Mitigating Hypoxia by Harvesting Algae for Bioenergy Production:

Analysis of Harvesting and Conversion Alternatives for the Gulf of Mexico Situation

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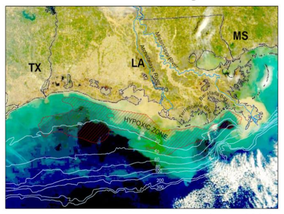
Background

Hypoxia describes a condition of low dissolved oxygen level (< 2mg/L) in natural water bodies that can result in large-scale kills of marine life.



(Kurg, 2007)


Photo: Nancy Rabalais, Louisiana Universities Marine Consortium

Impacts

- Most marine life must either retreat or die
- Increased travel distances for fishing,
- Air-born algal toxins that can affect human health
- Stark color & odor can reduce tourism

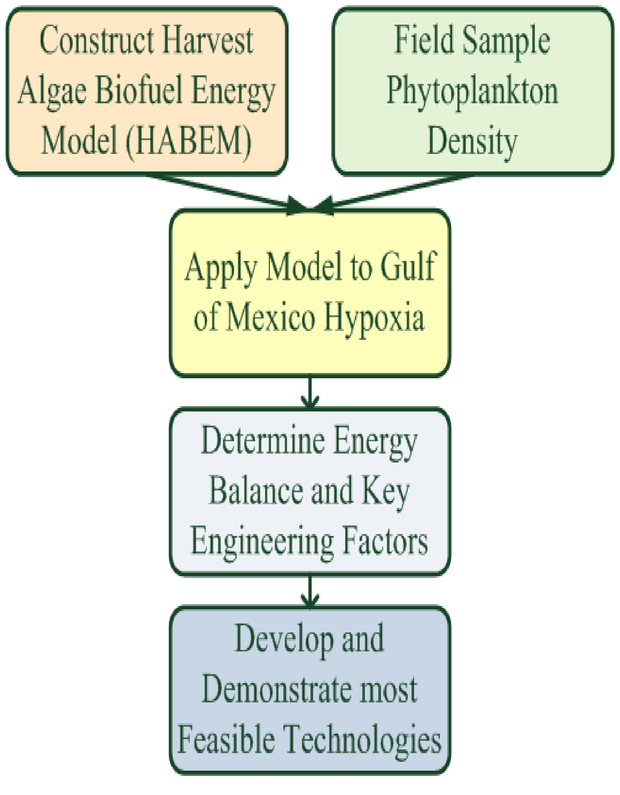
Proposed Mitigation

- Reduce fertilization in the Mississippi River Basin (EPA, 2007)
- Convert riparian farmlands to wetlands (CENR,1999)
- ***New Approach*- Harvest algal blooms and convert biomass into biofuel**

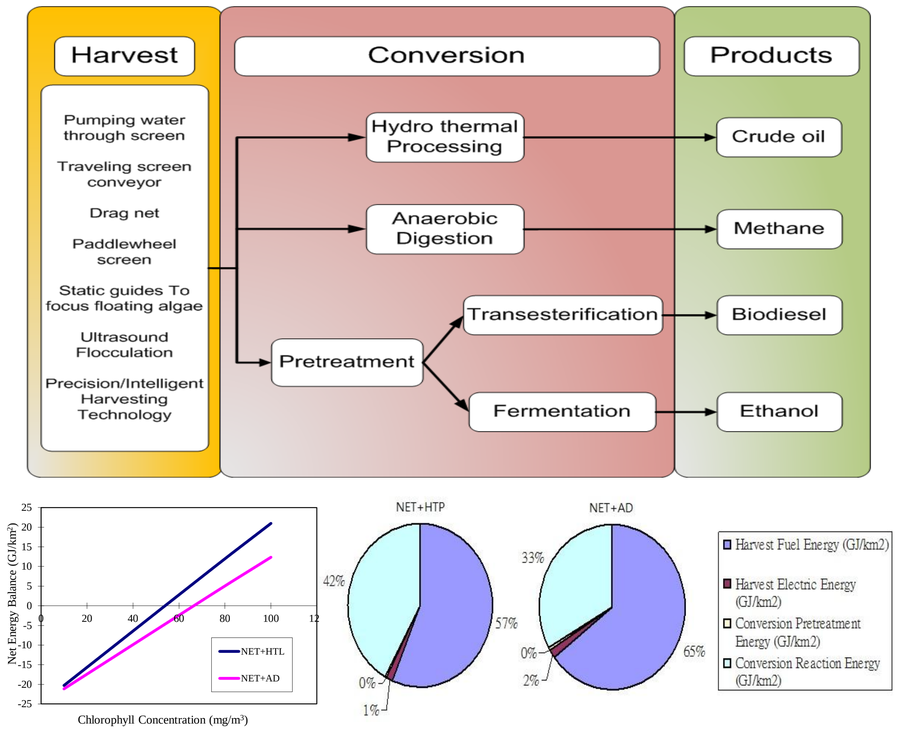
Objectives

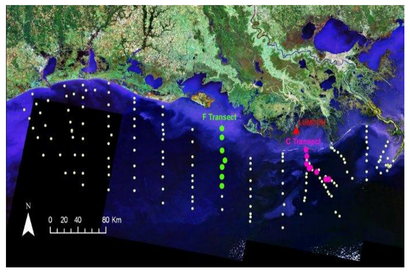
- Propose and describe various methods for harvesting & converting algae to bioenergy
- Develop an engineering model to compare the net energy balance for various harvesting and conversion methods
- Identify and evaluate promising opportunities for research to advance this novel hypoxia mitigation approach

Methods



Harvest Algae for BioEnergy Recovery (HABER) Model Overview



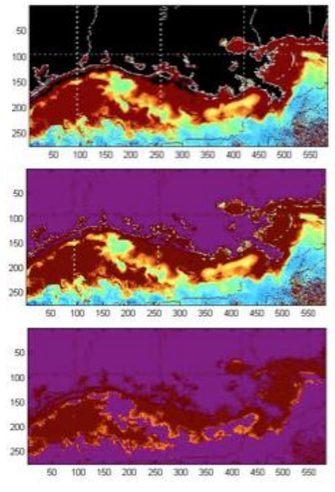


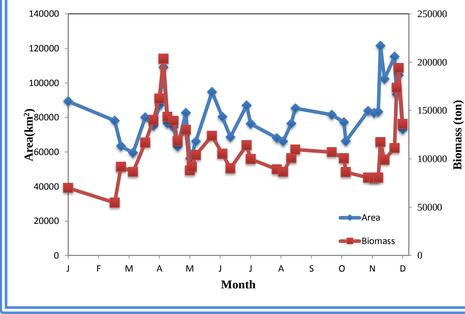
Field Sampling

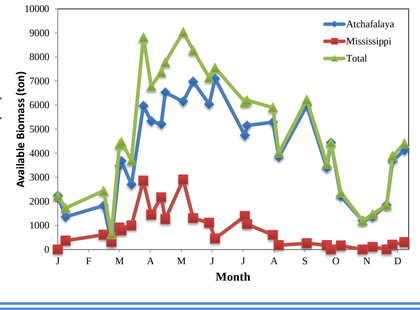
August 10, 11,2009, LUMCON cruise R/V Pelican went through two transects of the hypoxic zone, total of 15 stations sampled

Satellite Image processing

- Study site: northern Gulf of Mexico (88˚00W-92˚00W, 28˚00N- 31˚00N)
- Data retrieved from NASA SeaWiFS project.
- Program developed on MATLAB®







Conclusion

- The amount of algal biomass in the study area is estimated between 100,000 ton to 200,000 tons per year.
- Plankton net trawling was the most energy efficient harvesting method.
- Anaerobic digestion and hydrothermal processing had higher net energy yields.
- The proposed approach to hypoxia mitigation would lower costs and improve sustainability.
- Harvesting phytoplankton in the Gulf of Mexico and converting the biomass into biofuel can offset 98% of the expected harvest fuel consumption with vertical focusing technology.
- Improvement of algae harvesting technologies is needed to achieve a positive energy yield.

Proposed Algae Harvesting Technology Development

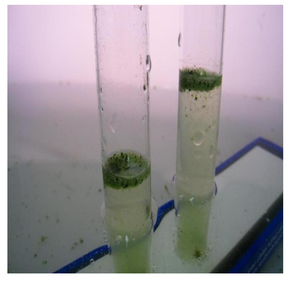

(Simplexity Creative)

Harvesting Vessel

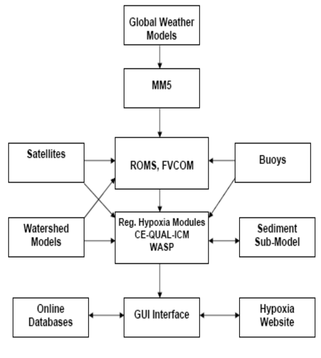
- Minimum harvest energy input and maximum harvest area
- Provide a motive force during harvesting
- Bioenergy conversion equipment on board

Algae Concentration

- Dissolved Air Floatation: Concentrate phytoplankton vertically to the surface for enhanced harvesting efficiency
- Eye spot Stimulation: Provide light or biomarker to attract algae focus
- Flocculation: Applied flocculants to aggregate algae for harvest



Forecasting System



- Real-time prediction of algal bloom areas
- Estimate the amount of biomass to be harvested
- Arrange harvest logistics for maximum harvest efficiency