The Manzanar Mangrove Initiative

An economic, incentive driven approach to end global warming

The object of the Manzanar Mangrove initiative is to create whole new forests of mangrove trees in vast areas of the world where mangrove trees do not grow at the present time. This will contribute to alleviating poverty in parts of the world and to diminishing the threat of global warming. Poverty would be alleviated by creating a renewable resource - mangrove trees which produce valuable timber, and by enriching the fish populations of adjacent seas. The mangrove forests would fix CO_2 by photosynthesis into mangrove lumber and thus decrease the possibility of a catastrophic series of events - global warming by atmospheric CO_2, melting of the polar ice caps, and inundation of the great coastal cities of the world.

How and where could this be achieved? The how is addressed by some simple considerations of hydroponics technology. Plants can be grown in an inert medium such as sand or even in water so long as certain conditions are fulfilled. The pH and salinity of the water must be at levels tolerated by the plant, the water must contain the mineral nutrients known to be required by plants, air must be provided to the roots, and the temperature range of the habitat must be tolerated by the plant. In short term experiments we have determined that mangrove trees can tolerate pH from 6 to 9. The pH of seawater is approximately 8. Mangroves grow in seawater, so obviously they can tolerate the salinity of seawater, and in fact can survive at salinity's a little higher than that of seawater. We have compared the composition of complex algae media to seawater and found that the only elements in short supply in seawater were nitrogen, phosphorus, and iron. If a flask of seawater is placed in the bright sun, algae grows slowly. If ammonium phosphate is added to the seawater, algae still grows slowly. If ammonium phosphate and iron are added to seawater, algae grow rapidly. This means that if a plant can grow in seawater, we only need to add ammonium phosphate and iron to satisfy its nutritional needs. This also means that mangrove trees can be grown where they now do not grow if the seawater is fortified with ammonium phosphate and iron.

Where can mangroves be grown where they now do not grow? We will consider three general categories of sites: intertidal zones, deserts above the high tide line, and sites such as the Aegean islands where the tidal variation is small.

Let us first consider the intertidal zone of the desert shores of Eritrea. Fifteen percent of the intertidal zone contains mangrove trees. Why should this be so? On examination it is found that the mangroves grow in mersas where the scant seasonal rains are channeled to enter the sea. Is it possible that the reasons the trees survive are because they have water of a lower salinity a few days each year. Highly unlikely! It is difficult to think of a mechanism to account for the survival of a tree only if it has water of lower salinity a few days a year. The rains also bring clay so the mersas contain heavy mud with decaying organic material. Is it possible that mangroves only grow in mersas because they need mud? This is unlikely because as mentioned before plants can grow in an inert supporting material if conditions of salinity, pH, mineral nutrients, etc. are satisfied. Our explanation for why trees grow in mersas is that the rains bring the nutrients from inland, and the vital nutrients are nitrogen, phosphorus, and iron. To test this hypothesis, mangrove seedlings were planted in a section of intertidal zone where no mangroves existed. After about three months, all of these seedlings (20) were dead. Another five hundred were planted in intertidal zones lacking mangrove trees, including a barren, dead coral reef This time each tree was provided with slow release fertilizer, consisting of diammonium phosphate and iron oxide. This was accomplished by placing about two hundred grams of diammonium phosphate, and ten grams of iron oxide in a plastic bag that was tied shut and punctured ten times with a ten penny nail. The bag was buried a few inches from the tree. With few exceptions these trees have survived and flourished - some for up to a year. We conclude that intertidal zones of coastal deserts in tropical and subtropical climes, which now contain no mangrove trees, can be filled with mangrove trees if seedlings are planted and provided with slow release fertilizer.

Eritrea has an intertidal zone approximately 1000 kilometers long and one hundred meters wide. At a density of 1000 trees per hectare, we could plant 10 million trees in the intertidal zone of Eritrea. If the entire Red Sea intertidal zone were planted we could plant about fifty million trees. Other desert intertidal zones also show great promise. The gulf of California has a tidal variation of about 6 meters, and therefore has an enormous intertidal zone of about a kilometer in width. The shore line of the gulf of California is about two thousand kilometers long, so about two hundred million mangroves could be planted in the intertidal zone of the gulf of California,

What are the economic benefits, and what are the costs of planting desert intertidal zones in tropical and subtropical regions? First of all fish production would increase in adjacent seas. Secondly, if mangroves such as Rhizophera, which produce valuable lumber were planted, a valuable renewable resource would be established. Finally the economic benefit of averting global warming, melting of the polar ice caps, and flooding of the worlds harbor cities are enormous. The value of the tree after twenty years would be roughly 100 USD, and as lumber about 400 USD. Eritrea's ten thousand hectares of intertidal zone could produce four billion USD in twenty years or 200 million USD per year. Mexico's 200 thousand hectares of intertidal zone on the Gulf of California could produce four billion USD per year. This would be powerful economic incentive for such countries to do their share as world citizens to avert the global catastrophe threatened by global warming. The cost of such a program would be mostly labor. We calculate it would require about one man-hour per tree to plant and tend the tree for twenty years. This would include gathering the propagules, growing them in small plastic bags in a nursery, transplanting the trees, and applying once a year a slow release fertilizer. We calculate that the trees would require about ten kilograms of diammonium phosphate over the twenty years at a cost of about two USD per tree.

The Greek, Aegan and Adriatic islands, and the northern shores of Africa on the Mediterranean have no mangrove trees. Here the tidal variation is too small to bring air to the roots as the tides recede. A simple approach would be to plant trees inland, above the high tide line and irrigate by pumping seawater. The trees should be fertilized with slow release nitrogen, phosphorus, and iron and planted in such a way that good drainage assures that salt buildup does not occur. In Eritrea we have planted trees above the high tide line and irrigated them with seawater. They thrive if fertilizer is applied and drainage is adequate.

The great deserts of the world, such as the Sahara, the Arabian peninsula, and the Atacama could be converted to mangrove forests with seawater irrigation. Since these regions are so vast, the economic contribution of the trees would be very large, and such forests would banish the problem of global warming.

We believe that planting mangrove trees in areas where they do not grow is the only feasible and cost effective approach to global warming. In addition, the economic contribution of such a program diminishes the chances that a second catastrophe does not overtake the human race. This would be human overpopulation caused by its linkage to poverty. ***Dr. Gordon Sato*** ***January 1998 Eritrea***