and industrialisation in or near the coastal zone and the associated new economic opportunities.

- Accompanying the rapid expansion of urban centres has been the extensive desalination of seawater to meet the demands of the population and industry in some of the countries such as Saudi Arabia.

- The contribution of fisheries to **GDP** is relatively small (**less than 1%), except** in **Yemen**, where this sector accounts for **15%** of **GDP** (FAO **2005**).
- Nevertheless, fisheries, provide food and employment for thousands of the region's inhabitants. For example, in Yemen, more than **220,000** people depend on fishing as their principal source of income (FAO 2005).

- in Djibouti, where the potential contribution to GDP could rise substantially from **0.1% to around 5%** (FAO 2005).