GLOBAL WARMING, CORAL REEFS AND TROPICAL ISLANDS: Why immediate action is essential and how it can be achieved

Briefing for delegates to the United Nations Convention on Climate Change, Bali, December 3-14 2007

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Coordinator, United Nations Commission on Sustainable Development Partnership in New Technologies for Small Island Developing States
Scientific Advisor, Yayasan Karang Lestari, Bali, Indonesia

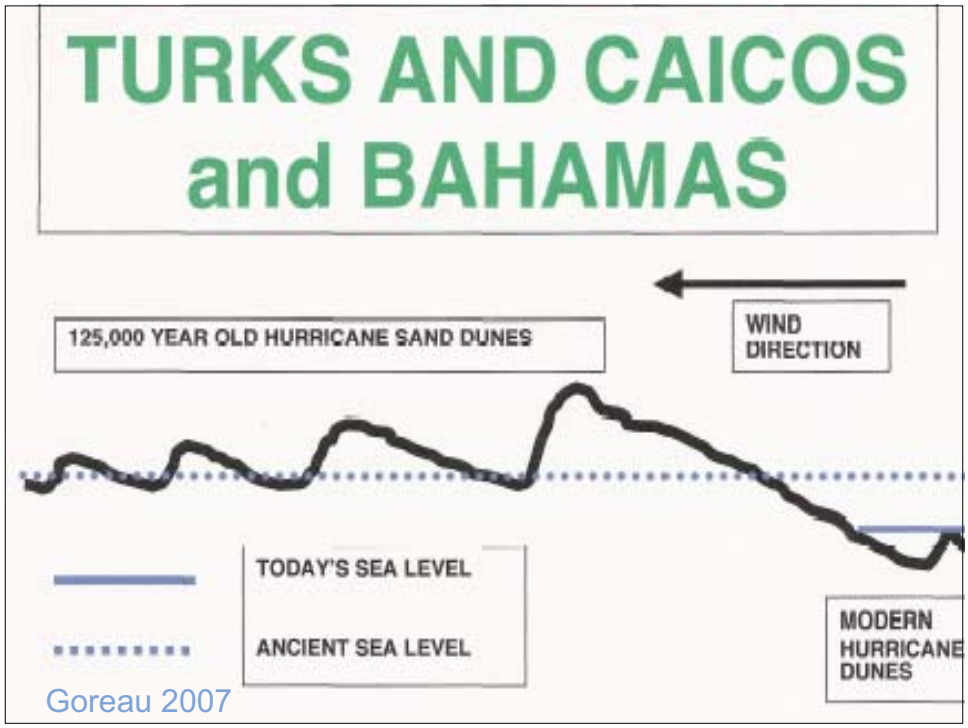
SUMMARY

- IPCC HAS SERIOUSLY AND SYSTEMATICALLY UNDERESTIMATED THE LONG TERM IMPACTS OF GLOBAL WARMING
- CORAL REEFS AND LOW LYING ISLANDS CAN'T TAKE ANY MORE WARMING
- CATASTROPHIC CORAL MORTALITY WILL HAPPEN THE NEXT EXCEPTIONALLY HOT YEAR
- GLOBAL WARMING MUST BE REVERSED, NOT ALLOWED TO CONTINUE
- THE TOOLS TO DO SO ARE AVAILABLE BUT ARE NOT BEING USED DUE TO LACK OF POLICIES AND FUNDING FOR THEIR IMPLEMENTATION

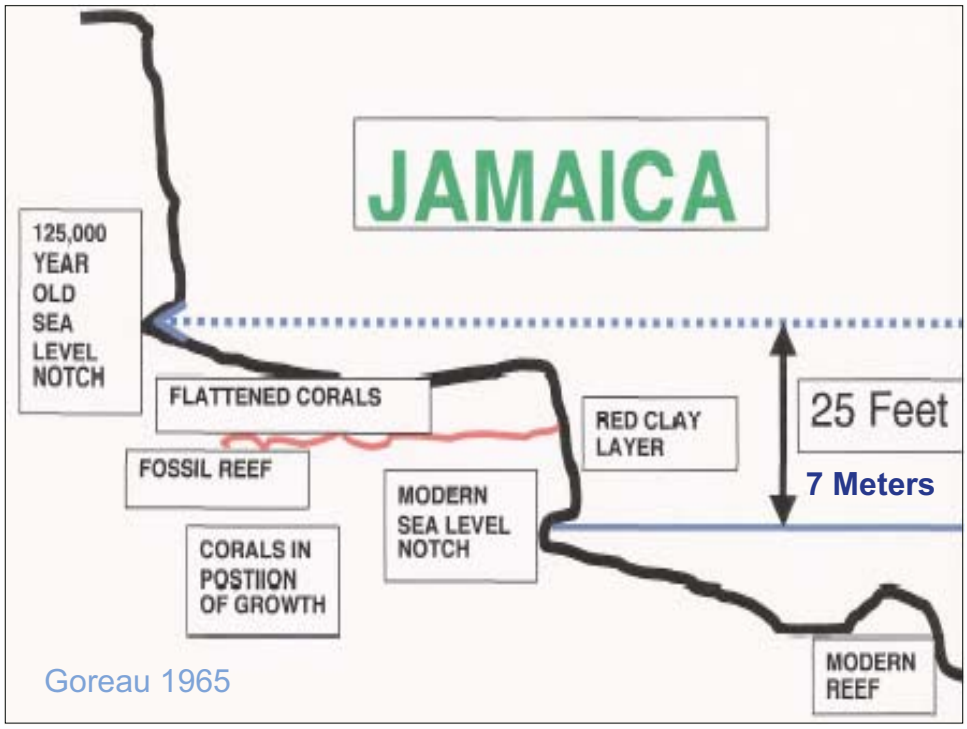
WHAT WILL A WARMER WORLD LOOK LIKE? LOOK AT THE PAST CLIMATE RECORDS, NOT AT MODELS!

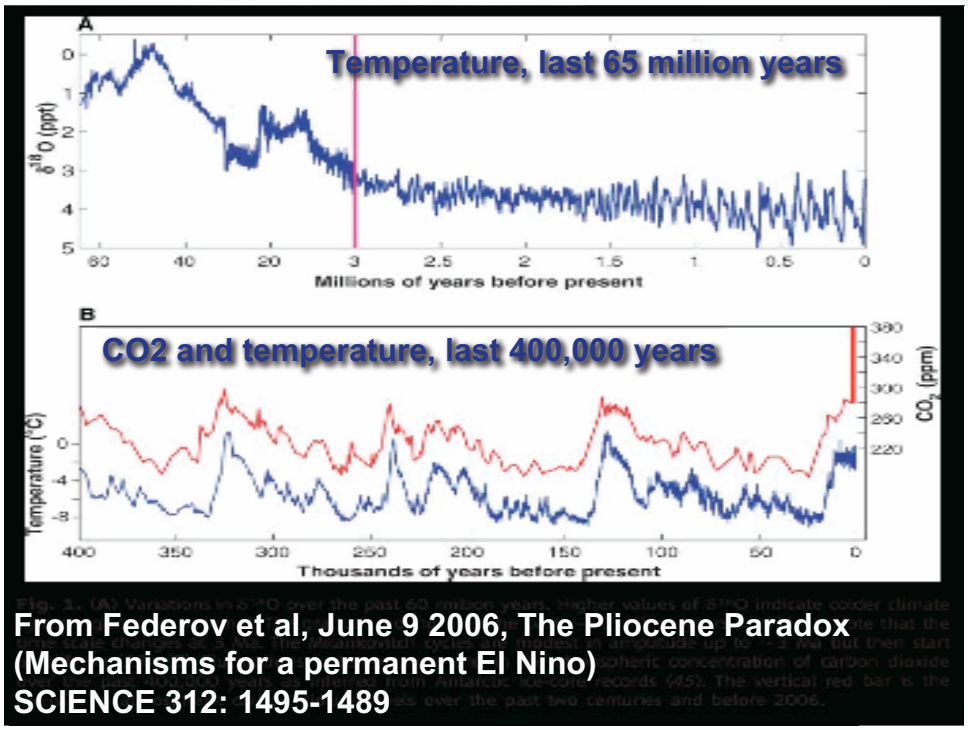
- The most sophisticated models used by IPCC are too simple to adequately describe the real changes of the past that are recorded in rocks, sediments, and ice cores
- The models are useful only as qualitative tools
- The Greenhouse Effect is a fundamental Law of physics. The only questions are how hot it will get and how fast
- Past climate records show that the models UNDERESTIMATE the changes we will face!

- The last time it was 1 C warmer than today, 125,000 years ago, sea levels were 7 m higher
- Crocodiles and hippopotamuses lived in London, England
- Huge waves, bigger than anything we know, flattened coral reefs and created new sand islands
- CO_2 was more than 30% less then than it is today
- Those conditions underestimate long term changes for PRESENT levels of CO_2 even if no more is ever added.
- When it was 4-5 C warmer, sea levels were 70-100 meters higher
- Model projections from climate change models must be way too low



Goreau 2007





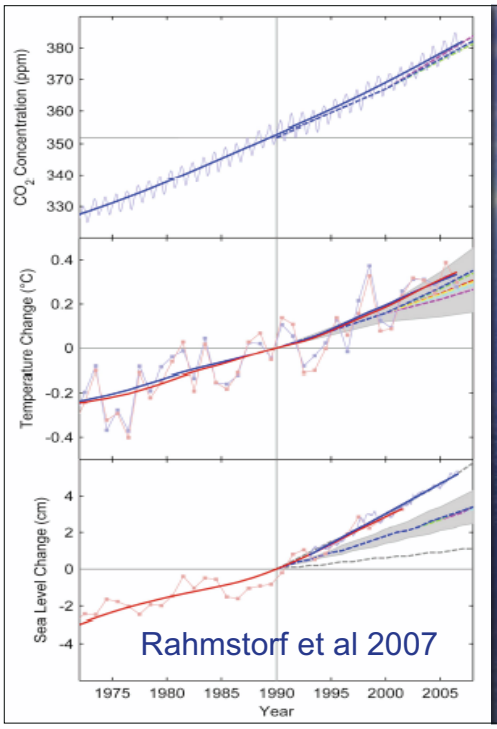
From Federov et al, June 9 2006, The Pliocene Paradox (Mechanisms for a permanent El Nino) SCIENCE 312: 1495-1489

GLOBAL CHANGE

- GLOBAL WARMING SPEEDS UP
- GLOBAL SEA LEVEL RISE
- INCREASED STORM INTENSITY
- INCREASED EXTREME TEMPERATURES
- POSITIVE CLIMATE FEEDBACKS
- OCEAN ACIDIFICATION
- NEW DISEASES
- HYDROLOGICAL CHANGES (DROUGHT)
- OCEAN CIRCULATION CHANGES
- ATMOSPHERIC CIRCULATION CHANGES
- ECOLOGICAL DISRUPTION

Global warming is out of control

- 9 of the 10 hottest years recorded have been in the last decade
- Statistically they will be equaled or exceeded very soon
- Corals can't take ANY further warming, they are right at their upper limits
- Massive mortality from global warming is not far off. No credible sign of adaptation
- Already more than half way through climate change-caused mass extinction of reefs
- CATASTROPHIC RECURRENT BLEACHING IMMINENT
- CORAL REEFS, TROPICAL ISLANDS, FIRST VICTIMS



GLOBAL CLIMATE CHANGE IS TAKING PLACE MORE RAPIDLY THAN IPCC PREDICTED, AND IS CERTAIN TO ACCELERATE IN THE FUTURE UNLESS GREENHOUSE GAS CONCENTRATIONS IN THE ATMOSPHERE ARE REDUCED AT LEAST A THIRD BELOW PRESENT LEVELS

CLIMATE MODELS SERIOUSLY UNDERESTIMATE THE IMPACTS

1) THEY DO NOT ACCOUNT FOR MOST OF THE POSITIVE FEEDBACKS THAT THE PAST CLIMATE RECORDS SHOW
2) THEY USE A HORIZON OF DECADES NOT OF THOUSANDS OF YEARS, WHICH IS NEEDED TO FEEL THE FULL EFFECTS
3) CLIMATE CHANGE WILL BE WORSE AND BECOME MUCH FASTER THAN MODELS PREDICT

Goreau briefings to Island Nation delegates at the Earth Summit, Rio de Janeiro, 1992

Comparison of the climate sensitivity of IPCC projections in comparison with actual sensitivity of the climate system shown in Antarctic Ice and Deep Sea Sediment records shows that:

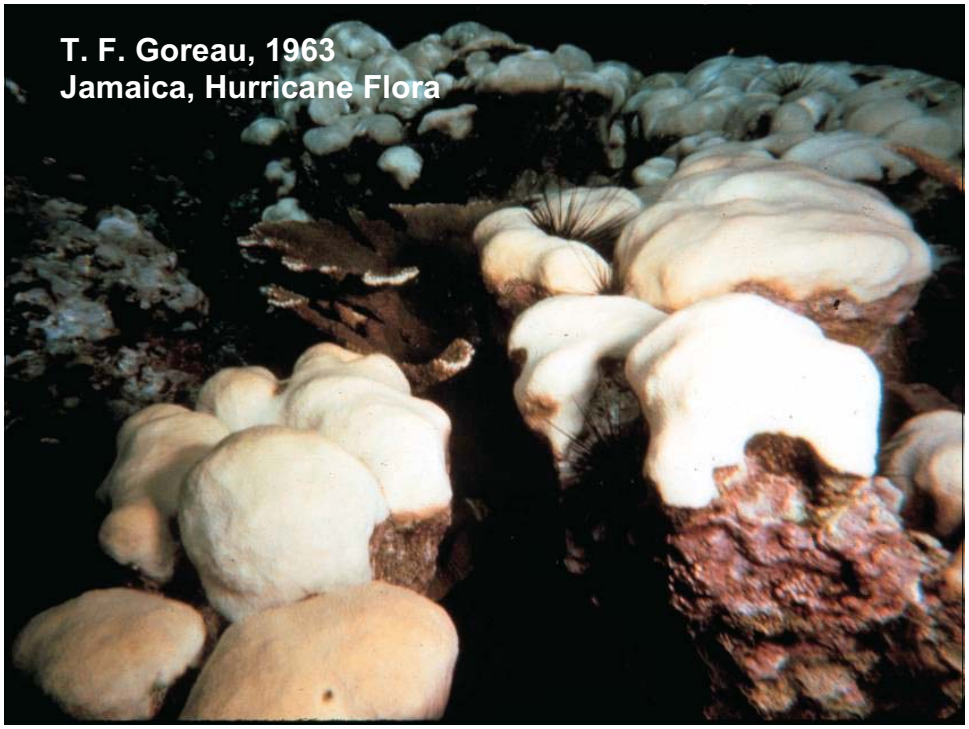
1) IPCC underestimates sensitivity of temperature to CO_2 about 10 times
2) IPCC underestimates sensitivity of sea level to temperature about 100 times
3) IPCC underestimates sensitivity of sea level to CO_2 about 1000 times

CORAL REEFS ARE THE MOST HEAT SENSITIVE ECOSYSTEM

1 DEGREE RISE FOR ONE MONTH IN THE WARM SEASON CAUSES BLEACHING

2 DEGREES FOR ONE MONTH OR
1 DEGREE FOR TWO MONTHS
CAUSES MASS MORTALITY

KNOWN FOR NEARLY 90 YEARS



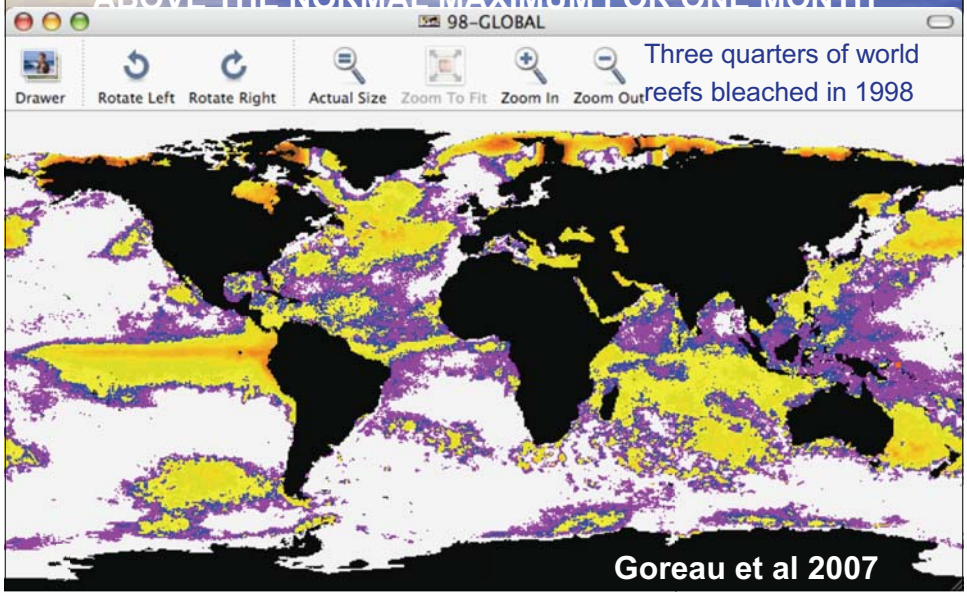
LOCAL CORAL BLEACHING ONLY PRIOR TO 1980S

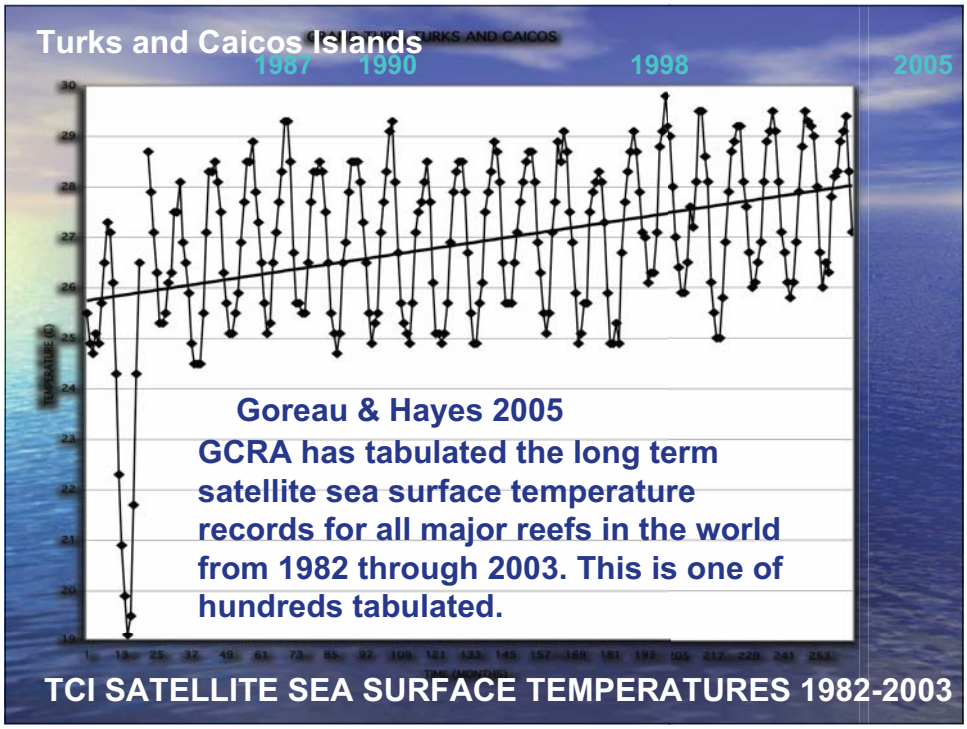
SINCE 1980S ALMOST ALL BLEACHING HAS BEEN MASS BLEACHING, OVER VAST AREAS OF OCEAN, UNRELATED TO LOCAL STRESS

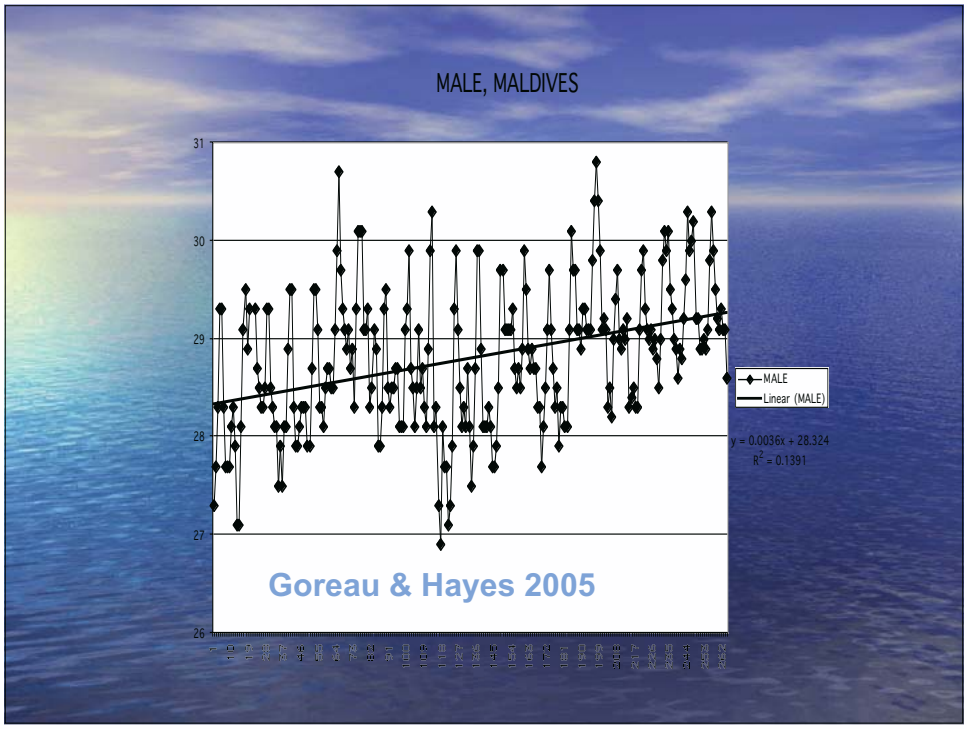
THE GOREAU-HAYES HOTSPOT METHOD, FIRST PRESENTED AT AL GORE'S SENATE PANEL HEARING IN 1990 HAS PREDICTED THE LOCATION, TIMING, AND INTENSITY OF ALL MAJOR MASS BLEACHING EVENTS, BEFORE THEY ARE VISIBLE IN THE REEF

1998 GOREAU-HAYES HOTSPOT

YELLOW AREAS GOT MORE THAN 1 DEGREE CELSIUS ABOVE THE NORMAL MAXIMUM FOR ONE MONTH






MALE, MALDIVES
31
30
29
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27
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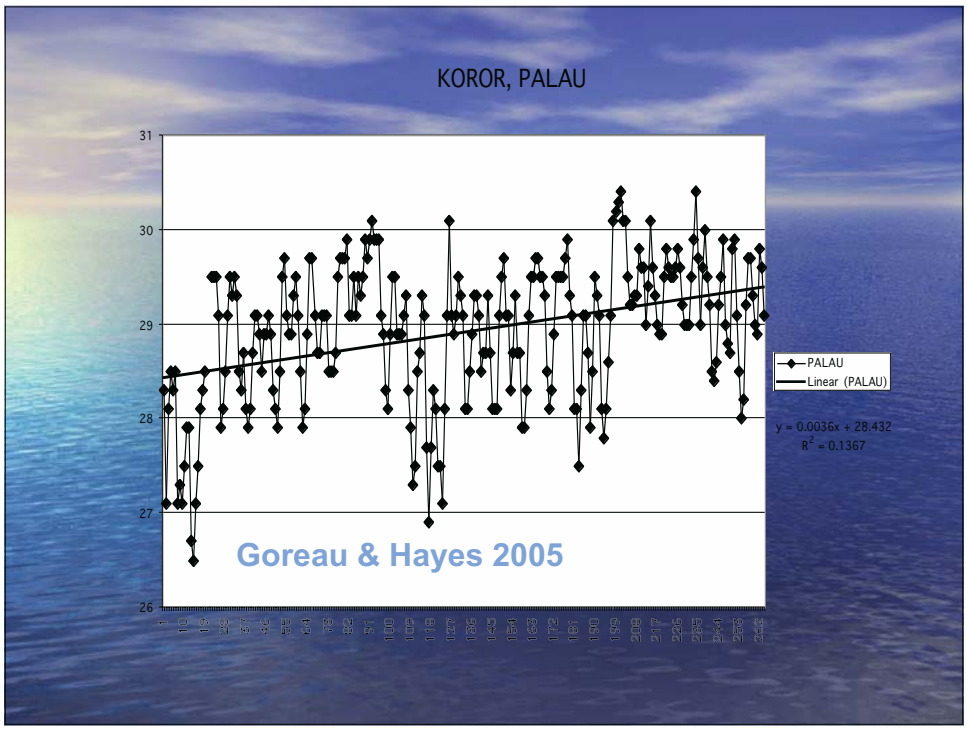
MALE
Linear (MALE)
y = 0.0036x + 28.324
R² = 0.1391
Goreau & Hayes 2005


KOROR, PALAU
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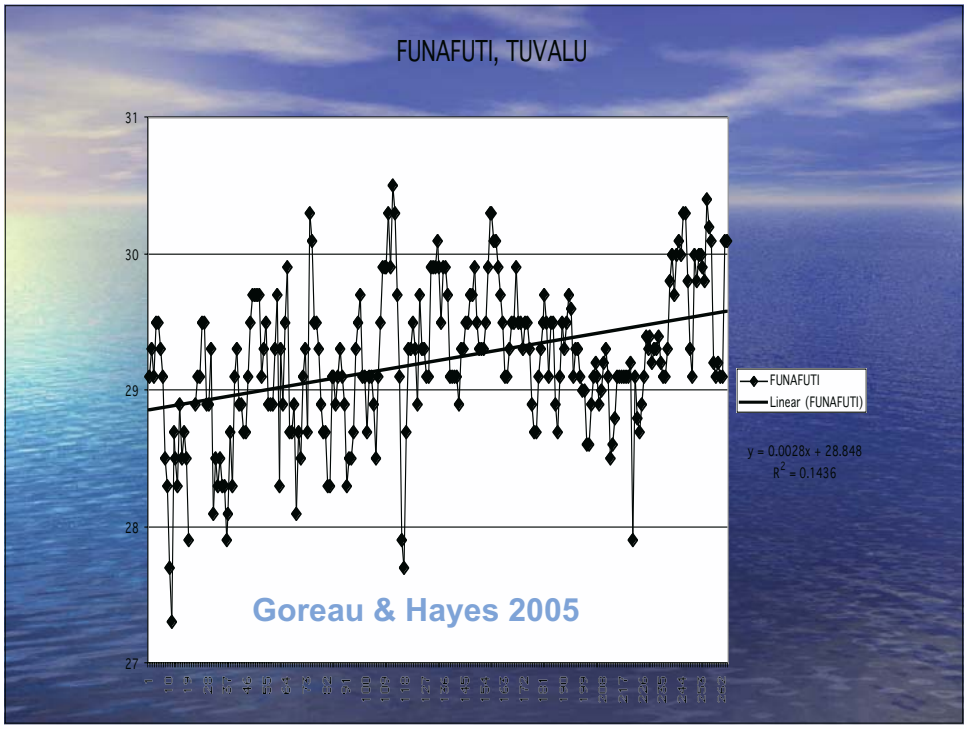
PALAU
Linear (PALAU)
y = 0.0036x + 28.432
R² = 0.1367
Goreau & Hayes 2005


FUNAFUTI, TUVALU
31
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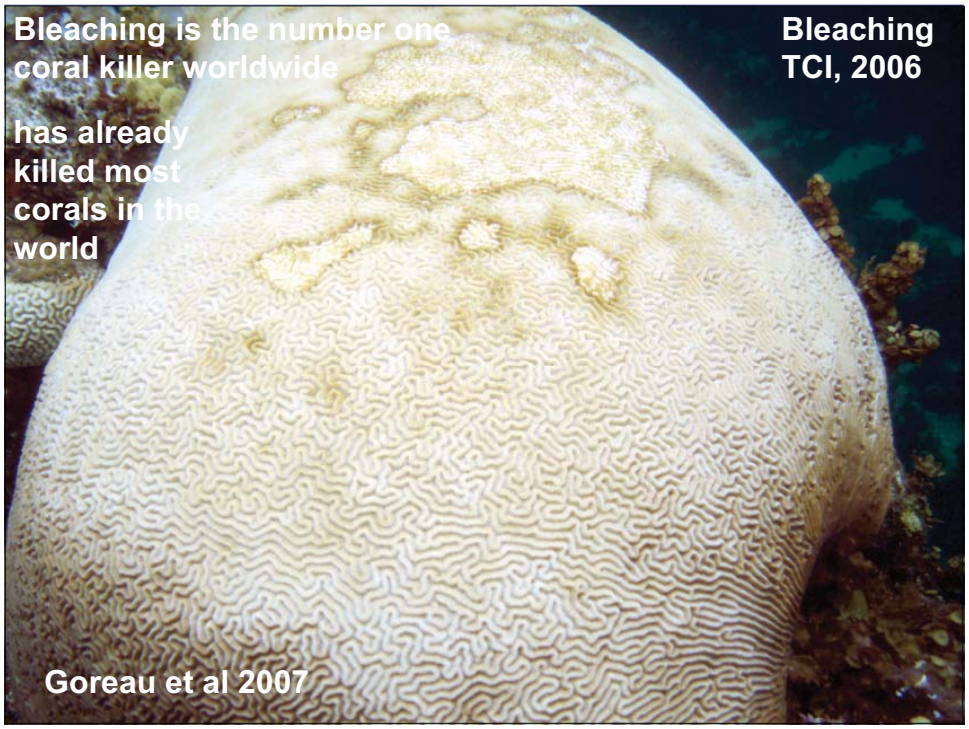
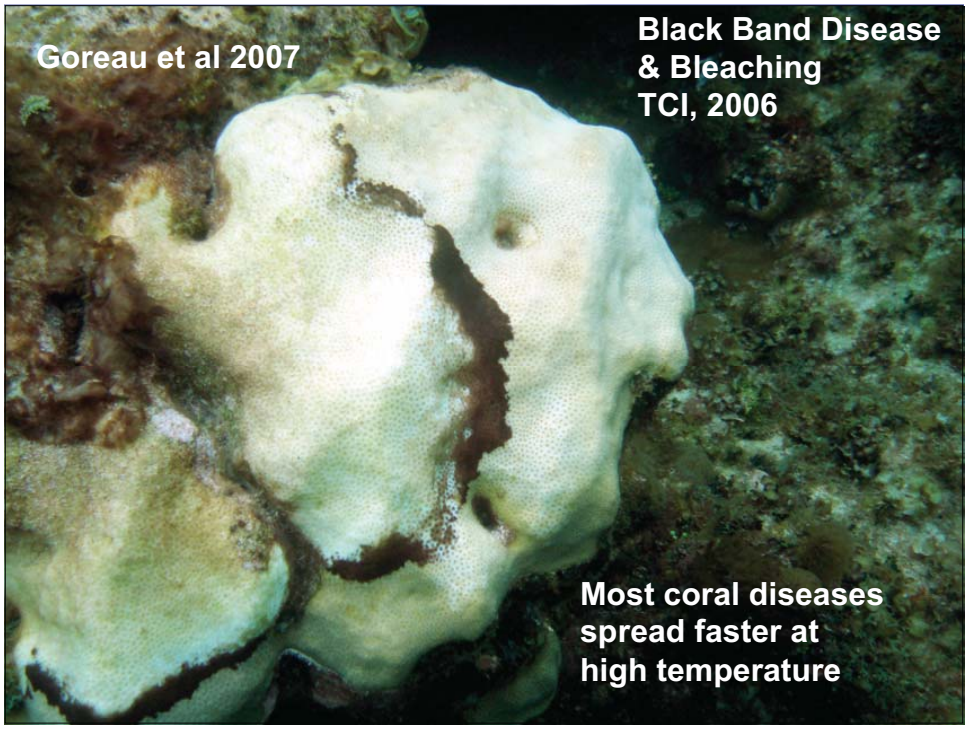
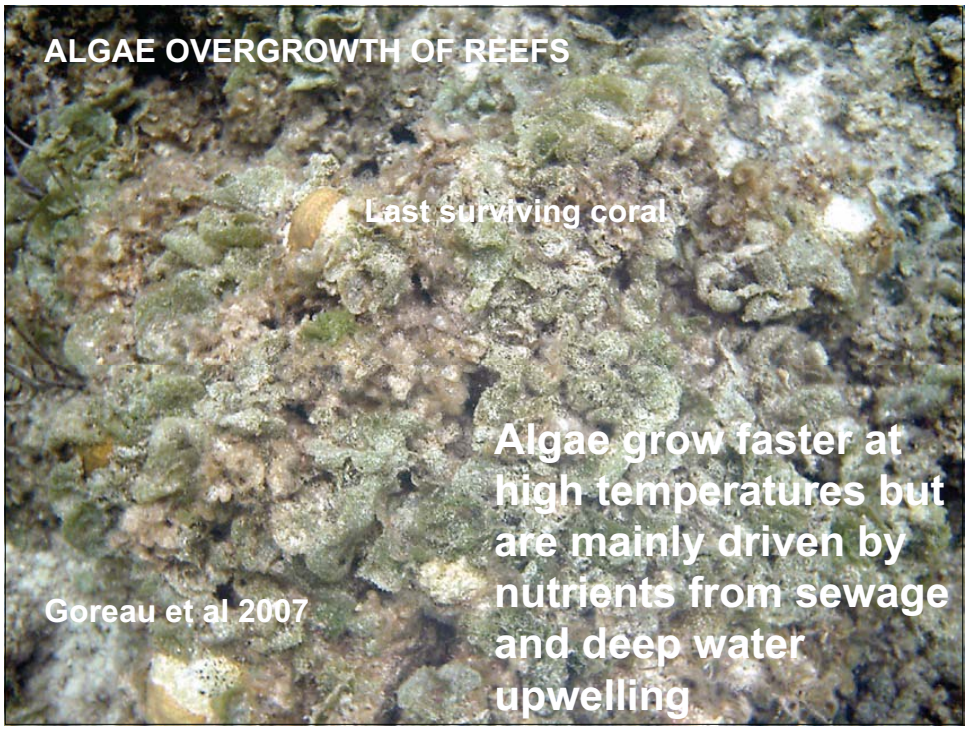
FUNAFUTI
Linear (FUNAFUTI)
y = 0.0028x + 28.848
R2 = 0.1436
Goreau & Hayes 2005


Bleaching is the number one coral killer worldwide
has already killed most corals in the world
Bleaching TCI, 2006
Goreau et al 2007

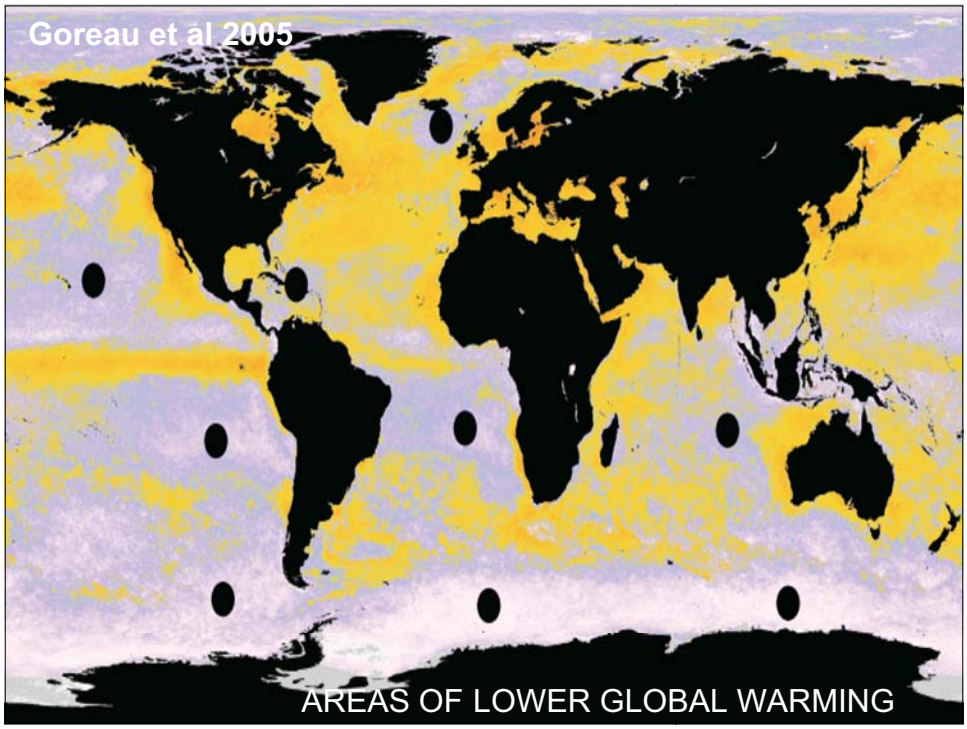

Goreau et al 2007
Black Band Disease
& Bleaching
TCI, 2006
Most coral diseases
spread faster at
high temperature


This disease is now worldwide.
Diseases are number two coral killers worldwide
Goreau et al 2007
White Plague Disease
TCI, 2006


Goreau et al 2007
Sea Fan Disease
TCI, 2006
2000.01.02

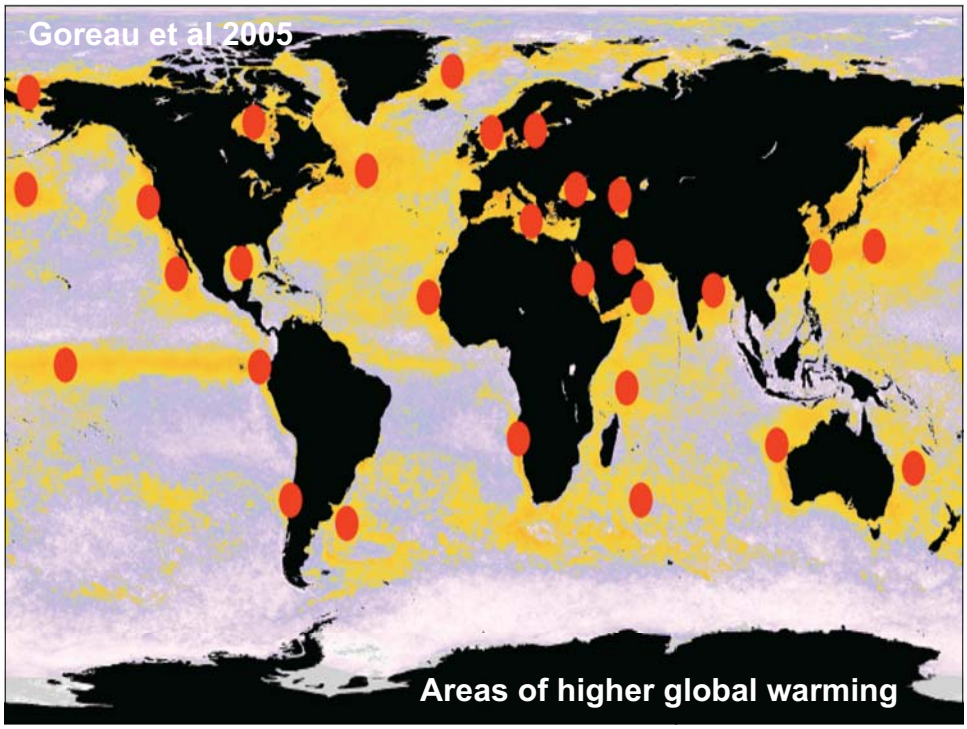

ALGAE OVERGROWTH OF REEFS
Last surviving coral
Algae grow faster at high temperatures but are mainly driven by nutrients from sewage and deep water upwelling
Goreau et al 2007

- The mean trend of temperature rise from our data base of long term satellite data from all major coral reefs of the world shows most are within a few years of catastrophic mortality
- But the real question is not the average increase, but when the next extreme high temperature event and high sea level events will take place
- These could happen at any time



Regions warming more slowly than average

- Interiors of ocean basins where wind is increasing, mixing cold deep water up
- Areas where strong currents mix deep water to the surface



Regions warming more rapidly than average

- Warm currents
- Cold currents
- Enclosed seas
- Upwelling zones: major fisheries collapsing from bottom up
- Almost all coral reefs and island nations

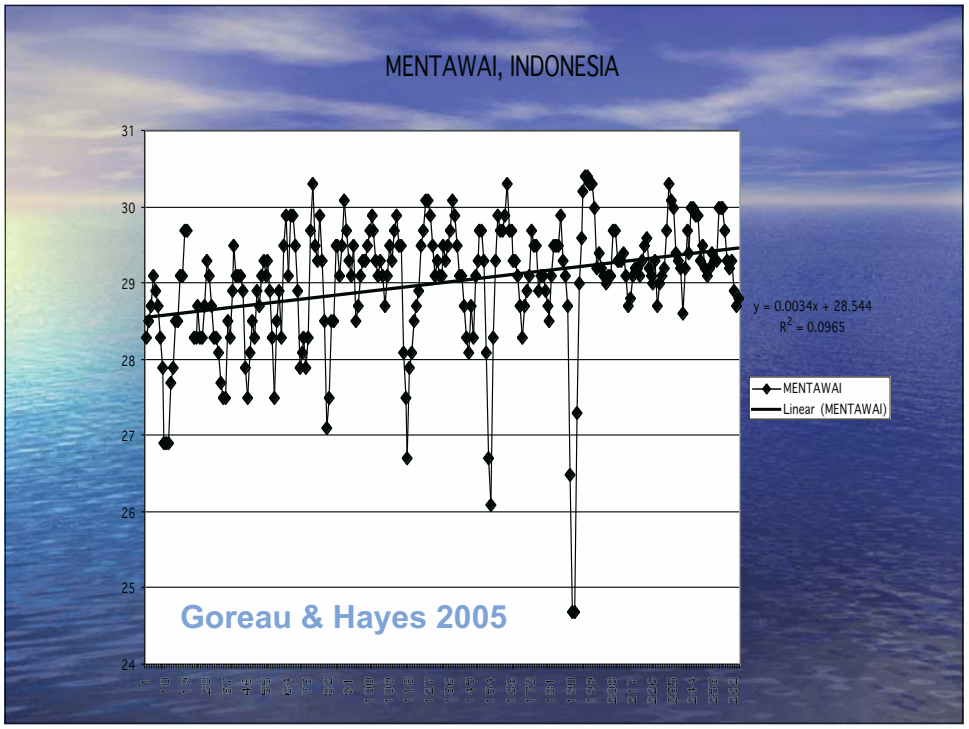
Global changes in ocean circulation are Already underway, affecting the entire planet

Sudden, severe, widespread, and prolonged changes in ocean upwelling of cold deep water

1989 Eastern Tropical Pacific

1998 Indian Ocean

More to come?


MENTAWAI, INDONESIA
31
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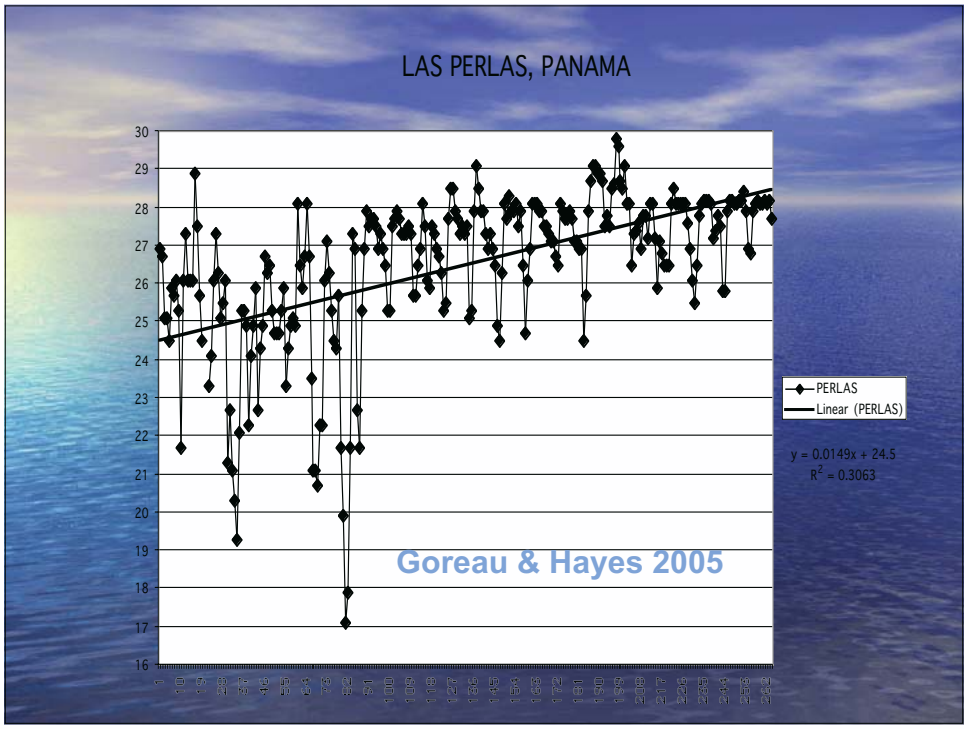
24
y = 0.0034x + 28.544
R2 = 0.0965
MENTAWAI
Linear (MENTAWAI)
Goreau & Hayes 2005


LAS PERLAS, PANAMA
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17
16
PERLAS
Linear (PERLAS)
y = 0.0149x + 24.5
R2 = 0.3063
Goreau & Hayes 2005

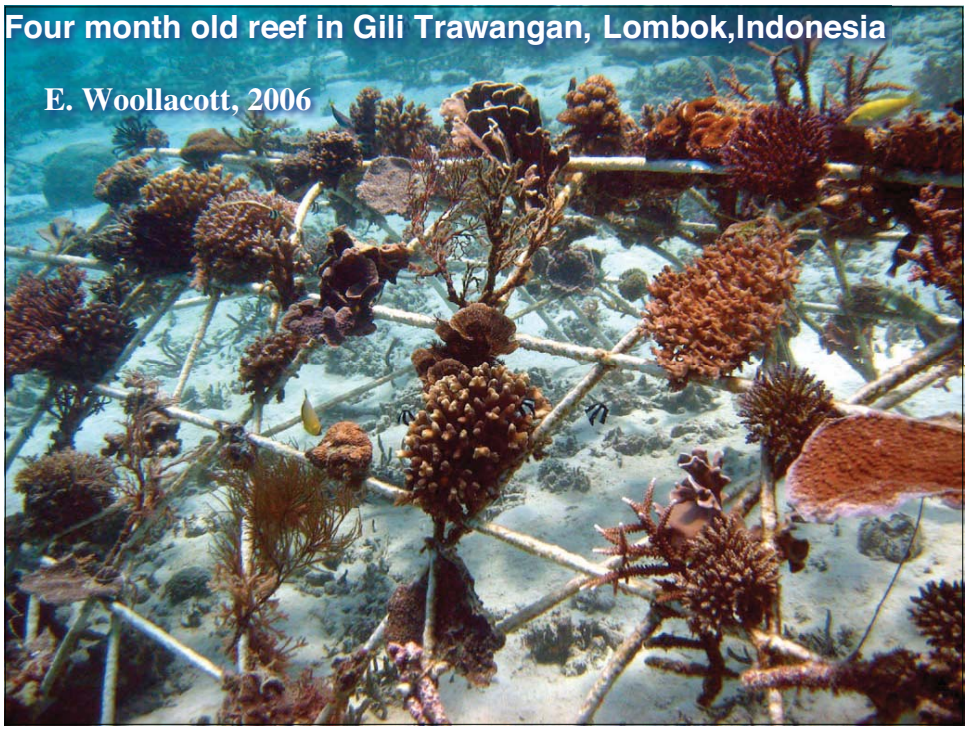
- The problem is fossil fuel use
- Stabilization of climate at present temperatures requires CO2 levels at least one third LOWER than today's
- This is not possible without serious reductions in fossil fuel use, or serious increases in carbon sinks
- Instead we are cutting the forests and eroding soil carbon. Melting permafrost will turn tundra peat into methane and carbon dioxide, all accelerating warming. Serious loss of Amazon rainforests looms.

- AT THE EARTH SUMMIT IN 1992 WE WARNED GOVERNMENTS IF THEY DID NOT STOP GLOBAL WARMING WE WOULD LOSE MOST OF THE CORALS IN THE NEXT 10 YEARS.
- THEY DID NOT ACT, SIGNED A TREATY THAT IS A DEATH SENTENCE FOR REEFS, AND MOST CORALS DIED
- REEFS REMAIN, BUT THEY ARE MOSTLY DEAD AND ERODING, NOT GROWING

- Kyoto only stabilizes rates of greenhouse gas rise, not concentrations
- It therefore is a death warrant for reefs even if countries lived up to their promises
- Only rapid global action can make a difference

- We will lose our coral reefs, fisheries, tourism, biodiversity, and shore protection within a few years unless we urgently start actively restore reefs with corals that are faster growing and more resistant to stress
- The technology already exists to do this
- It can be powered by solar, wind, and tidal energy

- Biorock structures are the only marine construction material that get stronger with age and are self repairing.
- The steel framework is completely protected from rusting
- Biorock material grown properly has three times the compressive strength of ordinary concrete.
- Structures cost much less than concrete or rock of the same dimensions
- Invented by Architect Wolf Hilbertz to grow construction materials from ocean minerals



August 2006
9 months old

Laurent Lavoye
Gili Trawangan

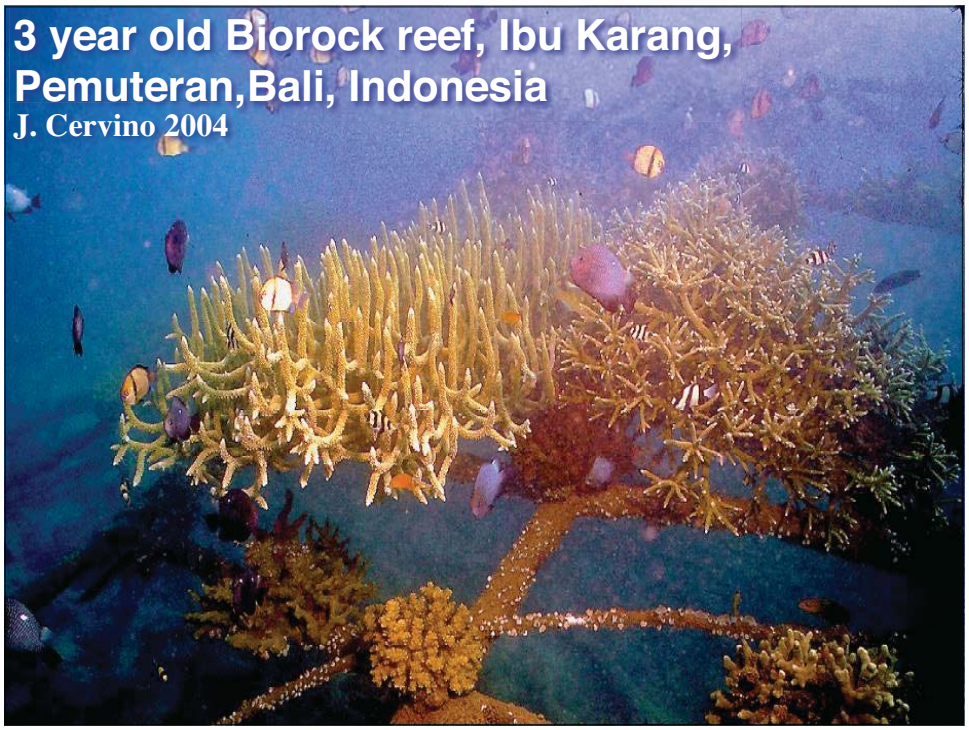
10 month coral

Chris Hendricks
Gili Trawangan
September 2006

1.5 year old reef in Gili Trawangan, Lombok, Indonesia

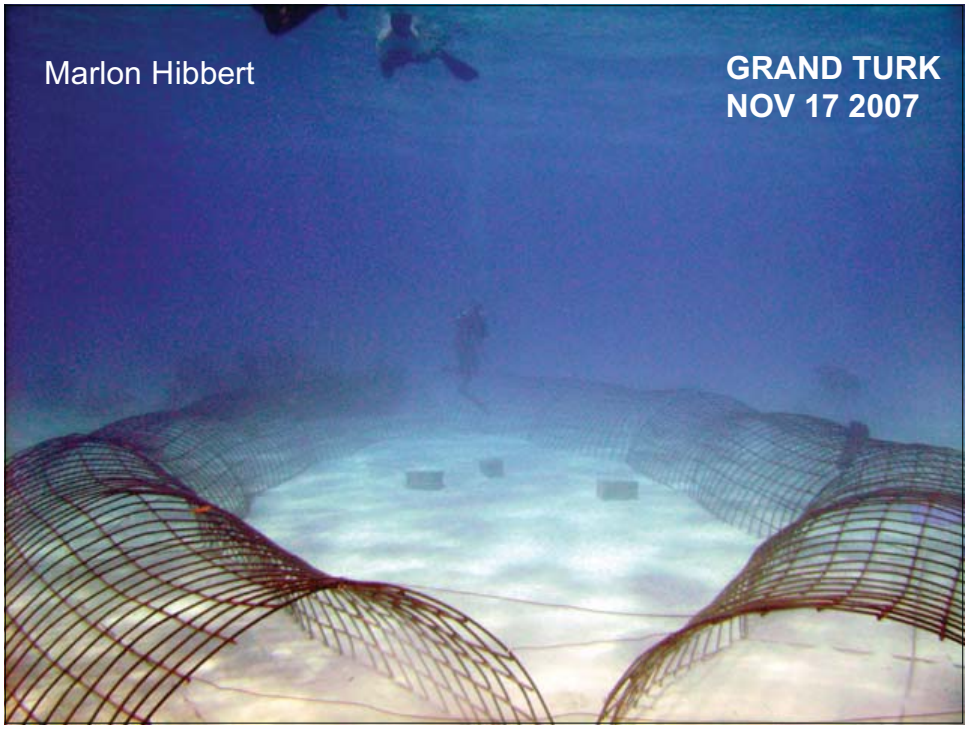
1.5 year old reef in Gili Trawangan, Lombok, Indonesia


1.5 year old reef in Gili Trawangan, Lombok, Indonesia
E. Woollacott, 2006


3 year old Biorock reef, Ibu Karang, Pemuteran,Bali, Indonesia
J. Cervino 2004


Fernando Perez
GRAND TURK
NOV 17 2007


GRAND TURK
NOV 17 2007
Fernando Perez



BIOROCK CORALS

- Grow 3-5 times faster
- Heal more than 20 times faster
- Survive high temperatures 16-50 times more than adjacent reefs
- Have hundreds of times higher baby coral settlement
- Attract incredible numbers of fish

- Corals can survive under lethal conditions
- Reefs can be quickly restored where they can't recover naturally
- Fishermen can grow reefs and greatly increase fish and shellfish populations and catches, becoming farmers instead of hunters
- Breakwaters can be built for a fraction of the price of concrete or stone, with vastly greater environmental benefits
- Winner of many international environmental and ecotourism prizes

BIOROCK REEFS CAN BE BUILT IN FORMS THAT GREATLY INCREASE HABITAT FOR AND POPULATIONS OF FISH, LOBSTERS, AND OYSTERS:

GROW ENTIRE COMPLEX ECOYSTEMS WITHOUT ADDITION OF FOOD, AND SO AVOID THE GENETIC IMPOVERISHMENT, DISEASE, PARASITE, AND POLLUTION PROBLEMS CAUSED BY CONVENTIONAL MARICULTURE

FISHING COMMUNITIES ARE HUNTERS, DESTROYING WILD ANIMALS AND THEIR HABITAT IN ORDER TO SURVIVE

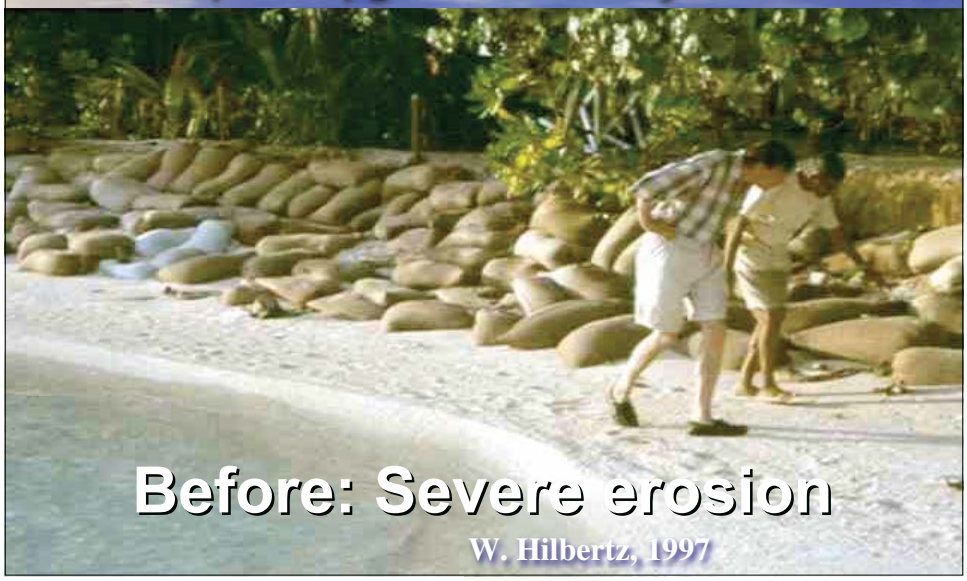
USING BIOROCK THEY CAN BECOME SEA FARMERS, WHO RESTORE AND IMPROVE HABITAT IN ORDER TO PRODUCE MORE

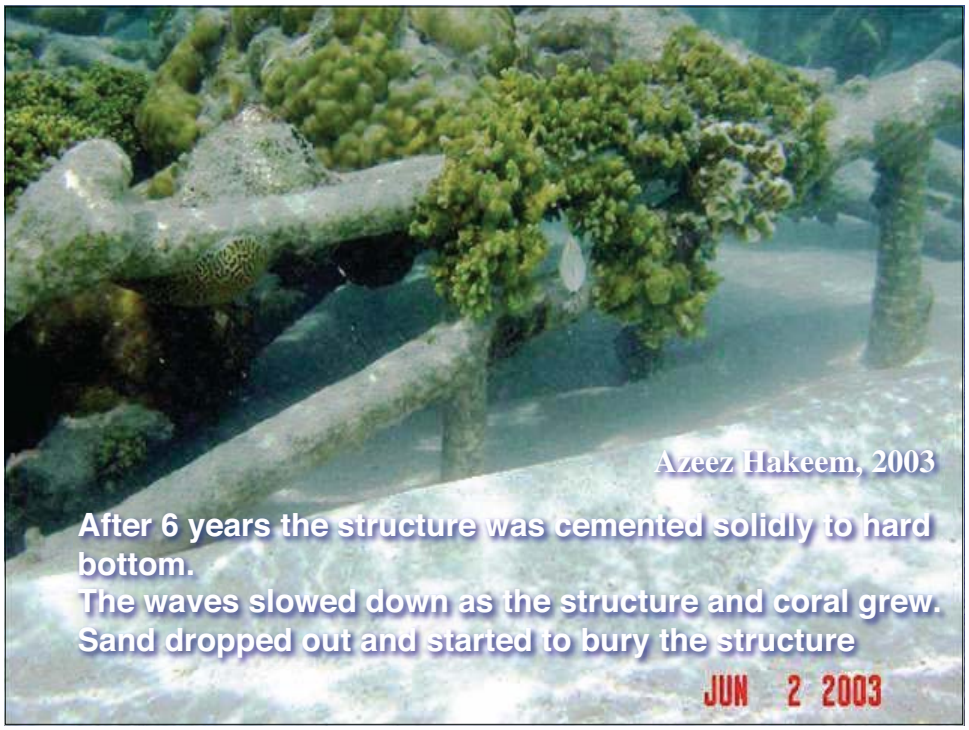
MARINE PROTECTED AREAS WON'T WORK AGAINST GLOBAL WARMING

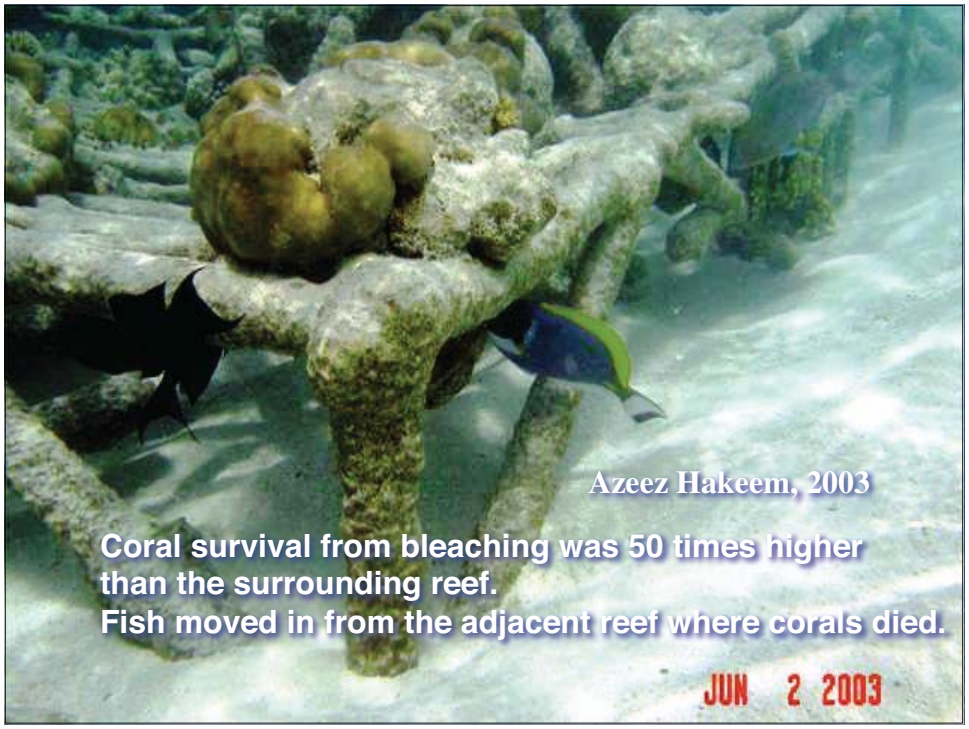
Biorock is the cheapest and most cost effective solution for:

- Coral reef restoration
- Fisheries restoration
- Shellfish restoration
- Shore protection
- Mariculture
- Building stone and aggregate
- Protecting reefs from global warming
- Ecotourism
- Began in Jamaica, now in more than 20 countries

Biorock shore protection project at Ihuru Island, Maldives, turned a severely eroding beach into 15 meters (50 feet) growth in a few years





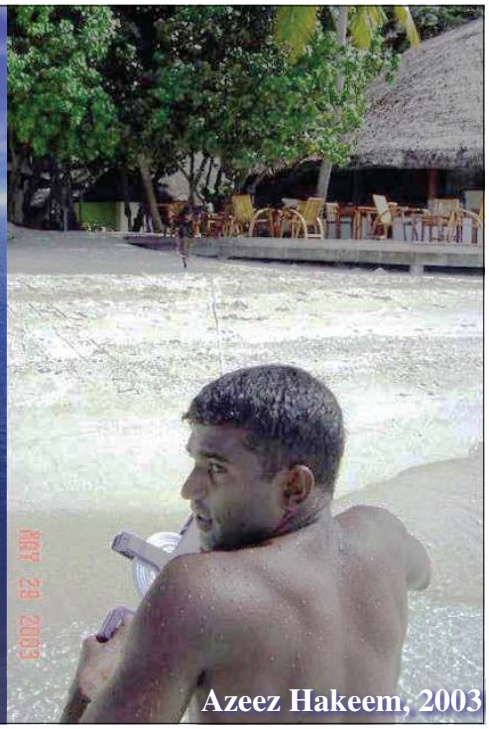

Azeez Hakeem, 2003
Coral survival from bleaching was 50 times higher than the surrounding reef.
Fish moved in from the adjacent reef where corals died.
JUN 2 2003

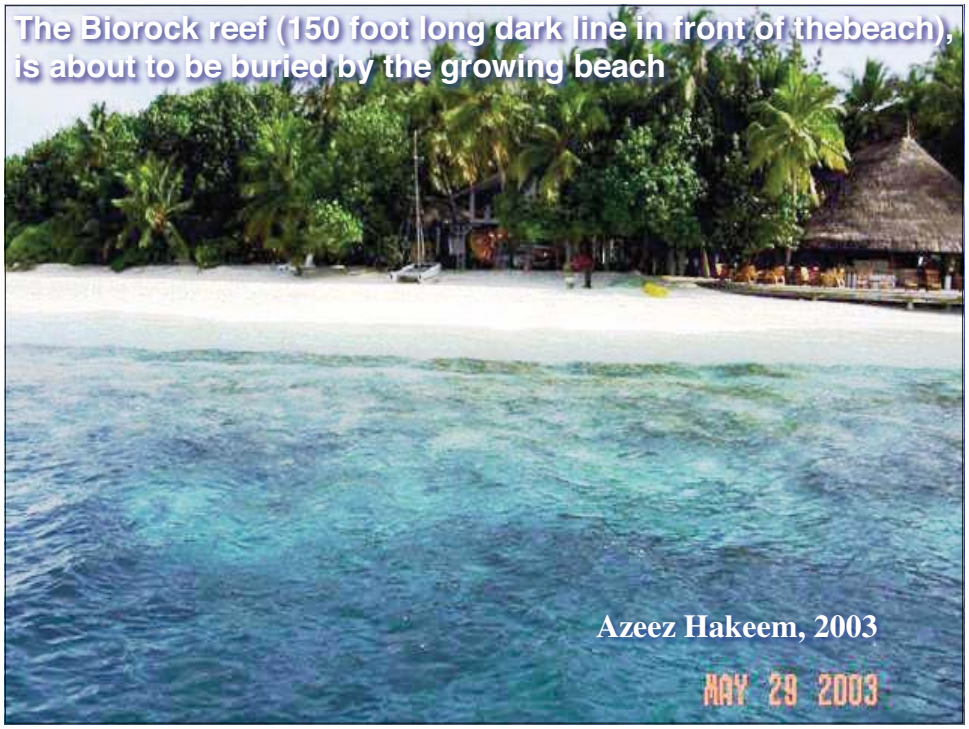

This created a prize winning ecotourism attraction
Azeez Hakeem, 2003
JUN 2 2003

The beach grew 50 feet (15 meters) in a few years

Measuring the new beach. When we began the sandbags were piled in front of the building, which was about to collapse into the sea.

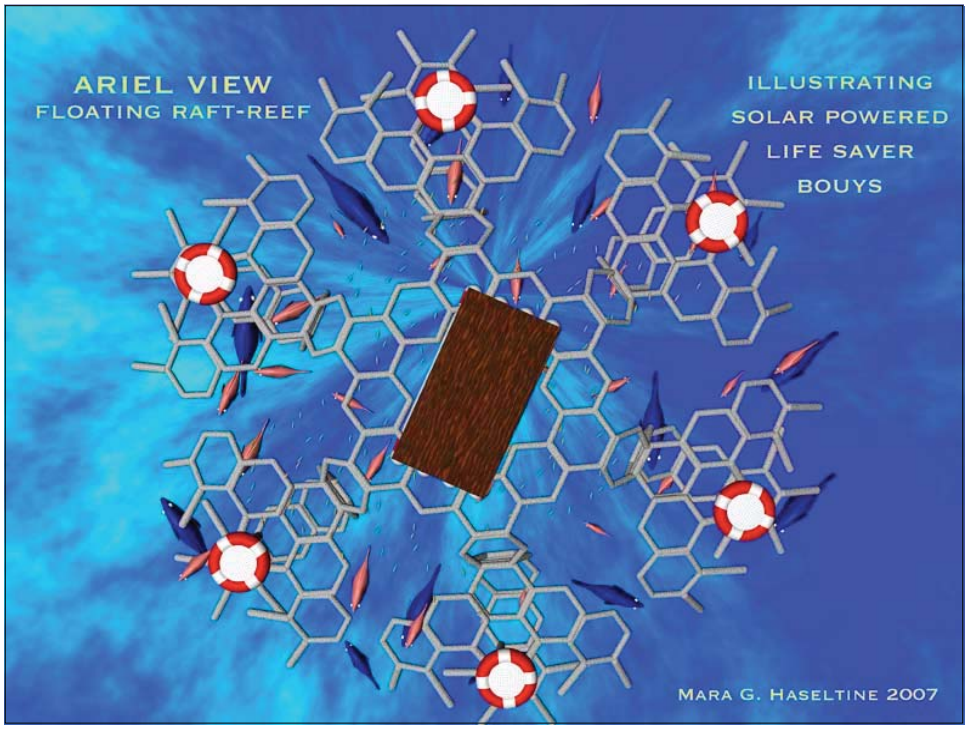
The Biorock reef breakwater uses about as much power as the beach lights, and cost less than one tenth what concrete, rock, or sandbag walls of the same dimensions.

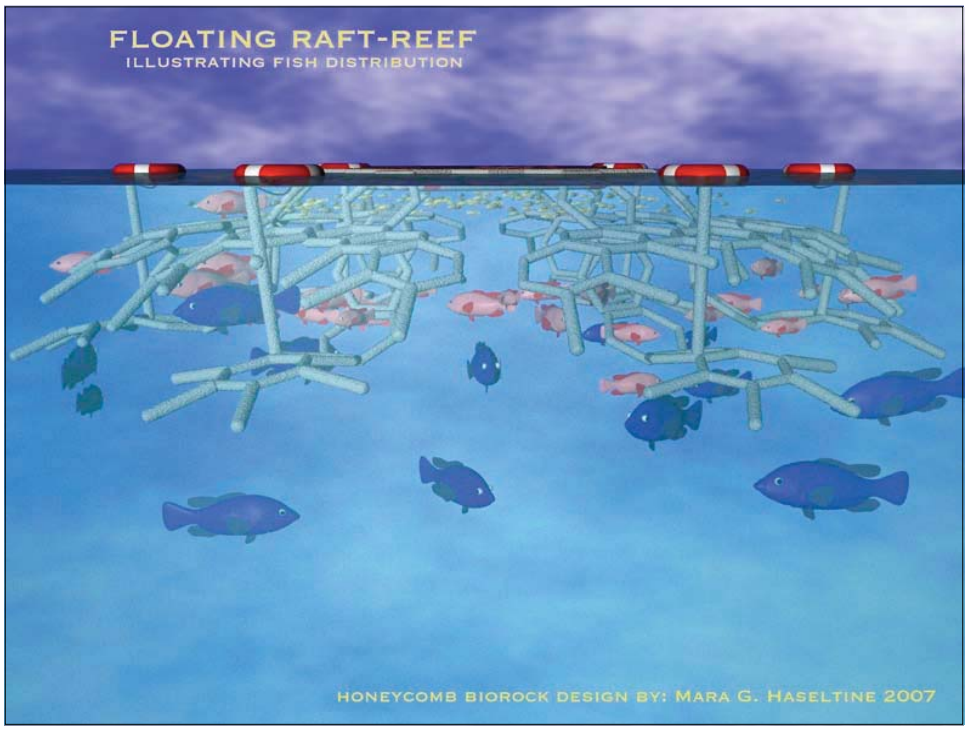




WE CAN ADAPT TO THE EFFECTS OF GLOBAL WARMING AND SEA LEVEL RISE ON CORAL REEFS AND ISLAND SHORELINES WHERE WE CAN PROVIDE POWER FROM SOLAR, WIND, TIDAL ENERGY, BUT ONLY WITHIN LMITS.

FLOATING CORAL REEFS CAN ALSO BE GROWN TO RESTORE COASTAL AND OPEN OCEAN FISHERIES.


ARIEL VIEW
FLOATING RAFT-REEF
ILLUSTRATING
SOLAR POWERED
LIFE SAVER
BOUYS
MARA G. HASELTINE 2007


FLOATING RAFT-REEF
ILLUSTRATING FISH DISTRIBUTION
HONEYCOMB BIOROCK DESIGN BY: MARA G. HASELTINE 2007

- ADAPTATION IS ONLY A SHORT TERM TACTIC, CLIMATE REVERSAL IS THE ESSENTIAL LONG TERM STRATEGY
-
- THE LONG TERM SOLUTION REQUIRES REDUCTIONS IN CO2 CONCENTRATIONS, NOT JUST STABILIZING THEM AT A LEVEL HIGHER THAN TODAY'S.

- No scientifically sound strategy to manage the impacts of global climate change can be done without a complete accounting of all greenhouse gas sources and sinks. This is NOT now the case!
- SIMULTANEOUS SOURCE REDUCTIONS AND INCREASED SINKS ARE NEEDED TO STABLILIZE CO2 AT LOWER LEVELS

LARGE SCALE RESTORATION OF ALL LAND AND SEA ECOSYSTEMS IS NEEDED TO NOT ONLY TO STORE CARBON BUT TO RESTORE THE NATURAL REGULATION OF CLIMATE, WATER, SOIL, AND FISHERIES THAT WE HAVE LARGELY DESTROYED

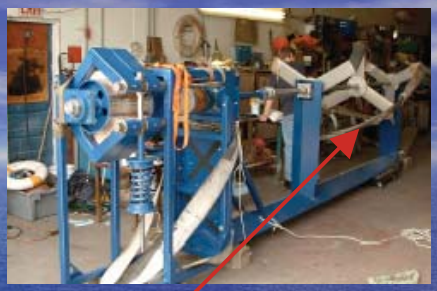
RECYCLING OF SOLID WASTES AND SEWAGE TO MAKE CLEAN WATER, FERTILIZER, AND FUELS IS ESSENTIAL TO INCREASE FERTILITY OF THE LAND AND STOP KILLING THE OCEANS. THE TECHNOLOGY EXISTS BUT ARE NOT USED.

United Nations Commission on Sustainable Development Partnership on New Technologies for Small Island Developing States and United Nations Framework Convention on Climate Change

- Rewrite the UNFCCC to make scientific sense and be a blueprint for effective action
- Large scale investment in cost-effective clean energy especially tidal current vertical axis turbines
- Gaseous and liquid fuels and fertilizers from wastes and biomass
- Sustainable Integrated Mariculture
- Large scale terrestrial and marine ecosystem restoration
- Large scale carbon storage in soils using ancient Amazonian Indian methods to greatly increase soil fertility and draw down excess carbon dioxide already in the atmosphere.

Source side measures

- Tidal energy is the only untapped cost-effective, clean, sustainable energy resource with the capacity to replace fossil fuels soon, solar is still too expensive.
- A crash program is urgently needed for large scale implementation
- Most SIDS, Indonesia, Philippines could supply their energy needs
- Little or no funding for tidal energy

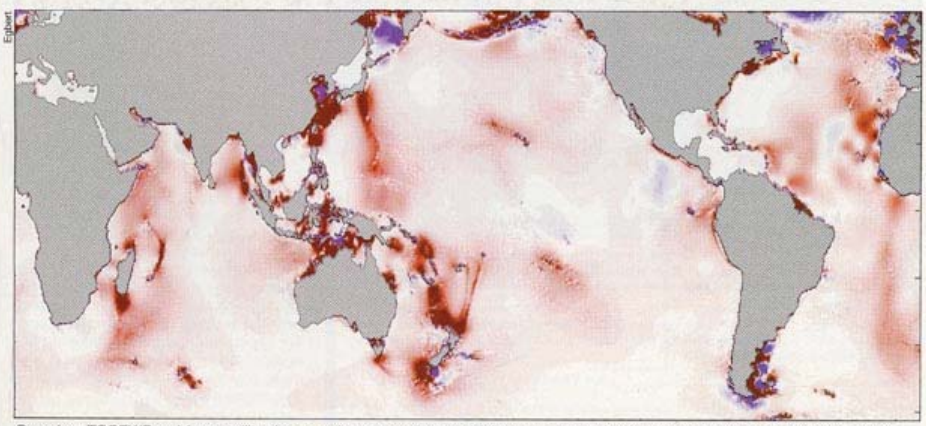


Gorlov Turbine and frame above water

Bason 2007

Gorlov Turbine and Frame System
(Merrimack River, Amesbury, MA)

World Map of Tidal Energy



Based on TOPEX/Poseidon satellite data, a color map estimates tidal energy dissipation in the ocean between 66°S and 66° N. Red areas show tides losing energy. Blue areas reflect noise in the data.

JULY 15, 2000 SCIENCE NEWS, VOL. 158 43

Red areas show most intense tidal energy

UNFCCC, Kyoto, and CDM are seriously flawed

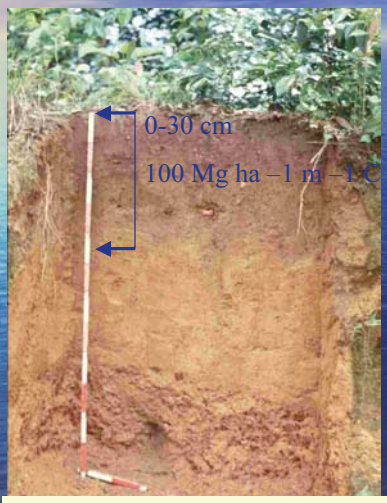
- Incomplete and inadequate accounting of ALL greenhouse gas sources and sinks
- Confuse net with gross fluxes
- Reward temporary reservoirs of carbon, like forests, while ignoring long term sinks like soils and sediments
- Open to claim false “sinks” like phytoplankton fertilization and coral reefs

SINK SIDE Solutions not currently recognized under CDM

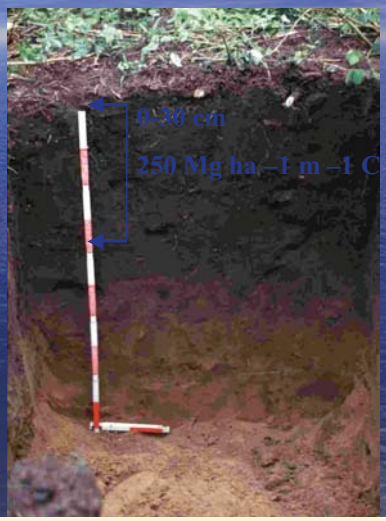
- **Addition of charcoal to soils, the ancient Amazonian Indian Terra Preta, greatly increases soil fertility, nutrient and water holding capacity**
- **The charcoal remains in soil for thousands of years**
- **This sink could be greatly accelerated**

Steiner 2007

Amazon soils:
Yellow =infertile **Black=fertile**



Oxisol



"Terra Preta do Indio"

© Glaser

Charcoal Carbon Sequestration

- Biomass carbon is converted to charcoal and then put back into the soil.
- About 2500 gigatons (Gt) of carbon are stored in soils
- This is about 4 times as much as atmospheric CO2 or total global forest biomass carbon.

- Soil charcoal remains thousands to millions of years in soils, and increases soil water and nutrient holding capacity, but is not included as a CDM sink, even though it is potentially one of the most effective means of increasing long term carbon storage, stabilizing climate change, and increasing fertility of tropical soils for sustainable development
- Improved kilns allow fuels to also be produced along with charcoal

Charcoal Carbon Sequestration

- Addition of charcoal to soils can store significant amount of carbon, for up to hundreds of millions of years.
- This is a permanent carbon sink, unlike forests which are only temporary
- However forest carbon is eligible for carbon credits while soil carbon is not!

Conventional Carbon Sequestration

- Currently carbon capture and storage (CCS) method costs approximately between $20-25/tCO2 which is including capturing, transporting and injecting costs. However, this cost does not include the cost of fossil fuel and of power plant which is part of the cost of producing CO2.
- Even if all fossil fuel carbon could be sequestered, this would only slow, not reverse, CO2 buildup in the atmosphere.

Carbon Sequestration by charcoal

- Charcoal carbon sequestration is the only means that can REDUCE the 34% excess of CO2 already in the atmosphere
- The charcoal has many direct benefits, greatly increasing soil fertility through its capacity to retain water and nutrients.

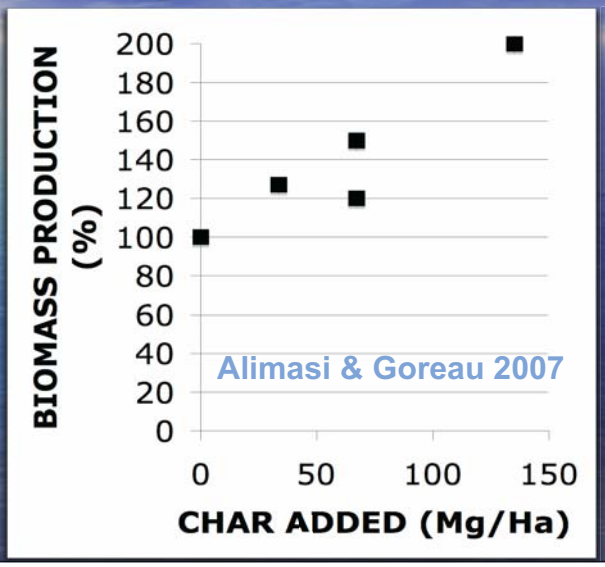
Benefits of Charcoal Carbon Sequestration

- Direct benefits:
  - increase crop yields, up to 200%, and 266% in some cases
  - increase food security and decrease rural poverty
  - Reduce the amount of organic and inorganic fertilizer use
  - reduce soil erosion and degradation
  - improve soil quality by improving porosity, water holding capacity and cation exchange capacity
  - income generation by selling charcoal

Benefits of Charcoal Carbon Sequestration

- improve soil fertility by reducing nutrient leaching.
- increase above ground and below ground biomass growth and carbon storage.
- reduce release of nitrous oxide and methane from soil.
- reduce need for deforestation.

Char greatly increases biomass production



Eliminating excess CO2

It is not enough to slow the growth of CO2, to avoid dangerous climate change the excess CO2 in the atmosphere must be removed. THIS IS NOT BEING DISCUSSED IN BALI!

This can be done by increasing global soil carbon by only 8% from around 0.5% by weight to around 0.54% with char, but should be focused on agricultural soils

CONCLUSIONS

MOST OF THE SOLUTIONS EXIST, BUT WE JUST AREN'T USING THEM BECAUSE POLICY MAKERS AND FUNDING AGENCIES DON'T KNOW ABOUT THEM

CRASH PROGRAMS FOR ADAPTATION TO CLIMATE CHANGE AND TO STABILIZE CO2 AT SAFE LEVELS BY IMMEDIATE INVESTMENTS IN SUSTAINABLE ENERGY, WASTE RECYCLING, LARGE SCALE ENVIRONMENTAL RESTORATION AND IN SOIL CARBON STORAGE ARE URGENTLY NEEDED BEFORE DAMAGE ACCELERATES

- There are no passengers on Spaceship Earth - We are all members of the Crew
- If we don't all work together we will boil or drown
- The fanatics who seek to divide us by colour, religion, language, politics, culture, income, or location to build their own power base are preventing our working together and solving our common problems

The big oil and coal producing and consuming countries are very well organized and throwing up constant smoke screens to deny and minimize the impacts of global warming and block any meaningful efforts to reverse it, because they want to continue their dirty unsustainable ways, and don't care what they do the rest of the world or to future generations.

Coral reef countries and island nations will be the first and worst victims of their greed, selfishness, ignorance, and stupidity.

We cannot afford to let them obfuscate, confuse, and delay any longer!

In Rio de Janeiro Island Nations let themselves be tricked into signing a Framework Convention on Climate Change that did not serve their interests.

IN BALI WE MUST TAKE THE LEAD!

- Dr. Goreau was educated in Jamaican primary and secondary schools,
- MIT (BS Planetary Physics)
- Caltech (MS Planetary Astronomy)
- Harvard (PhD Biogeochemistry)
- Formerly Senior Scientific Affairs Officer in charge of climate change and biodiversity at the United Nations Centre for Science and Technology when UNFCCC was being drafted
- Has dived longer and in more reefs all across the Caribbean, Pacific and Indian Ocean than any coral scientist
- Made first measurements of Amazon deforestation effects on greenhouse gas emissions
- Published papers on CO2 stabilization in the 1980s

Global Coral Reef Alliance

A tax exempt non-profit organization for coral reef protection, sustainable management, and restoration, based on a worldwide network of volunteers divers, scientists, fishing villages, environmental NGOs, government officials, and others who care about the future of our coral reefs and the ecosystems and people that depend on them

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