Northern Florida Climate, Energy and Sea Level Rise

Dennis M. Bushnell
Chief Scientist
NASA Langley Research Center

Introduction…..

- Brief will discuss the "unconventional" aspects, issues & projections for Climate and Flooding [situation and outlook] for Northern Florida, including:

- Climate Positive Feedbacks and their potential impacts

- The wide Spectrum of Green Energetics approaches

- Climate response options and resulting suggestions for Northern Florida

Will Address, **HOW MUCH, WHEN and WHAT CAN BE DONE**

“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**

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 Etc. Estimates…….

- Based upon “SOLID” Science
- By 2100;
  - 4-6 degrees C
  - A Meter to 2.3 Meter Ocean Rise

The greatest “known unknown” wrt climate is Aerosols, their effects are equal in magnitude and opposite in direction to CO2, Humans responsible for doubling the aerosol concentrations, which on balance is cooling, otherwise temperatures would be much greater. Aerosol formation dynamics and overall physical interactions with climate details largely unknown

How Far Off are the IPCC 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 faster, Sea Level Rise greater

Positive Feedbacks not included in Current Warming Estimates

- **Fossil Methane [22X CO2] Release[s] [Tundra/ Ocean]**
- **Tundra Soil and Ocean CO2 Releases**
- **Reduced Ocean CO2 uptake [Temp increase, Acidification, Algae Reductions]**
- **Reduced sulfur transport, ocean into atmosphere [Ocean Acidification]**
- **Further Albedo changes**
- **Further Water Evaporation**
- **Ocean Circul./O2 changes,H2S Prod.**

Methane Releases

- Massive amounts of Fossil Methane Hydrates present in tundra and oceans, off coastal regions
- Estimates indicate major east coast tidal wave if methane warming/ outgassing slumps ocean floor off Carolinas
- Sample Methane release observations:

- Siberia
- Arctic Ocean
- Bering Strait
- off Santa Barbara
- U.S. East Coast
- off Washington State

With the Positive Feedbacks..

- **By 2100+, Possibly:**

- much greater temperature rise

- At those Temperatures, beyond 2100 , all the Ice melts, some 75 Meter Ocean Rise, directly affects over 2 Billion people.

- Alteration of the Ocean Circulators, H2S production by anoxic bacteria in Anoxic Oceans, Poisonous 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_2 & Particulate release. Anthropogenic CO_2 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.

Rational[s] for "Going Green"

- **"Warming" [floods, storms, disease, ocean levels, droughts, species extinctions, tidal waves , Ocean Acidification, Ocean Circulation, H2S]**
- **National Security/Geo-Politics [Middle East and all that]**
- **Economics/ Balance of Payments**
- **Personal Economics/ "Independence"**

Current Worldwide Energy Usage

- Petroleum - 140 Exojoules
- Natural Gas - 85
- Coal - 90
- Biomass - 55 [**Potential to 4,000+**]
- Nuclear Fission - 28
- Hydroelectric - 9
- Geothermal - 2 [**potential to 5,000**]
- Solar - .2 [**Potential to 4,000+]**
- Others [Wind, etc.] - ~7 [**Potential to ~4,000]**

The “Opportunity” – U.S. Per Capita Energy usage is TWICE OECD countries and TRIPLE the world average,137th in the world in Energy Efficiency at a time when we are 13th in the world in terms of Quality of Life Index, we are OBVIOUSLY **not “energy competitive”, are extremely Profligate wrt energy**

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_2 during growth, sequestering some CO_2 in the roots. When utilize Biomass [distill, burn] for energy CO_2 returns to the atmosphere, better than a closed CO_2 cycle……..The problem with Biomass as an obvious Climate/ Energy solution has been the shortages of fresh water and arable land.

Advantages of Seawater AG

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

From Bioengineering…..

- Engineered Microbes which utilize CO2, sunlight and waste water to produce [projected] 20,000 gals of fuel/ acre-year, with Economics competitive with Petroleum at some $50/bbl.
- “Joule Biotechnologies” , Nascent Technology, A potential MAJOR transportation fuels breakthrough, **aquaculture**

Some Non Traditional "Green" Energy Sources

- High Altitude Wind, Massive capacity
- Float heat exchangers in the Gulf Stream, Horizontal OTEC, Massive Capacity
- CO2 conversion, via solar, into CO, other fuels, Solar Hydrogen Production
- **Biomass grown on wastelands using Halophytes/ salt plants and Seawater/ Saline irrigation , Agriculture**

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 much of the 68% of the fresh water now used for Conventional Agric. to direct human use.
Overall – “Solves” land, water, food, energy & Climate…

Water Sources

- 97% Saline/ salt water
- 3% Fresh water
- Some 70% of the Fresh Water in Glaciers, Much [of the rest] is in the Great Lakes and Lake Baikal
- .3 of the 3% [.9%] is in lakes, rivers and the atmosphere etc….

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**
- **Research ongoing on/for Halophilic [Salt-LOVING] Halophytes,The more salt the faster the growth…**
- **Huge areas worldwide are already salt-affected [1 B Hectares] and another Billion Hectares overlie Saline Aquifers.**
- **25% of irrigated land salinated….% Increasing, from pumping saline aquifers**

[Sample] Countries with Saline AG projects

- China
- Mexico
- Eritria
- India
- Pakistan
- Israel
- Libya
- Jordan
- Tunisia

- Current Status,Prototype Farms/Experiments for FOOD

- Egypt
- Iran
- Morocco
- U.S.
- Saudi Arabia
- Syria
- UAE
- Kuwait
- Australia
- Sudan
- Peru
- Chile

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

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, stops desertification of the sub sahara
- Utilizes what we have a Plethora of – wastelands and seawater to SOLVE serious Societal Problems NOW and Affordably

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

Halophyte Utilization

- Food
- Fodder
- Biomass/ Energy
- Petrochemical Feed Stock
- Wood
- Landscaping, ornamental
- CO2 sequestration
- Land Desalinization
- Wildlife Habitat

SYNOPSIS:

“Unusual” Frontier GREEN ENERGETICS

Green Energetic Sources – The “Unusual”

- **Drilled, Hot Rock Geothermal**
- **Halophyte and Algae/Bacteria Bio fuels [Saline/ Sea water agriculture and aquaculture]**
- **Plastic Nano PV**
- **Tidal Currents**
- **Genomic Biologic H2 Prod.**
- **Atmos. Solar CO2 processing into CO/Fuel[s]**
- **LENR’s**
- **Jet Stream Windmills,**
- **Horiz. OTEC/ Gulf Stream**
- **Osmotic Power/ solar recycleable**
- **Solar H2**

Solar Hydrogen Via Splitting Water

- PV plus catalysts e.g. nickel and cobalt [Artificial Leaf], To some 16%
- Gallium Phosphide photo cathode and Cobaloxime catalyst [Bionic Leaf]
- Dye-Sensitized Photoelectrosynthesis cell
- Antimony And Gallium nitride photoelectrochemistry
- Thermochemical Cerium oxide Redux reactions
- Bio-hybrid Photoconversion [Photosynthetic plant proteins and synthetic polymers
- Cobalt Oxide nanoparticles, also perovskite cells
- One atom think film of molybdenum Sulfide as catalyst
- Nanoporous Bismuth Vanadate with iron oxide and nickel oxide

Plus – Several methods in development to utilize sunlight, water and CO2 to produce H2 and other [storable] chemical fuels

Conservation – The "Unusual"

- CNT Computing & Elect. Loss Reductions
- Tele-Travel, Tele-Everything
- 30% plus Thermal-Electrics [serious waste heat recovery incl. power plants and parking lots]
- CNT/BNNT enabled weight reductions [Factors of 3 to 5], huge vehicle energy impacts
- Room Temp. S-C

The “Big Ideas” in Energy Conservation

- Structural “nano tubes”, FACTORS of 3-to-5-to-8 dry weight reduction, HUGE MPG increases
- Tele-Everything, Greatly reduced transportation for everything, including people
- Electric Motor Controllers, Major Energy Leverage
- Distributed Energy Generation/ seasonal energy storage
- Waste Heat Recuperators/ utilization [Thermoelectrics, Sterling, TPV, Pyroelectrics, Etc..]

IMPACTS OF ONGOING IT REVOLUTION UPON SOCIETY

- **Work (at home telecommuting, reduced local/corporal travel)**
- **Shopping (at home web based, (robotic?) delivery)**
- **Entertainment/leisure (at home immersive 3-D interactive/ multi-sensory via VR/holographic projection)**
- **Travel (3-D/interactive/multi-sensory tele-travel)**
- **Education (at home low cost asynchronous, web based on-demand, highly motivational, life-long distance learning, .edu)**
- **Health (at home interactive tele-medicine)**
- **Politics (increased real-time virtual involvement of the body politic)**
- **Commerce (tele-commerce already ubiquitous)**
- **Tele-Socialization, Tele -[onsite] Manufacturing**

Using Energy More Efficiently [Some Examples]

- Electric Motor controllers [load sensed/ input regulated, ~ 30% less energy, Elec. Motors consume some 50% of Electricity generated]
- Insulated Electrical Boxes in outside walls
- Regenerative Braking
- Truss-Braced Wing transport Aircraft with some 80% fuel burn reductions
- Photonic Crystals, 2X better than vacuum thermal insulation

Major Energy Storage Groupings

- Electric
- Gas/ Pressure
- Heat
- Mechanical
- Chemical
- Nuclear
- Conversion[s]
- Reduced Energy requirements to reduce storage requirements [“BOTH Raise the Bridge AND lower the River”]

Energy Storage – The "Unusual"

- SMES with CNT Magnets or Polymeric ultraconductors [Room Temp. S-C]
- SBER
- Metal [e.g. Zinc] H2 "storage"
- Isomers
- Positrons as Positronium
- Nano Casimir Force-Engineered H2 Storage
- Thermal accessed via low temperature high efficiency T-E
- Fulvalene Diruthenium [thermal storage]

Energy Storage
Recent Developments

- CNT Springs
- Seasonal Energy Storage
- Metallic H2
- Photonic Crystals for Insulation
- CNT and BNNT Pressure Vessels
- High Temp. S-C for Elec. Storage
- Nano-Enhanced Capacitors and batteries
- Zeolites for 4X water long term thermal storage

“Exotic” Battery Outlook

- Metal-Air batteries - Al, Li, Zn, using ionic fluids?, ~ to hydrocarbon Energy Density [~ vehicle range for same weight], Requires research for rechargeability
- Semi-Solid Flow cell, pumped suspended solid particles, also Vanadium and iron-chromium redox flow batteries, Magnesium-ion Batteries
- Sugar/enzyme , 10X Li-ion, refillable/ not rechargeable, Also Molten/Air [oxygen]
- Solid Electrolyte Batteries, also sodium-air
- Nano Tube skins/ structural could be an ultra-capacitor enabling Electrical Storage in the “Entire” vehicle

LENR [Low Energy Nuclear Reactions]

- Originally dubbed “Cold Fusion”, an experimental discovery with replication issues and no acceptable theory
- Now, 2.5 decades of massive world-wide data collection/experiments indicate is “real”
- Now, a possibly viable Theory [Widom/ Larsen]
- Not “Hot Fusion”, is electroweak interactions explicable via the “Standard Model” of Quantum Theory on Surfaces
- Theory being used to increase heat “quality” and practicality, no radioactivity safety issues
- Economics/Utility TBD…..

Drilled Geothermal

- Excellent MIT Study
- Usual Geothermal uses near-surface sources, limited in capacity/coverage
- For some 50% of many large land masses, if drill down 2 Km get 200+ degree C rock, 5 Km produces 300+ degree C rock.
- Drilling capability is some 10 Km
- Drill 2 somewhat adjacent holes, fracture rock in-between. Force 3,000 psi water down one hole and utilize the resultant Steam ejected from the other

Energetics "Wild Cards" Being Worked

- Metamaterials for Low Diffraction Power Beaming
- Positron Storage as Positronium
- High Efficiency Plastic Nano PV
- 30%+ Thermo-Electrics, adv. Bioreactors
- High Efficiency [KW/KG] Fuel Cells
- "On-Site" H2 Generation vice Storage [Zinc,….]
- Room Temperature S-C, IECF P-B11
- Tapping ZPE, High Yield LENR's
- Controlled Nuclear Isomer Energy Release
- SMES with CNT Magnets, Jet Stream windmills
- Lithium Tantalate Crystals, horiz. OTEC/ Gulf Str.
- CO from CO2 via Solar Energy , Solar H2

[An] Outlook for H2

- **Green [Solar] H2 is becoming doable**
- **H2 Infrastructure would take too long to put in place [compared to warming/ petroleum problem[s] time scales] and is exceedingly expensive**
- **Hydrogen Storage is still nascent, Nano Tech including Casimir Force Engineering could "help"**
- **Fuel Cells cost too much/weigh too much…[but improving much]**

- **Bottom Line[s]……Biofuel[s] [using existing infrastructures] are/will be the Green heavy transportation fuel of choice.**

“Conventional Nuc Fission Fuel Cycle Waste a Serious ”Problem” [near term waste storage approach is casks on an open parking lot at an Indian Reservation……],some estimates indicate [once through] fission Nuc fuel “runs out” in the 2020’s [Breeders,Thorium, Mox Fuel, closed cycles would provide very considerable “Extension”]

Suggested Green Energy Best Bets/“Ways Forward”

- **Seawater Ag, Aquaculture/ Cyanobacteria, Celulosic Biofuels to replace Petroleum for transportation**
- **Drilled Geothermal, Biomass, Solar Thermal , Nano Plastic PV and Wind to replace coal & NG**
- **Also - Tidal Currents, 20%-30% Efficient Thermo-electrics , SMES w/CNT Magnets [10X Chem storage?], extract atmos. CO2/process using solar energy into CO, Fuels , Horiz. OTEC/ Gulf Stream. Solar H2**
- **And – Research Positron storage as Positronium, LENR.**

PLUS - All the conservation approaches across the board

[Conservation could cut U.S. Greenhouse Gases by some 30%]

Can purchase, now, both designs for and manifestations of what are termed “off-grid”, “autonomous” or “self-sufficient” homes

[Energy, water, waste,food]

- no longer a “fringe” arena

Some Major Trend[s]

- Distributed Generation vice expensive/central energy sources/processing [reduced cost[s] and transmission losses] via Biomass [grass clippings, leaves, kitchen scraps, sewage, waste water greenhouses], Solar Thermal [active, passive] and Solar PV, LENR, Thermoelectrics, electrostatics and Piezoelectric [incl. rain], Micro Wind, Exercise Bikes, Heat Pumps [air, ground], Evaporative Coolers [200,000 off-grid homes NOW]
- Major Reductions in Energy Utilization [Tele-Everything/"Virtual Age", Conservation, CNT weight and Elec. Loss reductions,Etc…]

Current Distributed Energy Generation Percentage Utilization

- Denmark - 52%
- Netherlands - 39%
- Finland - 37%
- Russia - 31%
- Germany - 18%
- Japan - 16%
- China - 15%

The land required for a solar plant in the Southwest is, to first order, less than that for coal plant if one includes the land area required for coal mining in Montana, North and South Dakota, Wyoming

An Example of current Ideation - Concepts for Energy Generation from Highways

- Piezoelectrics in roadbed, from vehicle passage
- P-V in roadbed, From highways as “available” cleared “land”, major perspective capacity
- Solar Chimneys/solar thermal, from roadbed solar heating,subsurface heated air channels with turbines in heated air exhaust chimneys

Status of Renewables

- Far less subsidies than Fossil fuels [Fossil subsidies are 4X renewable subsidies]
- After several decades of reducing costs they are now at or below cost parity with Fossil Fuels. Less than coal and except for solar PV less than gas. PV will be less than gas in 2 years. Some PV now selling for less than 30 cents/ watt and still dropping
- PV developed with ever higher efficiency, some incorporating the waste heat as part of the output and some exploiting a wider spectral input and concentrators. Nano projections are up to some 70% PV efficiency eventually

Status of Renewables - 2

- Renewables are some 60% of new generation
- Utility scale solar now as low as 5.6 cents per KW-Hr, wind as low as 1.4 cents per KW-Hr [gas at 6.1 cents, coal at 6.6]
- By 2035, renewables surpass gas and coal, Solar largest single source by 2050
- Nucs are expensive, have serious waste issues, production rate for containment vessels is extremely low
- Halophytes could produce massive amounts of inexpensive biofuels [cyanobacteria aquaculture, halophyte Agriculture
- Distributed Generation likely to grow massively, power companies very worried, changes their business model much

Carbon Sequestration

- Spread Iron rich dust on Oceans to induce massive Algae blooms
- Biomass processing via pyrolysis to form “Charcoal”, bury to enrich soils
- Capture/Separate/Bury [**Expensive, “Leakage etc. TBD**…..]
- Genomic Biologics/ Root Sequestration, Halophytes sequester up to 18%
- Combined with Seawater to form Calcium Carbonate [Building stone]

Potential & Critical Impacts of Genomic and Synthetic Biology on Warming/Energetics

- **Terrestrial and Ocean Biota that thrive in the emerging conditions**
- **Optimized Terrestrial & Hydro Biomass including halophytes, algae, Bacteria**
- **[greatly] Enhanced Bio CO2 & Methane Sequestration, including oceanic algae**
- **Reflective Albedo?**
- **Bio-refining, bio fuel cells,**

Space Solar Power Issues….

- Of interest due to 24/7 Base load & 8X higher solar intensity
- Economics - Cost[s] of Space Access [~ order of magnitude too large], higher cost [rad hard] PV, Maintenance costs,
- Potential Energy Beam/Lobes effect[s] upon Biota, requires definitive studies [U.S. vs. Russian Exposure limits]
- Launch vehicle efflux effects [MANY launches]
- Potential storage solutions exist for competitive/ competitor terrestrial solar utilization as base load

The “Final” [Last Resort] Solution

- **Genomically modify the Biota [incl. humans] to “Take the Heat”**

- Ongoing studies of “Extremaphiles’, biologics in deep ocean vents, in deserts, in Yellowstone pools etc. plus the ongoing Bio Revolution [Genomics, Synthetic Biology] proffers the possibility of Designer Life forms [incl. Humanoids] capable of thriving in whatever evolves [Venus-like conditions is a “worst case” - ~ 400 degrees C if all the Ocean Methane/CO2 “Escapes”]

Tele-Travel, Transportation

- U.S. Past “Peak Car”, miles driven per year per capita dropping year on year
- Short haul air travel dropping much, long haul traffic projections dropping year on year
- By 2020 ish, some 40% of business travelers shift from long haul air in favor of superb immersive presence, 5 senses virtual reality
- On site printing manufacture vice central manufacture and hauling stuff around the countryside

Example IT Impacts – Teleshopping vs. “Physical Shopping”

- Overall, Negative environmental impacts of Physical Shopping are 50 times that of teleshopping
- Physical shopping requires/ produces 15 times the carbon emissions

- Per study by “MindClick GSM”, a Sustainability Consulting Firm

“It will be routine to meet in full-immersion virtual reality for business meetings and casual conversations in 5 to 7 years”

Ray Kurzweil,Author,”Age of Spiritual Machines” and “The Singularity is Near”

Seawater Rise, South Eastern VA

- Norfolk floods now at higher tides
- 2 to 3 times rise rate of rest of the nation
- Land subsiding due to pumping aquifers, asteroid impact at Cape Charles, last ice age , plus gulf stream shift off Carolinas
- In many areas Insurance companies will not write new homeowners policies
- Waterfront Home market softening, some appraisals reducing much year on year
- Flood Insurance rates raising

Approaches for Sea Level Rise

- Beach Nourishment/ Dune Building [requires sand, finite lifetime]
- Salt Marsh Restoration to mitigate wave action
- “Armoring”, hard protection, seawalls, riprap, levees,
- Elevation [Roads, structures, utilities]
- Regulation, Zoning, Building specs, land purchase [mainly forms of “Retreat”]
- Retreat, Some places / countries have adopted this,
- Flood Insurance and their rate structure
- Reduce green House gas emissions and do sequestration of such - WORLDWIDE

What is Particularly Expensive With respect to Sea Level Rise

- Raising roads, structures, utilities
- Armoring
- Failing to do cost/benefit analysis for the projected rise rates
- Failure to account for Hurricane [up to 18 feet plus] storm surge on top of the sea level rise

[In Northern Florida hurricanes occur every 12 to 16 years with major such at greater than 30 years, the frequency and intensity of storms expected to change going forward]

Sea Level Rise Issues/ Impacts

- Insurance [Flood, Homeowners, Mortgage]
- Reducing evaluations, appraisals, “saleability”]
- Length of Mortgages
- Costs of Raising, Armoring, Retreating
- “Repairs”, Upgrades
- Access [Roads, utilities, infrastructures]
- Recreation, Tourism

"You are [ultimately] looking at retreat, it is the only sensible policy, it makes no sense to defend the indefensible"

Prof. Colin Thorne, Univ. of Nottingham, U.K.

The Proclivity of Governmental consideration[s] of sea level rise is to base such upon historical data & expectations. The conservatism of the IPCC Projections and the positive climate feedbacks strongly mitigate in favor of faster sea level rise rates, changes the Raise/ Armor or retreat decision processes and time frames, cost/benefit analysis.

Global Warming "Solutions"

- **Green Energy ,Conservation**
  Mega /Geo Engineering Solution Spaces
- **Genomic Biologics w/greatly increased CO2 Uptake**
- **Trigger/Engineer Calderas [Nascent Volcanoes],Put massive amounts of dust in the Atmosphere**
- **Nano-Particulates spread on the monolayer of surfactant on the Oceans' Surface to alter Albedo, White roofs/ Concrete highways, Dust around the moon to shade the earth**
- **Gigantic reflective films/membranes in orbit, add sulfur to the atmosphere, LENR to transmutate C into Fe**
- **Seed Oceans with iron to provoke/enable Phytoplankton Blooms , Add Calcium Hydroxide to increase CO2 uptake, combine CO2 and seawater to form calcium carbonate**

Summary, Climate Change Impact[s] Mitigation

- Renewable, or at least a closed CO2 cycle, energy generation
- Carbon Sequestration
- Energy Conservation
- Geo-Engineering
- Human Bio-Engineering

Ways Forward For Northern Florida

- Renewable energy and conservation, as much, as soon as possible
- Use latest sea level rise projections to triage approaches for such, estimate return on investment, determine when “retreat” is the best approach
- Consider converting shallow flooded areas into aquaculture , including cyanobacteria, algae and fish farming
- Consider some “floating’ [homes, infrastructures]
- Grow Halophytes using salinated aquifers

Note – The Chinese have a nominal 1,000 year planning cycle, the Japanese some 140 years. The U.S. Planning cycle is 3 months on the “street” to the 4 year Presidential cycle. We are “Terminally Tactical”, change when have “Smoking Guns, Flaming Datums. We waited wrt climate change until the impacts were vividly apparent, actually had decades of notice……

Summary Thoughts

- The IPPC projections proving to be conservative, probably due to the Positive feedbacks, Many of the increasingly apparent climate change effects are not “pretty”
- It is possible to slow and possibly reverse climate change by going to renewables, Halophytes, Some mega engineering[white roofs/ roads, CO2 into seawater, Ocean fertilization], conservation

“2014 was the warmest year on record”