SECURING A FUTURE FOR CORAL REEFS

WE MUST NOT HAND AN OCEAN DEPLETED OF CORAL REEFS TO OUR NEXT GENERATION

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SECURING A FUTURE FOR CORAL REEFS

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by Carlos M. Duarte

ABOUT TWO-THIRDS OF THE GLOBAL extent of tropical coral reefs has already been lost – 14 percent of that in the last decade alone, largely as a result of climate change. Even if we reach the most ambitious goal of the Paris Agreement, 75–90 percent of those remaining are projected to disappear by 2035. Securing a future for coral reefs requires an all-hands-on-deck effort. We must mobilize scientists, technologists, innovators, policymakers and philanthropists. We need to develop and deploy at scale the next generation technologies and science that will enable us to conserve and restore coral reefs.

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RAINFOREST OF THE OCEAN, FIRST LINE OF DEFENSE OF TROPICAL SHORELINES

Tropical coral reefs are remarkable components of the world's oceans. They harbor one in every three species of named marine animals – an estimated 1 million marine species – and build the largest structures produced by any species on Earth. They are tropical shores' first line of defense against storms and cyclones, reducing damage from coastal storm flooding by over 50 percent.[1] They also support the livelihoods of over 600 million people in the tropics. In 2002, when a maximum was reached, coral reefs supported 2 percent of global fishery catches, driven by artisanal fisheries involving an estimated 6 million fishers, mostly from developing nations.[2]

Coral reefs are complex three-dimensional structures that form from the growth of coral colonies through the calcium carbonate that they deposit. Their polyps divide clonally to increase the size of their colonies, which coalesce with neighboring colonies to form reef structures that slowly grow over thousands of years, at rates of a few millimeters per year. Most of the coral reefs that exist today have developed over the past 5,000 years. There are individual living colonies that are several centuries old. These reefs dissipate wave energy and protect adjacent shorelines, typically producing a calm lagoon where seagrass and mangroves grow.

The three-dimensional complex structures that coral reefs produce provide habitat and refugia for many organisms. The most diverse coral reefs are those in the Coral Triangle, which includes the waters of Indonesia, Malaysia, the Philippines, Papua New Guinea, Timor-Leste and Solomon Islands. The Coral Triangle has the oldest seafloor in the ocean and supports the highest species diversity in the marine environment, including 600 different species of reef-building corals alone.

A FRAGILE EQUILIBRIUM

Coral polyps harbor symbiotic algae. The algae provide carbon, which is produced by photosynthesis, to feed the polyps. The polyps, in turn, shelter the algae from grazers and supply the algae with nitrogen and phosphorus.

This symbiosis is, however, fragile and can break down due to a number of stresses, including extreme temperatures, intense UV radiation, desiccation, pollution and dis- →

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ease. Under these pressures, the polyp expels the symbiont and in so doing loses the coloration that is conferred from the pigments of the algae. As a result, the corals appear white, the color of their carbonate skeleton, and are then said to be "bleached."

This is a major driver of coral loss. Without the food supplied by the photosynthetic symbiont, the polyps cannot survive. Mortality tends to be prevalent during severe bleaching events. Loss of the living coral cover leads eventually to disruption of the standing coral skeleton, which breaks down to form coral rubble. This facilitates the colonization of the coral structure by turf algae and macroalgae, which further precludes coral recovery. Indeed, bleaching events often lead to a dominance of macroalgae, particularly where nutrient availability in the environment is high.

UNDER PRESSURE

Tropical reefs today cover less than 0.1 percent of the seafloor. Assessing how much this has changed over time is difficult as there is no reliable estimate of historical coral reef cover. Initial estimates of 600,000 square kilometers were revised down to 255,000 square kilometers in the late 1990s.[3] Healthy coral reefs have a characteristic cover of living corals of about 60 percent of the reef area,[4] but a recent assessment showed that this cover declined to half that value between the 1950s and 2007.[5] Catches of fish associated with coral reefs peaked in 2002 and are in decline despite increasing fishing effort, and catch per unit-effort has decreased by 60 percent since 1950. These changes together threaten the well-being

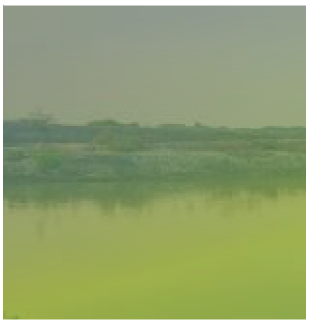
The window to conserve coral reefs is narrow and rapidly closing.

and sustainable development of those coastal human communities that are dependent on coral reef ecosystem services.

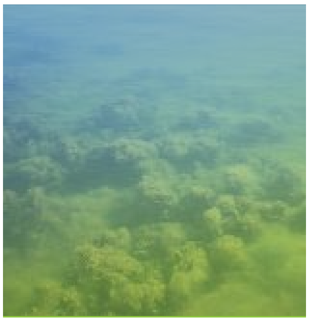
Early coral reef loss was attributable to the deforestation of watersheds and the associated siltation of coastal waters, a process that continues to lead to coral losses across the Coral Triangle. Eutrophication – an excess of nutrient inputs to coastal waters from agriculture fertilizer in runoff – leads to further losses by promoting a regime shift from corals to macroalgae, as documented in the Caribbean. Overfishing, along with mechanical impacts from anchoring and fishing activities, including dynamite fishing, which is practiced in Southeast Asia, can also lead to loss in coral cover. Deterioration of coral reefs makes them more vulnerable to natural events, such as cyclones, that may disrupt them.

However, global bleaching events attributable to climate change have emerged as the greatest threat to coral reefs. It is one that transgresses the boundaries of protected areas, so that even coral reefs in the best-managed protected areas are at risk. Heat waves in 2014–2017 alone led to global bleaching events affecting 70 percent of the world's coral reefs,[6] and there has been an estimated loss of approximately 14 percent of the world's coral since 2009.[7]

Causes of coral reef loss:



DEFORESTATION OF WATERSHEDS



EUTROPHICATION (EXCESSIVE NUTRIENTS FROM AGRICULTURAL FERTILIZERS)

OVERFISHING

GLOBAL BLEACHING EVENTS ASSOCIATED WITH CLIMATE CHANGE

PHOTO: GETTYIMAGES / DULYANUT SWDP, GETTYIMAGES / JOHNER IMAGES, GETTYIMAGES / FAHADEE.COM, GETTYIMAGES / BRETT MONROE GARNER

The Intergovernmental Panel on Climate Change (IPCC) projects that almost all the world's coral reefs (99 percent) will be lost if global warming reaches 2°C above pre-industrial levels. If global warming is limited to 1.5°C, 70–90 percent of existing coral reefs will be lost.[8,9] These estimates are derived from warming-induced bleaching alone, but ocean acidification[10] and sea level rise[11] also pose challenges to coral reefs. Even if mortality is avoided, reef accretion will not be able to keep pace with projected rates of sea level rise, with the risk that coral reefs will be flooded in the future, reducing their capacity to protect shorelines.

PHOTO: GETTYIMAGES / HOLGER LEUE

RECOVERING CORAL REEFS CARRIES THE GREATEST RISK OF FAILURE

Rebuilding the abundance of marine life by 2050 is possible across most ocean components, but because of the acute vulnerability of tropical coral reefs to climate change, rebuilding the abundance of coral reefs carries the largest risk of failure.[12]

Our capacity to restore coral reefs lags behind that of all other marine habitats, because coral-reef restoration efforts typically have a very small footprint, are expensive and slow, and may fail if the pressures that have driven the decline are not mitigated. The biggest of these is climate change. Failure to mitigate climate change thus far is raising the likelihood of catastrophic losses of coral reefs.

As a result, some scientists are giving up, accepting that coral reefs will be lost and grieving their demise, or targeting a few coral reefs that may be spared through conservation efforts.

In fact, coral reefs will not disappear altogether but, like many other components of marine ecosystems, they will adapt to climate change by shifting their biogeographic ranges toward higher latitudes where future climate regimes will be more suitable to supporting coral growth. However, given how slowly they grow, it will be some millennia from now before the coral reefs of the future ocean are in place. In the meantime, the prospect we are left with is one of an ocean depleted of coral reefs over many human generations.

SECURING A FUTURE FOR CORAL REEFS: BEYOND CONSERVATION

It is hard not to conclude that the paradigm of conservation developed in the 1990s has failed to secure a future for coral reefs. The reality is that during this time we have lost nearly two-thirds of the world´s coral reefs and are at risk of losing much of those remaining. This paradigm must, therefore, be replaced by one of net positive action, partially rebuilding coral reefs in the same way we aim at rebuilding other components of marine life.[13]

Coral reefs have a huge capacity to recover, as demonstrated by the recovery since 1958 of coral reefs in the Marshall Islands, where 76 megatons of nuclear tests caused absolute destruction.[14] Recovery timescales of coral reefs that are affected by local stressors range from a few years to more than a decade.[15] However, recovery from severe coral bleaching has taken well over a decade and will slow in the future as ocean warming shortens the interval between bleaching events. Indeed, the recovery potential of coral reefs can only be realized if the pressures responsible for their loss are removed.

Managing coral reefs for resilience therefore requires reducing the mul- →

In numbers

< 1%

The extent of the seafloor occupied by coral reefs

2/3

of tropical coral reef cover has been lost

50%

reduction in damages from storm flooding provided by coral reefs

99%

of coral reefs will be lost if global warming reaches 2°C tiple pressures that affect them, as well as effectively protecting coral reefs by including them in marine protected areas. Removing pressures requires action at sea, such as reducing overfishing and boating practices that impact on coral reefs, as well as on land, such as reducing inputs of damaging pollutants, ranging from agricultural fertilizer to plastic waste, and restoring watersheds to avoid nutrient inputs.

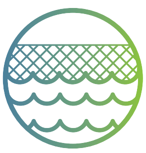
Managing for resilience may, at best, slow down losses, but not compensate for lost coral reefs. Developing innovative approaches to restoration within this decade is imperative to reverse coral losses at scale.[16] This requires an interdisciplinary approach including advanced understanding of coral biology and ecology alongside engineering approaches that take advantage of advances in material science and robotized underwater systems to scale up processes. An example of such a partnership is the recent development in 3D printing as a coral restoration technology, derived from the combined efforts of coral biologists and ecologists, material scientists, scientists working on bioengineering and bioprinting, and engineers advancing 3D printing technologies.[17]

The consequences of losing coral reefs for marine biodiversity and human livelihoods and well-being are too severe to settle for accepting loss, no matter how low the odds of reducing these losses might be.

Effectively improving the prospects for tropical corals requires broad and effective international partnerships. These are now largely in place. Next, we need a new instrument to support the development of the next generation of science and technology that will allow coral reefs to recover. The Global Coral R&D Acceleration Platform (CORDAP) is just such an instrument. Developed under the leadership of the G20 nations, it held its inaugural meeting on June 30, 2021. Chaired by the Kingdom of Saudi Arabia, with the United States as vicechair, CORDAP aims at fostering an international, interdisciplinary community of scientists and technologists who will cooperate to deliver the novel science and technology capable of ensuring the conservation and restoration at scale of coral reefs. The first projects are expected to be →

How to manage coral reefs for resilience and help them to recover

MANAGING FOR RESILIENCE



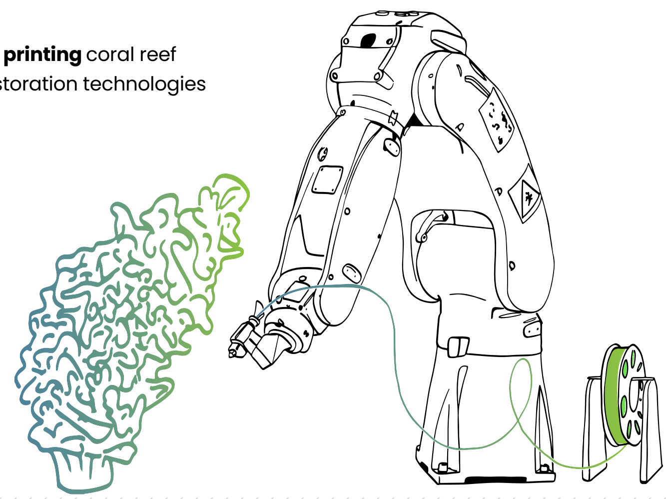
Include them in **marine protected areas**

Remove pressures at sea – **overfishing, boating practices**

Remove pressures on land – **reduce pollutants, avoid nutrient inputs**

DEVELOP INNOVATIVE APPROACHES TO RESTORATION

3D printing coral reef restoration technologies



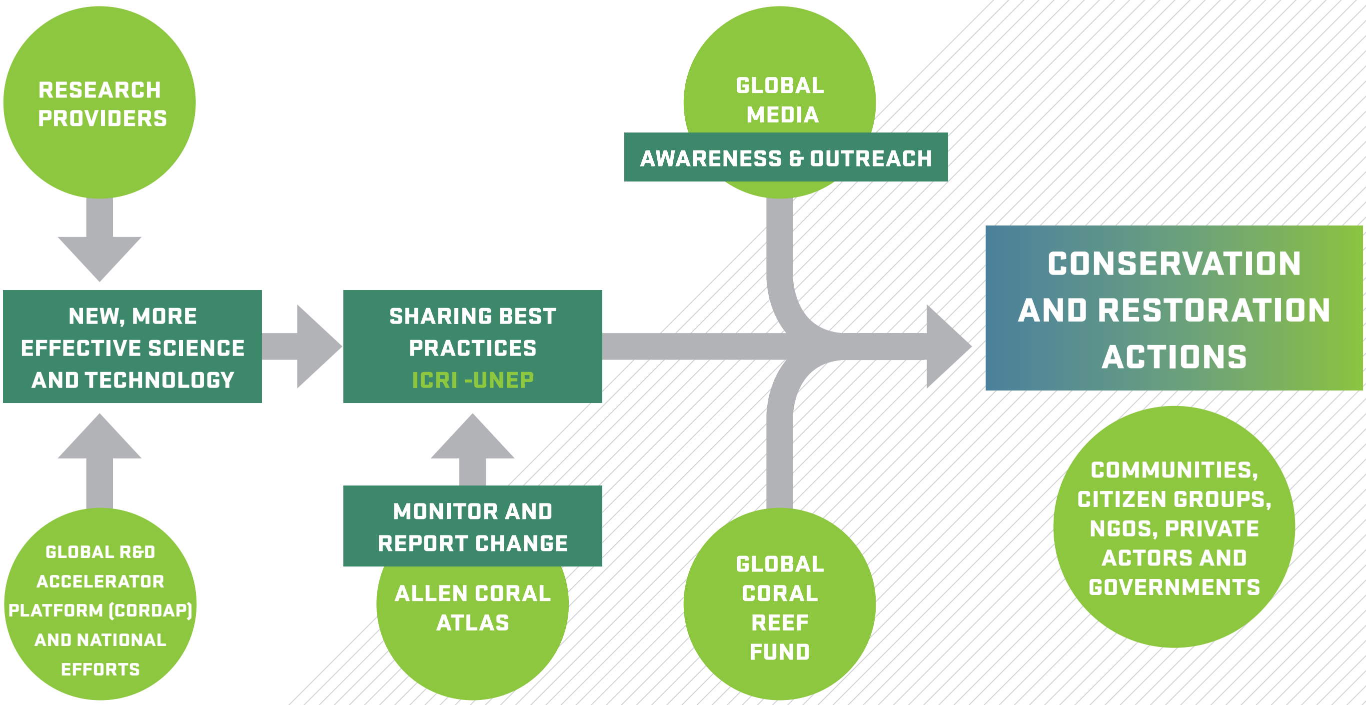
ILLUSTRATIONS: THE NOUNG PROJECT, JANOSCH WOJCIK initiated in 2022, with King Abdullah University of Science and Technology (KAUST) designated as the Platform Central Node providing administrative support and managing CORDAP communications and calls for research projects.

CORDAP will hand over the new technology and research to practitioners, while organizations such as the International Coral Reef Initiative and the UN Environment Programme will work to share best practices across nations. However, restoring coral reefs at scale will require significant funding. The United Nations has recently launched the Global Fund for Coral Reefs, an alliance between member states, philanthropists, financial institutions and UN agencies who are collaborating to establish a new paradigm to provide the resources for coral reef conservation and mobilize action to protect and restore coral reef ecosystems. Innovative financial models allowing for broad participation at global scale, from individual citizens to corporations and philanthropists, will indeed be required to deliver the resources needed to accelerate research and technology and apply it to conserve and restore coral reefs at scale. Furthermore, the launch of the Allen Coral Atlas, which maps coral reefs and will, eventually, monitor change at an unprecedented spatial resolution, provides a platform to track the success of these efforts. →

The greatest risk to coral reefs is not climate change, overfishing or any other of the current pressures; the greatest risk is that we give up.

PHOTO: GETTYIMAGES / BRETT MONROE GARNER

A global partnership to secure a future for coral reefs



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WHAT CAN YOU DO?

A future ocean depleted of tropical coral reefs is one that none of us wish for our children. Hence, securing a future for coral reefs must be an all-hands-on-deck effort, with each contributing within their capacity. We must avoid provoking despair and apathy by presenting the loss of coral reefs as a given. In fact, the greatest risk to coral reefs is not climate change, overfishing or any other of the current pressures; the greatest risk is that we give up, as it will be then when the efforts to conserve them will cease or become too small to be very effective. Media plays a key role in delivering this message, engaging citizens with supporting coral conservation efforts and celebrating victories while acknowledging challenges. Hence, media and their global audiences are key actors in the partnership to secure a future for coral reefs. As the singer Joan Baez wrote, we need “the antidote to despair.”

WHAT CAN BE DONE BY DECISION-MAKERS ON THE GLOBAL, NATIONAL AND LOCAL LEVEL?

- Protect coral reefs within well-managed marine protected areas.
- Remove all local pressures: pollution, organic and nutrient inputs, overfishing, bycatch mortality, and physical impacts.
- Step up our efforts to mitigate climate change in line with the most ambitious objectives of the Paris Agreement.
- Collaborate to develop the next generation of science and technology that is required to conserve and restore coral reefs.
- Develop participatory platforms and new financial mechanisms for the resources to deploy the new restoration technologies.
- Track and communicate progress.
- Tenacity, perseverance and active hope grounded in the delivery of the preceding actions. ←

ABOUT FII INSTITUTE

FII INSTITUTE is a new global nonprofit foundation with an investment arm and one agenda: Impact on Humanity. Global, inclusive and committed to Environmental, Social and Governance (ESG) principles, we foster great minds from around the world and turn ideas into real-world solutions in five critical areas: Artificial Intelligence (AI) and Robotics, Education, Healthcare and Sustainability. We are in the right place at the right time: when decision- makers, investors and an engaged generation of youth come together in aspiration, energized and ready for change. We harness that energy into three pillars: THINK, XCHANGE, ACT. Our THINK pillar empowers the world's brightest minds to identify technological solutions to the most pressing issues facing humanity. Our XCHANGE pillar builds inclusive platforms for international dialogue, knowledge-sharing and partnership. Our ACT pillar curates and invests directly in the technologies of the future to secure sustainable real-world solutions. Join us to own, co-create and actualize a brighter, more sustainable future for humanity.
This paper is part of our Sustainability Series, where the Institute's approach to addressing issues within this field emanates from our focus on SDG 13, SDG 14 and SDG 15. To drive results, the FII Institute's attention will initially focus on ecosystem preservation in both land and sea capacities, before moving onto sustainable marine and land exploitation and carbon-capture solutions in 2022. We will tackle this in a sequential manner, in which inhibitors to progress are identified, potential solutions are mapped out, and organizations and individuals to partner with are approached.

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