NGI-BP Phase 2

Comprehensive Study of the Impact of the Deepwater Horizon Oil Spill on the Health and Productivity of Gulf Coast Salt Marshes

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Research Questions: (1) Which wetland patches (location) are most degraded due to the spill? (2) Which salt marsh species is the most vulnerable to the spill? (3) What is the degree of damage and extent of recovery in the spill impacted marsh habitats? (4) Is the damage due to sedimentary biogeochemical processes resulting from the degradation of the oil and increased microbial production of reduced chemical species such as sulfide? (5) Was some of the damage due to local climatic perturbation and early senescence rather than the spill? (6) Is there a high probability of marsh fire due to spill related marsh degradation or browning?

Research Category: Observation, Analyze, and Understanding

Work Completed from the Phase 1 funding: Phase 1 funds were primarily used for field data collection (remote sensing and biogeochemical) efforts. Three intensive field campaigns (Aug-Sep-Oct) were conducted in LA-MS recording precise *in situ* remote sensing reflectance (R_{rs}) and other biophysical parameters (chlorophyll, Leaf Area Index, and vegetation fraction) from salt marsh areas with different degree of contamination (Photos: Appendix 1). Sediment cores were also collected from MS contaminated sites for biogeochemical analysis. A comprehensive time series remote sensing and biophysical parameters database has been developed as part of the Phase 1 study from 61 sampling locations in LA and MS. Initial remote sensing and biogeochemical analysis results are very promising (Appendices 2 and 3).

Work Proposed for Phase 2: The overall goal of the proposed research is to quantify and map the *ecological impact* of the oil spill on the photosynthetic activity, physiological status, and primarily productivity of the coastal salt marshes. The field data collected during the Phase 1 will be used in satellite model calibration and validation through a remote sensing mapping protocol to generate time-series map products for the salt marsh biophysical properties along the LA-MS coast. The marsh biophysical products developed through this project will be used in combination with the biogeochemical and climatological data for assessing and evaluating the productivity of marshes that are impacted by the massive oil spill, thus providing State regulators important information for restoration and managements. The specific tasks proposed for Phase 2 funding are:

Task 1 (Mishra): Monthly time-series (pre and post spill) maps (12 maps per year; 36 maps covering 2009-2011) of salt marsh biophysical characteristics for the LA and MS coast showing the extent of damage and degree of recovery (if any).

Task 2 (Mishra): Identification of 'hot spots' of wetland degradation due to the spill and setting up three sites for long-term CO2 exchange and net primary productivity (NPP) study.

Task 3 (Mercer): Monthly time-series analysis of climate data for three years (before-during-after; 2009-2011) along the LA-MS coast. The specific goal of this task is to separate the marsh degradation due to climatic perturbations from the spill impact.

Task 4 (McNeal): Analyzing the relationship between the sedimentary biogeochemical response to the oil spill and the coastal salt marsh health. The microbial community and activity response to increased organic carbon loading from the transported oil contaminant will be measured, where sulfide production will be of particular interest. Salt marsh locations will be chosen along

LA and MS with different severities of oil contamination and control sites (those without salt marsh and without contamination) at each location will be measured to determine if the biogeochemical phenomena are unique to the salt marsh locations. These observations will assist in the understanding of the oil stressor to potential salt marsh decline and the biogeochemical processes responsible for the impact of the oil on this critical ecosystem.

Task 5 (Cooke): Quantifying the changes in the pre-and post spill probabilities of marsh fire due to the degradation of marsh biophysical parameters. Previously established protocols in combination with the biophysical maps developed through the Task 1 will be used to calculate the fire frequency and size probabilities in the LA-MS coastal marsh habitats.

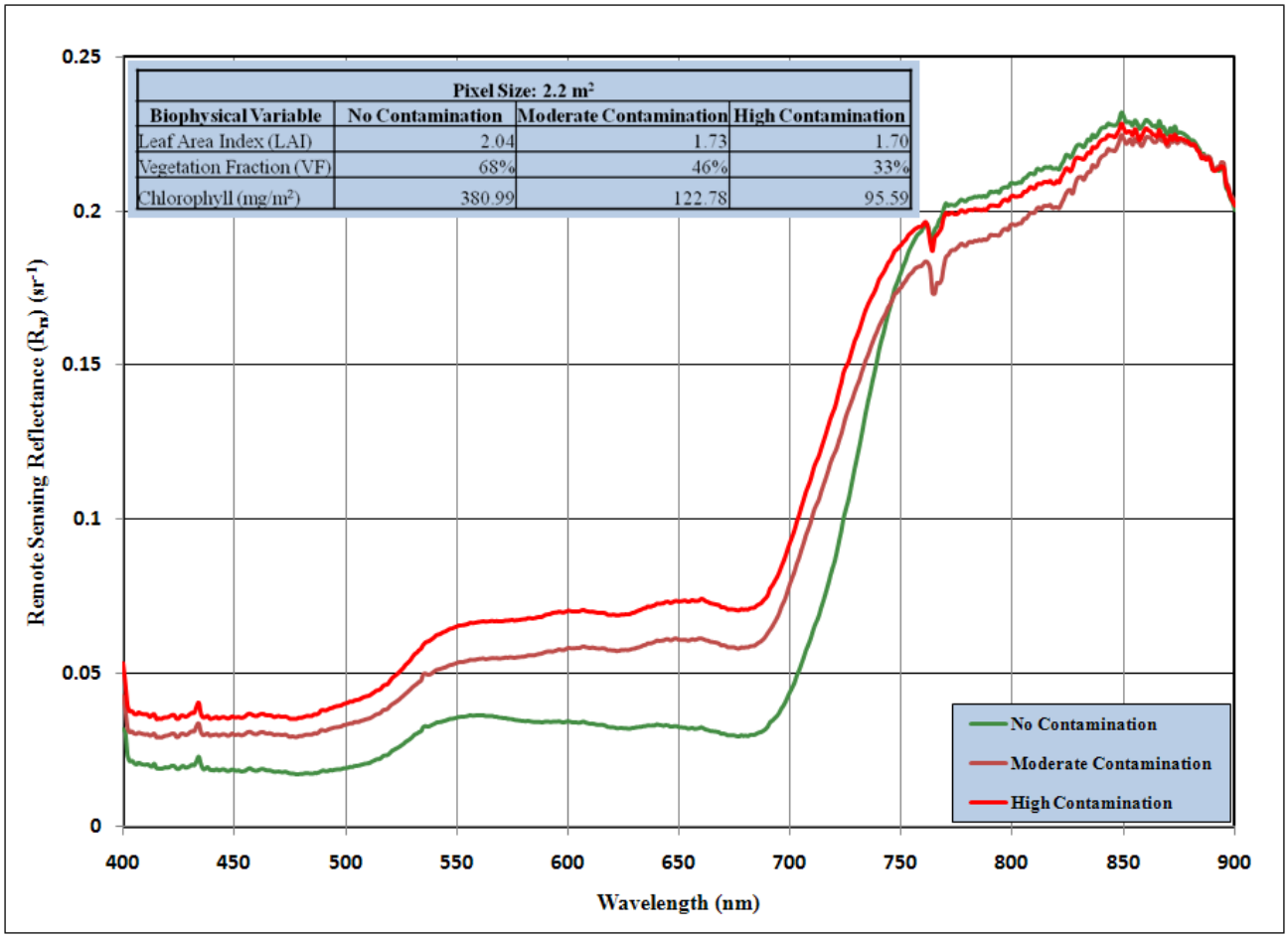
Collaboration with the Other NGI Institutes: We have ongoing collaboration (from the Phase 1 funding) with GCRL-USM (Biber and Wu) who are studying the changes in the photosynthetic activity in the spill impacted salt marsh habitats. We have synchronized the field trips and sampling locations so that our results can be ultimately combined to develop tangible map products and publications.

Long-term Goal: Our ultimate goal is to obtain funding from the GOMA-BP 10-year research program to perform a comprehensive long-term assessment of the spill impacted coastal salt marsh habitats. We will utilize the Phase 2 funds to answer the above described research questions which will lead to publications and attract GOMA funding.

Appendix 1:

In situ collection of hyperspectral remote sensing data for salt marsh biophysical model calibration and accuracy assessment, Marsh Point, MS.

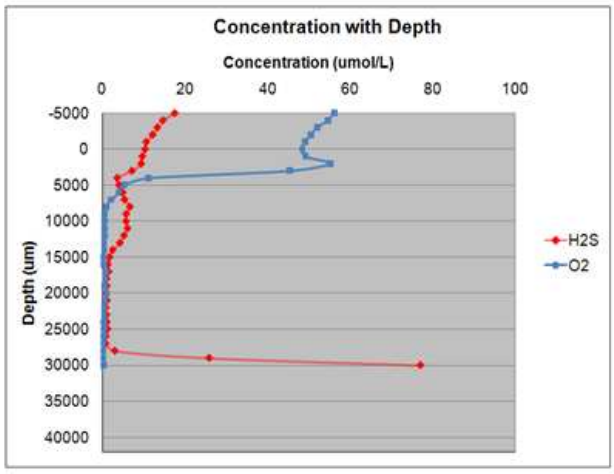
Appendix 2:



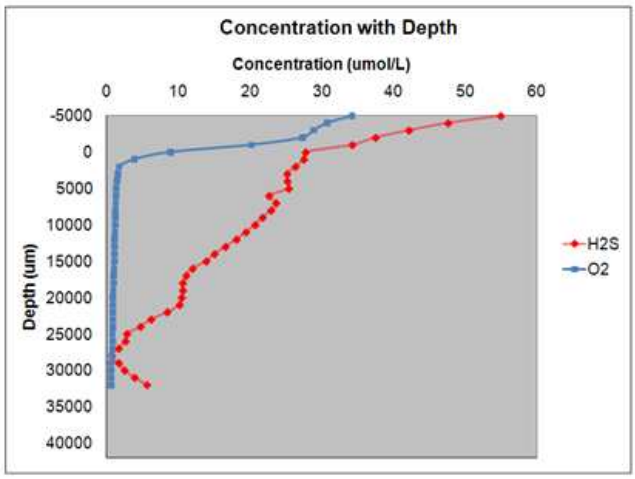
Significant difference was observed in the remote sensing reflectance spectra between marsh patches with different degree of oil contamination.

Appendix 3:

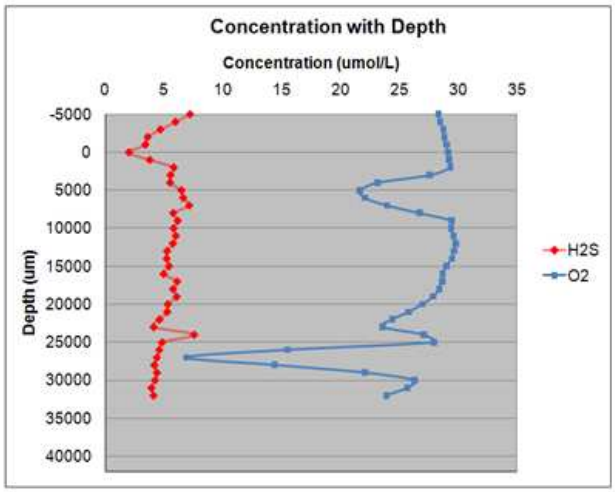
Non-Contaminated Sediment



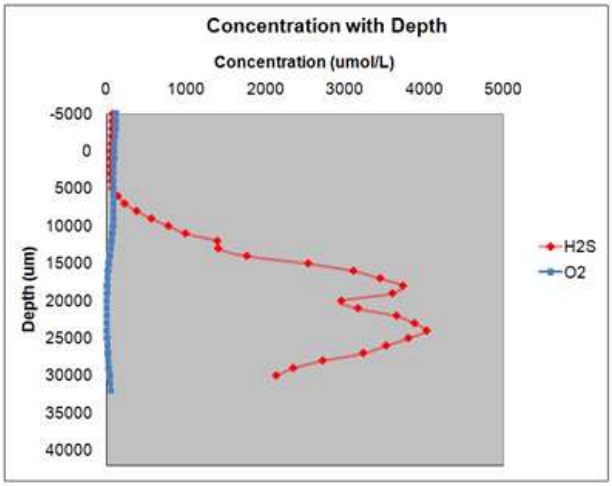
Contaminated Sediment



Non-Contaminated SaltMarsh



Contaminated SaltMarsh



Significant increases in sulfide concentrations (~4000 μM) were detected in salt marsh contaminated sediment as compared to contaminated sediment (no salt marsh, ~55 μM) and non-contaminated sediment (30-60 μM, salt marsh and no salt marsh). Sedimentary sulfide has been shown to impact above ground biomass and health and we postulate that the increased carbon from the oil will induce a similar effect during degradation of the organic rich materials by microorganisms residing in the sediment.