# IMPLEMENTING NEW TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT OF SMALL ISLAND DEVELOPING STATES

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## BACKGROUND

The Small Island Developing States (SIDS) are the first and worst victims of global climate change. They have already lost most of their corals, fisheries, and shore protection to global warming, and will lose the rest in a few years if current trends continue. Every year more and more low-lying islands vanish beneath the waves. SIDS can take no further warming or sea level rise. Yet at present CO2, temperature, and sea level rise are all accelerating and increasing faster than the rates projected by the Intergovernmental Panel on Climate Change (IPCC). But we have not yet felt the impacts because the excess CO2 already in the atmosphere will continue to absorb heat for centuries, and its full surface warming will be felt only when the deep sea heats up and ice caps melt, which takes up to thousands of years.

The last time global temperatures were 1 degree C above today's values, sea levels were 8 meters (25 feet) higher than they are now, and hippopotamuses and crocodiles flourished in London, England. At that time CO2 was more than <u>one third less than it is already</u>, so the impacts caused by the present levels of CO2 will be far larger. The last time temperatures were 3-5 degrees higher than today, sea levels were around 30 meters (or a hundred feet) higher than now. That is where we are headed if we don't very urgently reverse our course. For SIDS there is no time left to lose.

It is clear that prevent these impacts we must reduce CO2 by more than one third below present levels, yet even if current agreements and conventions were lived up to, they would only marginally slow the rate of increase, condemning coral reefs to death from heat shock and low lying islands to drowning. Stabilizing CO2 is simple, we just must put less into the atmosphere and remove more from it. This means large scale development of clean energy sources and drawing down the existing excess CO2. It is critical to realize that increases in energy efficiency to 100% and sequestering ALL fossil fuel CO2, would <u>not</u> reduce the current excess CO2 built up over the last century. Only actually removing CO2 from the atmosphere and permanent storage will work.

Cost-effective technologies are critically needed by SIDS to sustainably provide food from land and sea, restore fisheries and coral reefs, protect beaches and shorelines from rising sea level, provide clean and affordable energy for development, increase soil productivity, prevent pollution, and reverse global climate change. Collaborative approaches, focused on endogenous capacity development coupled to technology transfer, are needed to implement proven technologies to meet these critical needs. The most important proven new technologies are not being currently applied, due to insufficient knowledge of their potential, lack of funding, lack of organization to implement them, lack of training, and lack of appropriate international agreements that reward them. SIDS have begun to take the lead in developing and applying new technologies for global sustainable development, thereby locally reversing destructive impacts of global change. Some of these critical technologies are outlined here, along with policy steps to implement them on the scale needed. The solutions are at hand, proven, and cost effective, but we just aren't using them.

## ATMOSPHERIC POLLUTION

Due to lack of industrial development and low per capita energy use, SIDS are negligible sources of atmospheric pollution. These include gas, aerosol, and particulate pollutants that warm the earth, deplete the ozone layer, cause acid rain, increase smog, and deposit toxic metals and persistent organic pollutants. However, due to the global distribution of these pollutants by winds, SIDS will be the first and worst victims of their production elsewhere especially through global warming and sea level rise. Although climate change agreements technically do not fall under the purview of CSD, it is clear that there can be no real sustainable development without addressing climate issues. Full and complete accounting of all greenhouse gas sources and sinks is needed in the climate treaties, long term carbon sinks need to be recognized and rewarded, and a mechanism must be found to stabilize atmospheric composition at safe levels for future generations.

## INDUSTRIAL DEVELOPMENT

Many SIDS possess huge clean energy resources that are untapped, primarily tidal and solar. We need to use these resources to generate clean industries that are based on renewable natural resources by conserving our ecosystems, enhancing their productivity, and restoring damaged forests and reefs to both store more carbon and be more productive. Solar and wind are excellent energy resources for SIDS but are still either too expensive or limited in intensity and reliability in many places. Wind is not reliable except for some islands in the Caribbean and Pacific Trade Wind Zones, while solar panels are too expensive, due to lack of mass production. Support is needed for the development and large-scale production of cheaper solar panels. Energy taxes should pay the real long-term costs of air pollution by greenhouse gases.

## NEW SUSTAINABLE DEVELOPMENT TECHNOLOGIES FOR SIDS TO ADAPT TO AND PREVENT CLIMATE CHANGE AND INCREASE RENEWABLE ENERGY RESOURCES

Many remarkable, new, proven, cost-effective technologies could greatly contribute to sustainable development but are currently unfunded, and require policies to promote and fund their implementation on a large-scale. They include:

OCEAN TIDAL ENERGY

Of all the renewable energy technologies, only two, solar and tidal energy, have the capacity to meet the Earth's energy demands. Unfortunately solar energy is still much more expensive than fossil fuels, and will remain so until there is large scale investment in mass production to drive the price down to a competitive level. This needs to be done urgently. The only abundant sustainable energy resource that is already cost competitive with fossil fuels is the energy of the earth's tides, which are not to be confused with tidal waves (tsunamis), wave energy, or thermal energy. These are widely distributed and highly reliable: we can accurately predict tides anywhere thousands of years in the future. Although proven and cost effective, there is no large-scale investment in tidal energy, which needs to be urgently changed.

Tidal energy is the largest sustainable and non-polluting energy resource of almost all Pacific and Indian Ocean island nations, Cape Verde, some sites in the Caribbean, and many coastal Least Developed Countries (such as Guinea-Bissau and Guyana), but is totally unutilized. Tidal energy is yet to be recognized as a viable renewable energy resource by governments and funding agencies, because of lack of adequate information and advocacy, even though it is far cheaper than solar energy and more abundant than wind, hydro, or geothermal power. Cost-competitive cross flow vertical axis turbines to turn tidal currents into electrical currents are already available. Small pilot projects in remote rural areas have been built in the Brazilian Amazon and the Philippines. These new turbines can also be used for river power without dams in high, wet islands land-locked countries that are not dry and flat. Turbines to tap tidal and river power can be used wherever there are adequate currents, can range in scale from very small and isolated communities to that of the largest power plants, and be integrated with other energy systems.

In terms of policy what is required are a) recognition of tidal energy as an energy technology deserving international funding, and b) support for systematic assessment of the tidal energy resources of SIDS by making measurements of the speed and duration of currents at all potential sites to devise effective plans to tap their vast, unutilized energy.

BIOMASS ENERGY

New kilns are available that allow any biomass, not just plant oils and sugars, to be converted into hydrogen based biofuels. This is a process distinct from the biodiesel that can be made from palm oils or alcohol from sugar cane, and allows non-agricultural land to be a source of fuels, avoiding conflict with food production as do ethanol and oil fuels. Most SIDS have large areas of coconut palms with little economic value but great potential for biofuels, if the low productivity caused by poor soil fertility is remediated. If biomass is managed renewably, the fuels produced do not add net new carbon to the atmosphere. They can be produced in areas that are not suitable to for agriculture, unlike ethanol producing crops that require the best soils or heavy fertilization.

Biofuel production should be based on non-edible or non-usable biomass. Even more important, such fuels can actually be carbon negative, when more carbon is stored in soil than is burned as fuel. In that case they act to reduce atmospheric carbon dioxide. What is required in terms of policy action is introduction of carbon taxes and carbon trading schemes that take total and net carbon balance of fuel production and use into account, and pays for the full impacts of reversing their damage and sequestering their carbon. Biomass fuels that produce no net carbon dioxide should not be taxed, and carbon negative are receive fuels should receive a net payment from users of fossil fuels that add emit greenhouse gases to the atmosphere.

## CARBON SEQUESTRATION

The new biomass kilns produce carbon negative energy, because they produce more black carbon char than biofuels. If this char, instead of being burned like charcoal, is buried, it turns into low cost and permanent carbon sequestration. Unlike the high technology deep CO2 gas burial currently being examined, which is both temporary and costly, char and charcoal are perfectly preserved in soils for hundreds of millions of years. Moreover they greatly improve soil fertility. This method of creating highly fertile soils was developed by Amazonian Indians in ancient times, but their methods of making it have only recently been rediscovered after having been lost for nearly 500 years. Because of the great benefits of increased soil productivity, this is the most rapid, long lasting, and cost-effective form of carbon sequestration. Sequestration of CO2 produced from fossil fuels only partially mitigates the damage caused by their use, but cannot reduce the already existing excess of CO2 in the atmosphere. Growing biomass to sequester soil carbon is the only method can actually reduce this excess and reverse future impacts.

There is 2-4 times more carbon in soil than in all the living biomass of the world, but this sink is not recognized in the UNFCC, the Kyoto Protocol, or the CDM. Soil is a superior carbon sink to trees because it much longer lasting. Carbon in living trees, may burn, be cut, eaten by pests, killed by diseases, or die from drought or old age, and then the carbon is released back to the atmosphere. Biomass provides only temporary storage of carbon, but soil and sediment carbon are long-term carbon sinks. Complete accounting of ALL greenhouse gas sources and sinks is needed at all time and space scales, and carbon trading agreements should ONLY recognize and reward permanent sinks, which they don’t do now.

## SOIL FERTILITY RESTORATION

Carbon char in soils greatly increases soil capacity to store both water and nutrients as long as the nutrients deficient in the soils are added to it. This can be mostly cheaply done by using char to absorb and recycle nutrients in waste water effluents and use them to increase soil productivity, turning poor soils into rich soils and allow crops to flourish that could not previously be grown, instead of allowing nutrients to flow into the seas, killing coral reefs and fisheries.

Current agricultural practices are mining and destroying soil fertility and increasing erosion rates. Land management needs to focus on increasing soil productivity by increasing long-term storage of carbon and nutrients, and preventing weedy algae from smothering our coastal resources. Reforestation of hillsides is needed to prevent erosion, recharge aquifers, and reduce floods caused by more intense rain and storms caused by global warming. Farmers need training in the principles and practices of restoring long-term fertility of agricultural land by absorbing nutrients on soil carbon instead of degrading the soil or adding short acting chemical fertilizers that are largely wasted and quickly flushed out of the soil into rivers and aquifers.

## WASTE RECYCLING

Sewage can be turned into a non-polluting hydrogen fuel for vehicles and engines, fertilizer, and clean water using electrical plasma treatment and electro-coagulation of wastes. These new methods move well beyond composting toilets and anaerobic digestion technologies, and can be carried out without the large areas needed for conventional sewage settling ponds and sludge drying areas, which are hard to find on densely populated islands. However they need considerable electrical current, and are best carried out in conjunction with large-scale tidal, wind, or solar generated electricity. The fuels produced are not only clean, they cost about one third of petroleum based fuels and do not produce greenhouse gases, therefore acting to reduce future global warming. They can be used to power vehicles and generators. Sewage collection systems can be turned into fueling stations and producers of solid fertilizer and clean water on local scales, replacing large central sewage plants where they now exist.

No country in the world now treats its sewage to adequate levels to remove and recycle all nutrients, with the exception of the Turks and Caicos Islands, which requires all developments to recycle all their wastewater on their own properties for landscape irrigation with treated effluents. Policies are needed to locally recycle all waste nutrients on land, increasing soil fertility instead of polluting aquifers, rivers, and the ocean, causing massive overgrowth of weeds that kill valuable ecosystems like estuaries and coral reefs. No human generated nutrient release to the coastal zone should be permitted. Sewage should be treated as a valuable resource processed to produce clean water, fertilizer, and fuel rather than something dumped out of sight polluting ground waters and down stream ecosystems. Maximum use of fuels made from sewage should be promoted.

## AQUACULTURE

Severe declines in fisheries can be reversed by restoring critical degraded habitats such as coral reefs, mangroves, and riverside vegetation. Many new methods now exist to propagate the most valuable and over harvested marine fishes and invertebrates for large-scale cultivation of food and pharmaceuticals. These include sea cucumbers, algae, sponges, corals, oysters, lobsters, and fishes. Unlike conventional mariculture, which reduces biodiversity, promotes diseases and parasites, and pollutes surrounding waters with excrement and rotting of added feeds, the new methods are free of these serious defects.

What is required is support for training fishermen in the new more productive and less harmful techniques, to become sustainable farmers of the sea. Also required are funding for greatly expanded research and training programs in fisheries management agencies and in local schools and institutions. Community based management of marine resource access rights is needed to prevent the “tragedy of the commons”.

## CORAL REEF AND FISHERIES HABITAT RESTORATION

Coral reefs are the most productive, diverse, and environmentally important habitat in SIDS, but they are the most vulnerable ecosystem of all to gobal warming, pollution, and erosion from deforested land. I have dived for over 50 years and dived in almost all SIDS. Their corals are largely dead or in critical condition. Even if all the remaining corals were completely protected, there is too little left to restore SIDS fisheries, shore protection, tourism, and marine biodiversity. Only large-scale restoration of degraded habitats can restore their lost environmental and economic services. Solar, tidal, and wind energy have been used in more than 20 countries in the Caribbean, Pacific, Indian Ocean, and Southeast Asia to increase growth rates of corals and marine organisms on electrically stimulated growing limestone frameworks, which greatly increase survival of corals under conditions of extreme high temperature stress, and quickly build up dense fish and shellfish populations. This allows reefs to be kept alive where they would die, and new reefs and fisheries habitat to be grown in a few years in places where they cannot recover naturally. Reef fisheries are collapsing due to habitat destruction as much as over-fishing, so management of fishing effort alone cannot restore fisheries without large-scale habitat restoration. Because electric reefs can be built in any size or shape, new habitat specifically favoring certain species of fish, oysters, lobsters, and other marine organisms can be grown in areas where they now lack habitat.

Most of the world’s corals have died in the last few decades and the pace of their destruction will rapidly increase unless global warming is reversed and large-scale restoration is funded. There is a need for significant increase of funding for serious habitat restoration, which will be the only way to maintain the reefs that provide SIDS with most of their fisheries, tourism economy, marine biodiversity, and shore protection. Consideration should be given to encouraging or mandating shore hotels to grow reefs for ecotourism, habitat restoration, and beach protection, and support for community-based restoration of reefs to increase sustainable fisheries stocks and catches. Pilot programs to restore coral reefs with the new technology are already underway in Indonesia, Philippines and nearly 20 other countries, with only small locally-raised sources of funding.

SHORE PROTECTION

Healthy coral reefs are the best shore protection. Low voltage electrolysis of seawater has been used to grow reefs in front of shorelines to turn severely eroding beaches into rapid growth in a few years. In the Maldives, the lowest country on earth, a beach that was being piled high with sandbags to keep trees and buildings from falling into the sea, grew 15 meters (50 feet) in a few years after a reef was grown in front of it. It was not damaged by the Tsunami that passed over the island. This technology is the only hope for low-lying shorelines to protect themselves from sea level rise while restoring their beaches, fisheries, and ecotourism. It can use non-polluting local renewable energy resources to grow ecologically rich natural reef breakwaters at a fraction the cost of seawalls that provide none of these benefits. These reefs grow at several centimeters per year, and can keep up with sea level rise. They can be grown on large scales to protect whole islands wherever tidal energy resources are abundant. The limestone rock material grown is up to three times stronger than ordinary concrete, These breakwaters are self repairing because physical damage to portions of them grows back preferentially. This technology can be used to provide prefabricated limestone building materials, sand, and aggregate, replacing mining of reefs and sand.

Sea level rise has been considerably greater than the upper limit predicted by IPCC, and will increase greatly in coming years unless greenhouse gas emissions are severely reduced and carbon sequestration greatly increased. Because an unavoidable amount of sea level rise may already be in the pipeline even if greenhouse gas emissions are reduced, polices to promote large-scale increase of soil carbon sinks to draw down excess atmospheric carbon, and prevent runaway global sea level and temperature rise. Greatly increased funding is needed for growing living shore defense reefs around SIDS, using their renewable energy resources, to enhance, rather than destroy, beaches and coastal ecosystems as seawalls do.

The time for talking is now over, only rapid action can make a difference!