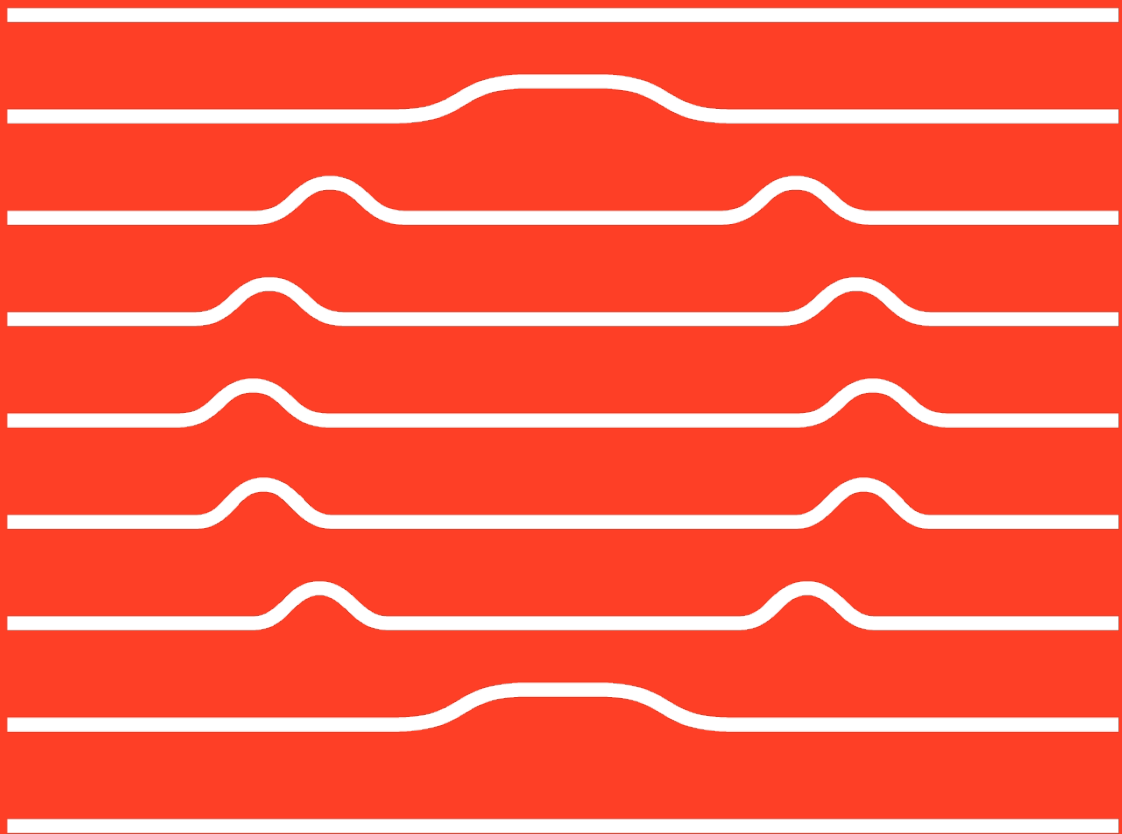




Transnational  
Red Sea  
Center

Bridging Science  
& Diplomacy for  
the Future of Corals

A Swiss initiative  
to save the last « coral refuge » on Earth



## EXECUTIVE SUMMARY



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Federal Department of Foreign Affairs FDFA

EPFL





Transnational  
Red Sea Center

Bridging Science & Diplomacy  
for the Future of Corals



## A Swiss initiative to save the last « coral refuge » on Earth

Over the past 30 years, 50% of corals have disappeared worldwide due to global warming, pollution, and other destructive human activities, and only 10% are expected to survive past 2050. The demise of coral reefs, which are of utmost importance for marine life, means the loss of the planet's most diverse ecosystems and poses a major threat for the stability of many countries and regions around the globe, where hundreds of millions of people rely on these fragile ecosystems for their existence.

But there is hope. Recent studies involving scientists from the Ecole Polytechnique Fédérale in Lausanne (EPFL) have shown that corals in the Gulf of Aqaba are extremely resistant to rising water temperatures and ocean acidification compared with corals elsewhere in the world, because of their unique evolution in the Red Sea system. Therefore, the Red Sea and the Gulf of Aqaba *de facto* represent the most promising coral *refuge* on Earth, creating real hope for the survival of at least one major coral reef ecosystem, provided that the environmental pressure exerted by human activities in the surrounding countries (Djibouti, Egypt, Eritrea, Israel, Jordan, Saudi Arabia, Sudan, Yemen) is mitigated. The preservation of the coral reefs of the Red Sea can only be achieved through collaboration at the regional scale.

The Transnational Red Sea Center, a scientific research organization based at EPFL, was created in March 2019 with the support of the Swiss Confederation to raise awareness and promote such a joint effort. An independent and non-profit organization, capitalizing on Switzerland's neutrality, its long tradition of promoting dialogue and EPFL's reputation for scientific excellence, it intends to bridge science and diplomacy in a long-term vision, aiming to:

- Understand the biological mechanisms by which the Red Sea corals have developed an extraordinary resistance to climate change that makes them unique compared to other coral reefs in the world;
- Promote environmental protection policies for the Red Sea coral ecosystem by engaging public and private actors at the regional level, not only through scientific, but also through educational and cultural collaboration;
- On the principle of Open Science, pave the way for future technological applications potentially enabling to rehabilitate other reefs worldwide

From 2022 onward, the Transnational Red Sea Center will carry out a series of scientific and cultural expeditions in close collaboration with relevant regional and international marine institutions, with the support of the Federal Department of Foreign Affairs (FDFA). At the same time, high-tech monitoring stations will be deployed in strategic locations while outreach activities will be carried out to engage the local communities in partnership with local stakeholders.

The Transnational Red Sea Center is a significant example of science for diplomacy and diplomacy for science.

## Background and Motivation

Coral reefs, host to millions of marine species, are under stress and dying from the effects of global climate change, primarily rising water temperature and ocean acidification caused by increased atmospheric CO<sub>2</sub>-levels, and from local stress, such as pollution, overfishing, and physical destruction. The last few years alone have been tragic for coral reefs around the world. Due to massive bleaching events during the warm summers of 2016 and 2017, major damage and mass mortality occurred in many reef-localities, notably the iconic Great Barrier Reef in Australia, which has now lost about 50% of its coral cover. On the current trajectory of global warming, only about 10% of the preindustrial coral reef cover is expected to survive past the year of 2050. This is a profound problem for humanity, not only because of the gigantic loss of biodiversity that results from the decline of coral reefs, but also from a socio-economic perspective: hundreds of millions of people living in tropical countries are directly depending on the services from healthy coral reefs, e.g., seafood, shore protection, and tourism.

But there is one hope for a major coral reef ecosystem to survive until the end of this century. Several recent scientific studies (including by teams at EPFL, in Israel, Jordan, and Saudi Arabia) have shown that corals in the Gulf of Aqaba and the northern Red Sea are extremely resistant to rising water temperatures, compared with corals anywhere else in the world. The reason is that these corals have, since the last ice age, evolved in a geological setting and with an environmental history that are unique to the Red Sea region. This evolution has led to extremely high resistance to increasing sea-surface temperatures.

This represents a fantastic opportunity and creates real hope for the survival of at least one major coral reef ecosystem, which might serve as a source of corals for other reef environments in the future. However, this hope rests on the necessity to protect the Red Sea reefs from future sources of environmental stress. This, in turn, requires regional-scale collaboration between scientists, lawmakers and a broad range of stakeholders, including public and private investors.

## Science for Diplomacy and Diplomacy for Science, the need for a neutral partner

All nations in the Red Sea region share a strong interest in protecting the Red Sea coral reefs. Indeed, these coral reefs are of the greatest importance to the cultural and national identities (and economies) of the Red Sea countries. At the same time, it is clear that effective scientific collaboration underpinning and informing effective coral reef protection calls for a neutral partner who can coordinate and manage the required research activities, which necessarily must be regional in scale and thus transnational in order to have a real meaning and impact.

The fundamental new idea is to use Switzerland's and EPFL's neutrality, its longstanding tradition of promoting dialogue, and its reputation for scientific excellence, to unite scientists in the Red Sea region and drive scientific collaborations among regional stakeholders, while connecting at the highest political level to promote the preservation of Red Sea corals. The Swiss Foreign Ministry has pledged its full support to this idea and is already working across the region, through its diplomatic network, to create high level links with key governmental agencies to help the planned scientific work move forward. The explicit objective of the collaboration between the Transnational Red Sea Center and the Swiss Foreign Ministry is thus to merge science and diplomacy in an effort to boost environmental protection of the Red Sea coral ecosystem.

## The short-, mid-, and long-term vision to match the timescale of global change

Four *Red Sea Coral Science Expeditions* (see below) will constitute the first phase of activity of the Transnational Red Sea Center. However, in the mid- and long-term, the Transnational Red Sea Center will increasingly federate scientists from each partner country and from a wide range of disciplines, including oceanography, biology, genetics, ecology, geology, nature conservancy, civil and environmental engineering, social science, demography, agronomy, industrial fishery, water resources, economy, informatics, and 'big data'.

The Center will make direct use of already existing research platforms in the different partner countries, for example at the Jordanian Marine Station in the Gulf of Aqaba, the InterUniversity Institute for Marine Sciences (Israel), King Abdullah University of Science and Technology (KAUST, Saudi Arabia), and marine stations along the Egyptian coast. In addition, new autonomous monitoring stations will be created in strategic localities, equipped with *state-of-the-art* instrumentation. In this way, the Center will become a virtual Environmental Science University of the Red Sea region and will have a very significant and broad international outreach, including to coral research centers in Australia, Japan, China, France, and the USA.

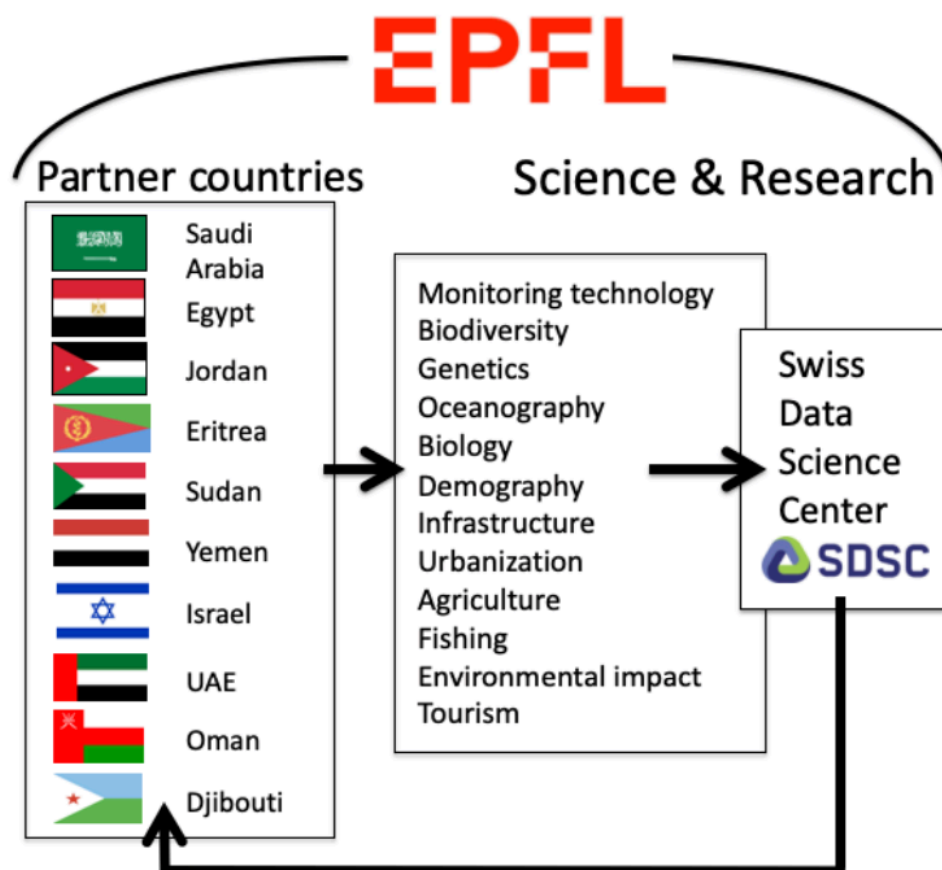
It is proposed that each government will appoint a lead scientist who will be responsible for identifying and connecting scientists in his/her country to the Center. A high-level governmental civil servant will also be appointed to act as 'bridge' and facilitator between the Center and the relevant ministries and public institutions in each country. This will create a direct link between cutting-edge science and policy-making, in a coordinated fashion, which has never existed in the region.

In parallel, diplomatic efforts will continue to bring the Red Sea countries to the table in bi-lateral and multilateral talks about coordinated protection of the Red Sea system. Scientific and diplomatic meetings, workshops, and conferences will be organized in both Switzerland and in the Red Sea countries, during which common trust will be established through a concrete demonstration of the completely transparent approach and functioning of the Transnational Red Sea Center, which is projected to function for decades to match the timescale of global change.

## Open Science, a principle at the heart of the project

Importantly, the Transnational Red Sea Center will operate according to the principle of *Open Science*, which means that all data generated by scientists representing the Center will be made fully available with a minimum of delay. To achieve this level of transparency and openness, the Center will employ a *science data expert*, who will work directly with the newly created, EPFL-based *Swiss Data Science Center* that is specialized in data management, statistics, machine learning, algorithms, optimization, and visualization.

The Swiss Data Science Center develops cutting-edge tools for data science aimed at the environmental sciences, economics, biology, life sciences, and social science to enable these scientific communities to effectively work with complex, real-world systems. The Swiss Data Science Center is thus the perfect partner for the Transnational Red Sea Center and the Red Sea countries, which will generate a multitude of highly diverse and big data sets, from genetics to economics. These data will be made available in easily accessible form to all partners, generating an extremely efficient cycle of collaboration at all levels, as illustrated schematically below.



## 2022-2025, a series of scientific expedition

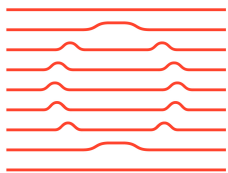
As a first step in the development of the vision described above, the Transnational Red Sea Center is launching a series of Science Expeditions during the summers of 2022 to 2025. These expeditions will cover the entire Red Sea system and beyond (the waters from where the Red Sea corals ancestors originated) and have the following scientific priorities:

- Establish the first ever Red Sea-wide coral ecosystem and biodiversity 'baseline'
- Quantitatively determine the resilience of 6-10 key coral species through systematic thermal stress testing
- Assess the environmental impact of socio-economic development and identify hotspots of environmental stress – today and in the future – along the shores of the Red Sea
- Systematically sample for water and air quality, as well as microplastics pollution
- Genetically analyze coral and environmental DNA (eDNA), shedding light on the unique evolution and biodiversity of Red Sea corals reefs in comparison with corals from the Indian Ocean, the Persian Gulf, and Great Barrier Reef (Australia).
- Use cutting-edge seascape genomics, i.e., the combination of genomic information with environmental mapping (incl. satellite remote sensing), to understand and predict the coral adaptation patterns on the scale of the entire Red Sea system.

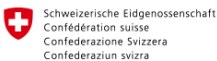
An important aspect of the planned expeditions will be the employment and testing of new technologies under challenging fieldwork conditions. As an example, these expeditions will test the most recent eDNA analytical technologies, providing on-board genetic information on reef-biodiversity, which can support sampling strategy in quasi real-time. These technical advances will be directly transferable to future expeditions and contribute strongly to the introduction of relatively small vessels into coastal oceanography.

## Bridging cultural differences

The Red Sea region is rich in cultural and religious diversity that has, in the past, led to conflict and geopolitical tension. A key objective of the Center is to unite the Red Sea countries across religious and cultural boundaries in the common pursuit of scientific knowledge that will form the basis for protection of the Red Sea corals. Science is not only the basis for effective environmental protection, it also offers a common and even platform for dialogue, permitting people of different religious conviction and cultural background to communicate effectively. The Center will therefore, through its scientific activities, contribute directly to create a peaceful dialogue between all partner-countries in the Red Sea region.



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Federal Department of Foreign Affairs FDFA

FDFA Foreign policy Travel advice & representations Living abroad Entry into Switzerland and residence

< News

Press release

Information for the media

## The FDFA supports dialogue between science and diplomacy

Press release, 19.03.2019

The coral reefs of the Gulf of Aqaba were the focus of an international conference held on Tuesday in Bern on the theme of dialogue between science and diplomacy. The head of the FDFA, Federal Councillor Ignazio Cassis, announced Switzerland's support for an EPFL project to establish a transnational Red Sea research centre.



The coral reefs of the Gulf of Aqaba are the focus of an international conference on the theme of dialogue between science and diplomacy. © EPFL/Guilhem Banc-Prandi

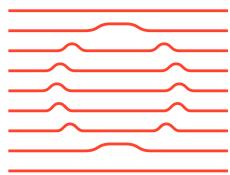
A study published in 2017 by researchers from the Swiss Federal Institute of Technology in Lausanne (EPFL) showed that corals in the Gulf of Aqaba and the Red Sea are more resistant to rising water temperatures than corals anywhere else in the world. This discovery has the potential to help restock coral reefs in other parts of the world which are more vulnerable to the effects of global warming.

Against this backdrop and in order to facilitate collaboration among the region's scientific communities, the EPFL has decided to set up a regional research facility, the Transnational Red Sea Centre.

Addressing the conference, Federal Councillor Cassis explained the reasons that motivate the FDFA to support projects that provide opportunities for dialogue between scientists and policymakers. As an innovative country with a large scientific community, Switzerland has the resources and credibility to facilitate and promote dialogue in the Red Sea region, which remains a politically and culturally fragile part of the world.

<https://www.dfae.admin.ch/eda/en/fdfa/fdfa/aktuell/news.html/content/eda/en/meta/news/2019/3/19/74383>





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## Annex - Official and scientific references

### ROYAL SOCIETY OPEN SCIENCE

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#### Research



**Cite this article:** Krueger T, Horwitz N, Bodin J, Giovani M-E, Escrig S, Meibom A, Fine M. 2017 Common reef-building coral in the Northern Red Sea resistant to elevated temperature and acidification. *R. Soc. open sci.* **4**: 170038.  
<http://dx.doi.org/10.1098/rsos.170038>

Received: 13 January 2017

Accepted: 30 March 2017

#### Subject Category:

Biology (whole organism)

#### Subject Areas:

physiology/ecology/environmental science

#### Keywords:

global climate change, coral bleaching, *Stylophora pistillata*, *Symbiodinium*, NanoSIMS, coral refugia

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Electronic supplementary material is available online at <https://doi.org/10.6084/m9.figshare.c.3744350>.

THE ROYAL SOCIETY  
PUBLISHING

## Common reef-building coral in the Northern Red Sea resistant to elevated temperature and acidification

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Coral reefs are currently experiencing substantial ecological impoverishment as a result of anthropogenic stressors, and the majority of reefs are facing immediate risk. Increasing ocean surface temperatures induce frequent coral mass bleaching events—the breakdown of the nutritional photo-symbiosis with intracellular algae (genus: *Symbiodinium*). Here, we report that *Stylophora pistillata* from a highly diverse reef in the Gulf of Aqaba showed no signs of bleaching despite spending 1.5 months at 1–2°C above their long-term summer maximum (amounting to 11 degree heating weeks) and a seawater pH of 7.8. Instead, their symbiotic dinoflagellates exhibited improved photochemistry, higher pigmentation and a doubling in net oxygen production, leading to a 51% increase in primary productivity. Nanoscale secondary ion mass spectrometry imaging revealed subtle cellular-level shifts in carbon and nitrogen metabolism under elevated temperatures, but overall host and symbiont biomass proxies were not significantly affected. Now living well below their thermal threshold in the Gulf of Aqaba, these corals have been evolutionarily selected for heat tolerance during their migration through the warm Southern Red Sea after the last ice age. This may allow them

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<https://royalsocietypublishing.org/doi/10.1098/rsos.170038>

## Thermal refugia against coral bleaching throughout the northern Red Sea

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### Funding information

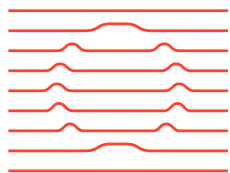
The Egyptian Ministry of Higher Education and Scientific Research, Cultural Affairs & Mission sector; ARC Future Fellowship, Grant/Award Number: FT130100202; KAUST, baseline research funds; KAUST, Grant/Award Number: CCF 1973-22-01

### Abstract

Tropical reefs have been impacted by thermal anomalies caused by global warming that induced coral bleaching and mortality events globally. However, there have only been very few recordings of bleaching within the Red Sea despite covering a latitudinal range of 15° and consequently it has been considered a region that is less sensitive to thermal anomalies. We therefore examined historical patterns of sea surface temperature (SST) and associated anomalies (1982–2012) and compared warming trends with a unique compilation of corresponding coral bleaching records from throughout the region. These data indicated that the northern Red Sea has not experienced mass bleaching despite intensive Degree Heating Weeks (DHW) of >15°C-weeks. Severe bleaching was restricted to the central and southern Red Sea where DHWs have been more frequent, but far less intense (DHWs <4°C-weeks). A similar pattern was observed during the 2015–2016 El Niño event during which time corals in the northern Red Sea did not bleach despite high thermal stress (i.e. DHWs >8°C-weeks), and bleaching was restricted to the central and southern Red Sea despite the lower thermal stress (DHWs < 8°C-weeks). Heat stress assays carried out in the northern (Hurgada) and central (Thuwal) Red Sea on four key reef-building species confirmed different regional thermal susceptibility, and that central Red Sea corals are more sensitive to thermal anomalies as compared to those from the north. Together, our data demonstrate that corals in the northern Red Sea have a much higher heat tolerance than their prevailing temperature regime would suggest. In contrast, corals from the central Red Sea are close to their thermal limits, which closely match the maximum annual water temperatures. The northern Red Sea harbours reef-building corals that live well below their bleaching thresholds and thus we propose that the region represents a thermal refuge of global importance.

### KEYWORDS

coral bleaching, global warming, refugia, remote sensing, thermal tolerance



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## Annex - Official and scientific references



POLICY AND PRACTICE REVIEWS

published: 26 February 2020  
doi: 10.3389/fmars.2020.00090



# Science, Diplomacy, and the Red Sea's Unique Coral Reef: It's Time for Action

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## OPEN ACCESS

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### Specialty section:

This article was submitted to  
Coral Reef Research,  
a section of the journal  
Frontiers in Marine Science

**Received:** 06 November 2019

**Accepted:** 03 February 2020

**Published:** 26 February 2020

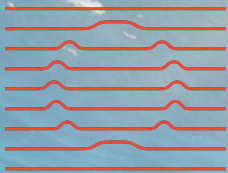
### Citation:

Kleinhaus K, Al-Sawalmih A, Barshis DJ, Genin A, Grace LN, Hoegh-Guldberg O, Loya Y, Meibom A, Osman EO, Ruch J-D, Shaked Y, Voolstra CR, Zvuloni A and Fine M (2020) Science, Diplomacy, and the Red Sea's Unique Coral Reef: It's Time for Action. *Front. Mar. Sci.* 7:90. doi: 10.3389/fmars.2020.00090

Rapid ocean warming due to climate change poses a serious risk to the survival of coral reefs. It is estimated that 70–90 percent of all reefs will be severely degraded by mid-century even if the 1.5°C goal of the Paris Climate Agreement is achieved. However, one coral reef ecosystem seems to be more resilient to rising sea temperatures than most others. The Red Sea's reef ecosystem is one of the longest continuous living reefs in the world, and its northernmost portion extends into the Gulf of Aqaba. The scleractinian corals in the Gulf have an unusually high tolerance for the rapidly warming seawater in the region. They withstand water temperature anomalies that cause severe bleaching or mortality in most hard corals elsewhere. This uniquely resilient reef employs biological mechanisms which are likely to be important for coral survival as the planet's oceans warm. The Gulf of Aqaba could potentially be one of the planet's largest marine refuges from climate change. However, this unique portion of the Red Sea's reef will only survive and flourish if serious regional environmental challenges are addressed. Localized anthropogenic stressors compound the effects of warming seawater to damage corals and should be mitigated immediately. Reefs in the rest of the Red Sea are already experiencing temperatures above their thermal tolerance and have had significant bleaching, though they too would benefit from fewer local anthropogenic stressors. The countries bordering the entire Red Sea will need to cooperate to enable effective scientific research and conservation. The newly established Transnational Red Sea Center, based at the Ecole Polytechnique Fédérale de Lausanne (EPFL), can serve as the regionally inclusive, neutral organization to foster crucial regional scientific collaboration.

**Keywords:** Red Sea, coral reef, coral bleaching, climate change, science diplomacy



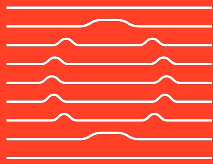


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