

# Halophytes For Land, Water, Food, Energy and Climate

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# **“SPACESHIP EARTH”**

**The crew are:**

- Plundering the ship’ s supplies**
- Tinkering with the temperature and life-support controls**
- Still looking for the instruction manual**
- Engaging in bloody skirmishes in every corner of the vessel**
- Increasing the size of the crew by 2 million  
PER WEEK**

**P. Creola**

# **The (Economic) Ages of Humankind**

- **Hunter/Killer groups (~1 Million - ~5K BC)**
- **Agriculture (~5K BC - ~1850 AD)**
- **Industrial (~1850 AD - ~1950 AD)**
- **Information/BIO/NANO(~1950 AD - ~2030 AD)**
- **Virtual (~2030 - ?)**

- Hunter-Gatherer - “Nature Provided”
- Agriculture - Controlled Nature (Plants/Animals), enabled civilization
- Industrial - Mechanized Agriculture  
[1800-97% Farmers, Now-2%]
- IT/BIO/Nano - Automating Industry/Agriculture [ 1950-60%, Now-11%, heading to 2%]
- Virtual - Robotization of IT/Bio/Nano/Industry/Agriculture [TBD]
- **Technology MATTERS** - For Both Good and ill.....

# **Humans Have “Taken Over” and Vastly Shortened “Evolution”**

- Human Engendered ‘Evolution’ ~E7 times “Natural”**

## **Of the Planet**

- Global Warming, Pollution, Deforestation, Species Extinction, Ground Cover changes, Ocean Acidification**
- Huge “Public Works” (e.g. 3 Gorges Dam)**

## **Of the Human Species**

- Genomic Design and Repair**
- “Mind Children” (Moravec)**

## **Products/Life Forms**

- Cross Species Molecular Breeding**
- “Directed Evolution” (Maxygen etc.)**

# IPCC Estimates.....

- Based upon “SOLID” Science
- By 2100;
  - 5-6 degrees C
  - A meter to 2.6 meter Ocean Rise

# How Far Off are the Climate/Warming Estimates?

- **Projected arrival of ice-free Summers in the Arctic Ocean has shifted, in a few years [ based upon “ground truth”, what is actually happening] from 2100 to 2040 to 2018.....**
  - **Greater than projected worst case CO2 rise rate, Oceans warming faster, Ocean Acidification 10X faster**

# Positive Feedbacks not included in Current Warming Estimates

- **Fossil Methane [22X CO<sub>2</sub>] Release[s]  
[Tundra/Ocean]**
- **Tundra Soil and Ocean CO<sub>2</sub> Releases**
- **Reduced Ocean CO<sub>2</sub> uptake [ Temp increase,  
Acidification, Algae Reductions]**
- **Reduced sulfur transport, ocean into  
atmosphere [ Ocean acidification]**
- **Further Albedo changes**
- **Further Water Evaporation**
- **Ocean Circul./O<sub>2</sub> changes, H<sub>2</sub>S Prod.**

# With the Positive Feedbacks..

- **By 2100+, Possibly:**
  - **much greater temperature rise**
  - **At those Temperatures, beyond 2100 [ ~ 2130ish?]  
all the Ice melts, some 75 Meter Ocean Rise,  
directly affect over 2 Billion people.**
  - **Alteration of the Ocean Circulators, H<sub>2</sub>S  
production in Anoxic Oceans, Toxic atmosphere  
and Ozone layer Depletion [Losing area of  
Oceans equal to state of Texas each year now to  
anoxic conditions]**

The “Great Dying” [The Permian  
[90%] Extinction- 250 MY ago]  
triggered [as was Venusian Warming]  
by massive Volcanic CO<sub>2</sub> release.  
Anthropogenic CO<sub>2</sub> release[ 100X  
largest volcanic rate] is substituting for  
the Volcanic input, triggering the  
positive feedback mechanisms

AND, there is the very rapid  
Glacial Melting, Many of the  
worlds major rivers [ e.g. in  
Eurasia the Mekong, Yangtze,  
Indus, Ganges Brahmaputra, etc.]  
are Glacier fed. These are drying  
up, will seriously/adversely affect  
some 1/6th of the planets  
humans SOON.

# Two Major Plant types

- **Freshwater plants**, AKA GLYCOPHYTES, currently most of the food & fodder produced by agriculture utilizes fresh water plants
- **Saline/ salt water Tolerant plants**, AKA HALOPHYTES, Utilized for food and fodder in India and some other countries

Biomass takes up CO<sub>2</sub> during growth, sequestering some CO<sub>2</sub> in the roots. When utilize Biomass [distill, burn] for energy CO<sub>2</sub> returns to the atmosphere, better than a closed CO<sub>2</sub> cycle.....The problem with Biomass as an obvious Climate/Energy solution has been the shortages of fresh water and arable land.

# Some Non Traditional “Green” Energy Sources

- High Altitude Wind, Massive capacity
- Float heat exchangers in the Gulf Stream, Horizontal OTEC, Massive Capacity
- CO<sub>2</sub> conversion, via solar, into CO, other fuels.
- Solar produced Hydrogen
- **Biomass grown on wastelands using Halophytes/ salt plants and Seawater/ Saline irrigation**

# The Ecosystem appears to be “Crashing”

- Fresh Water Shortages
- Species Extinctions, Emergence of Fragile Mono-culture Biomes
- CO2 etc. induced “Climate Change”
- “Pollution” of all manner
- Deforestation
- Losses of Topsoil & Wildlife Habitat
- Overall, Humans Practicing “Anti-Terraforming”

**“Prevention of collapse of the  
Ecosystem has now become the  
overwhelming issue”**

**European Commission on Key  
Technologies for Europe, 2005**

# Water/Food

- Current food production based on Fresh Water Plants
- We are “running out” of Fresh Water
- The Ecosystem is “Crashing”, the “code word” is “Sustainability”

[Engendered by Population Growth, ~ 40% Plus too many of us for the Ecosystem to support NOW, Short some 40% of a Planet, if/as ROW attains U.S. Consumption rate will need 3 to 4 more planets...]

- Resulting in “PEAK EVERYTHING” .....
- A “Solution” is to switch to Halophytes [ “Salt Plants” ], produce food on wastelands using saline/salt water, 22 nations working this, ‘Solves” Land, water, food, energy, minerals and climate change.

Just a goodly portion of the Sahara capable of providing [ using halophytes, seawater Irrig.] sufficient Biomass to replace ALL of the Fossil Carbon, provide petrochemical feedstock and requisite food whilst returning some of the 68% of the fresh water now used for Conventional Agric. to direct human use. Overall – “Solves” land, water, food, energy & warming...

“Water Scarcity is now the  
single greatest threat to Human  
Health, The Environment and the  
Global Food Supply”

# Where the Fresh Water Goes

- 68% for fresh water plant Agriculture
- 15% Industrial
- 15% household

We COULD, via Genomics, careful engineering, corrosion solutions to enable seawater cooling, Policy/Law, changes in life styles/ diet, pollution abatement ETC. reduce MUCH the fresh water requirements for humans, perhaps by over 50%? Much of this meeting is devoted to Populating these solution spaces.....

# Ongoing Changes to the 3%

- Population increases
- Fracking requirements
- Energy generation cooling requirements
- Glacier melting/ rivers drying
- Pollution, increasing evaporation
- Soil Salinization from pumping saline aquifers
- Climate changes affecting rainfall
- Reduced capacity and salinating aquifers

# Nano impacts on the 3%

- Nano Plastic inexpensive PV for pumping
- Filters to reduce energy cost of desalinization and for “cleanup”
- Corrosion protection allowing use of seawater for cooling etc.
- Coverings to reduce evaporation
- Non wetting surfaces
- Sensors for monitoring

Conventional/Historical “Wisdom” -  
Seawater/Saline incursions/occurrence  
Detrimental-to-Disasterous for  
Agriculture

Unconventional - **Saline/Salt  
water Agriculture a Viable-  
to-Desirable Alternative to  
Conventional Agriculture**

# Advantages of Seawater AG

- **97% of all water is seawater, will not “Run Out”**
- **Seawater Contains:**
  - **wide variety of important minerals needed in the human diet**
  - **~ 80% of Nutrients required for Agriculture [need to add Nitrogen, Phosphorus and Iron]**
- **In proximity to a number of Dry/Desert Areas**

# The Emerging Desert Mantra

## [Some 44% of land worldwide is “Wasteland”]

- **Desert Area Characteristics**
  - Sunlight
  - Brackish/Saline Ground Water
  - Many near/on seacoasts
- Utilize these “Resources” For:
  - Nano-Plastic PV & Solar Thermal
  - Saline/Seawater Agriculture for Biomass/Energy and Food using halophyte plant stocks

# Alternative Seawater AG Employment Approaches

- **Desalinization [in General, too expensive for Agriculture]**
- **Cold/deeper Ocean water to [via heat exchangers] precipitate moisture from the atmosphere**
- **Seawater Greenhouses [involve vaporization/re-precipitation]**
- **Direct Plant Seawater Irrigation**

# Characteristics of Desert/ Wasteland Halophyte AG

- No observable salt buildup thus far, if occurs can be “mined” for valuable minerals
- Produces a cooler/ moist surface which induces fresh water rain downwind; on the Sahara, puts rainfall into the middle east
- Utilizes what we have a Plethora of – wastelands and seawater to SOLVE serious Societal Problems NOW and Affordably

# Halophyte [Salt-Plant] Utilization [Per Yensen]

- **Patents issued for Halophyte Crop[s]  
[Genetics, Genomics]**
- **10,000+ “Natural” Halophyte Plants, 250 of these  
are potential “Staple” crops**
- **Huge areas worldwide are already salt-affected  
[1 B Hectares] and another Billion Hectares  
overlie Saline Aquifers.**
- **Over 100 halophyte plants now in “trials” for  
“Commercial” applications**
- **25% plus of irrigated lands salt affected, Twice as  
much salt affected land as irrigated land,**

# Halophyte Characteristics

- Can have yields equal to Glycophytes
- Cover the product spectrum, seeds, fruits, roots, tubers, grains, foliage, “wood”, oils, berries ,gums, resins, pulp, Rich in energy, protein and fats
- “Salt Penalty” for Halophytes is an additional 35% water requirement to handle excess salts

# [Sample] Countries with Saline AG projects

- China
- Mexico
- Eritria
- India
- Pakistan
- Israel
- Libya
- Jordan
- Tunisia
- Current Status, Prototype Farms/Experiments for FOOD/Fodder
- Egypt
- Iran
- Morocco
- U.S.
- Saudi Arabia
- Syria
- UAE
- Kuwait
- Australia
- Sudan

# Chinese Seawater AG Reporting

- Genetically Modified [grown on “Beaches” using Seawater]:
  - Tomato
  - Eggplant
  - Pepper
  - Wheat
  - Rice
  - Rapeseed

For centuries, on the Indian Subcontinent, there has been a very successful Saline/ Brackish water Agriculture for Food and Fodder. Halophyte farming has been conducted for many years without noticeable salt buildup....

The Potential[s] for enhanced  
[Halophyte] Plant Growth via  
Nano/Bio Technology thought to  
be Large, 60% improvements thus  
far, "Only Beginning"

- A Recent Capability - Nitrogen Fixation  
[utilization/extraction from the air]

# On-going Research Areas

- **Enhanced Plant growth rates and enhanced “Salt-Loving”**
- **Reduced water/nutrient Requirements**
- **Irrigation Efficiency Improvements**
- **Plant /Lifeform tailoring for specific Bio-Conversion/Refining Processes**
- **‘Safe’/’Contained’ Saline/Seawater Irrigation Practices,Avoid-to-Obviate Fresh Aquifer Contamination**

# Sample “Wastelands” Suitable for Halophyte Biomass production

- Western Australia
- Around the Arabian Sea/Persian Gulf
- Middle East
- The Sahara
- Southwest U.S. incl. West Texas
- Atacama in South America
- “Others” worldwide

# Some Halophyte Resources

- Int. Center for Biosaline Ag, UAE
- Saline Ag Research Centre , Pakistan
- George E. Brown Jr. Salinity Laboratory, U.S.
- The Seawater foundation, U.S.
- Halophyte Biotechnology Center, Univ. DE, U.S.
- Halophyte Data Base, N.P. Yensen
- Institute of sustainable Halophyte Utilization, Pakistan