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Assessing water quality in the Gulf Of Mexico using remote sensing data.

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Water Quality in the Gulf of Mexico

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Introduction

The Gulf of Mexico suffers from an annual dead zone in the height of spring-summer months. The “dead zone” is a direct result of hypoxic conditions that create areas of stress and unlivable conditions for marine life. In the last five years the zone has held an average size of 14,353 sq km (EPA); which is only 4 sq km less than the size of Connecticut (14,357 sq km). The state sized zone has continued to be an enormous threat to the biodiversity in the surrounding aquatic ecosystems. Hypoxic conditions in The Gulf of Mexico are a direct result of anthropogenic causes. Nutrient rich fertilizers and waste runoff into the Gulf of Mexico play a key role in the hypoxic conditions. Many aquatic environments are limited by the same nutrients, phosphorus and nitrogen, that are rich in fertilizers. When the waste nutrients reach the water, algal populations thrive as they grow best in nutritive conditions. An overgrowth of algae leads to an algal bloom, algal death, and eventually decomposition of the algal populations by oxygen consuming bacteria. The water conditions then become anoxic and unsuitable for the marine life.

The hypoxic zone not only has environmental impacts, but economic side-effects as well. It puts fisheries out of business as shrimp and fish species must flee to better suited conditions. The severity of the hypoxic conditions increases in the summer months, precipitation, sunlight, and wind also affect the size. The amount of nutrients in the Gulf of Mexico is not directly measured with satellite data; however, chlorophyll concentrations are a useful indicator for assessing nutrient loading. When there is an algal bloom there is a noticeable color change; this change occurs due to the increase in chlorophyll, the green coloring matter in plants. Phytoplankton contain chlorophyll and this can be picked up by satellite measurements of chlorophyll. Nutrient increase in the Gulf of Mexico contributes to the increase of chlorophyll in the most anoxic areas.

Monitoring chlorophyll concentrations around the coastal areas is a great tool for assessing water quality. Here, I use MODIS-Aqua 9 km Chlorophyll-a data to analyze the trends for summer and winter in 2014. Colored Dissolved Organic Matter (CDOM) refers to the optically observable component in dissolved oxygen. It refers to the organic matter in water that absorbs strongly in the UV and light reflectance also infers a lot about water quality. MODIS Aqua-9km was used as an additional tool to the Chlorophyll-a data in hopes of inferring more about the water quality and building a stronger assessment of the area.

I noticed an anomaly in 2012. The dead zone was 7482.48 sq km, almost half the size of the five year average from 2009-2014. In 2012 there was also a record breaking drought and I hypothesised that remote sensing data would help correlate the two. From previous knowledge I understood decreased precipitation played a large role in the size of the dead zone, but wanted to investigate to what extent. 2009 suffered a similar lower than normal dead zone area and there was a 2008-2009 drought in South Texas. Both year averages were steps in the right direction, but at what cost? If drought is to blame for the smaller dead zones-this is not an actual improvement because there are other economic and environmental losses from droughts.

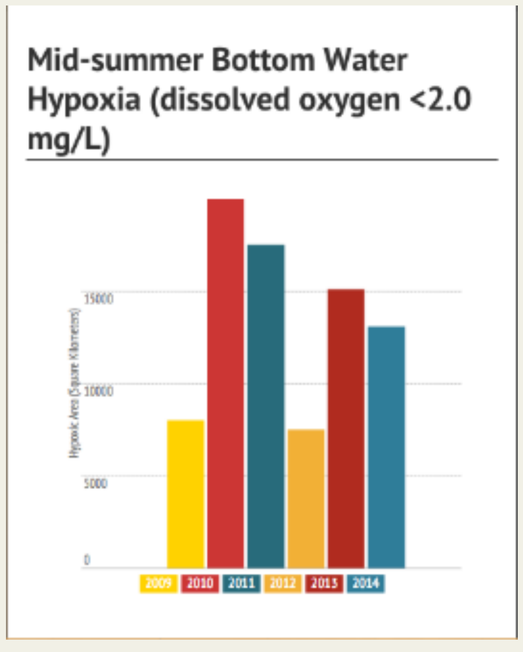
Research Questions

- **How can CDOM and Chlorophyll data be used to analyze water quality in the Gulf of Mexico?**
- **How does the summer weather influence the size of the dead zone?**
- **What happened in 2012 that caused the smaller than usual dead zone?**

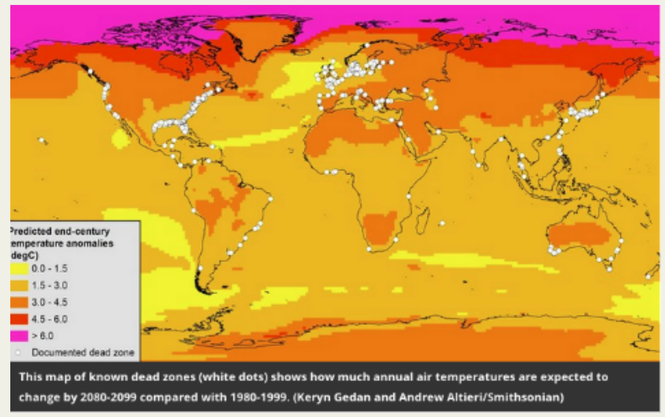
Study Site and Methods

- Study area: W: -97.388, N: 30.382, S: 27.343, E: -82.875
- Conductivity Temperature Depth (CTD) stations by NOAA to observe 2012 anomaly and form five year average of the dissolved oxygen levels
- MODIS Aqua 9 km Colored Dissolved Oxygen (CDOM) measurements
- MODIS Aqua Chlorophyll a data in the spring/summer and early winter periods. Averages of each period

Graphs/figures

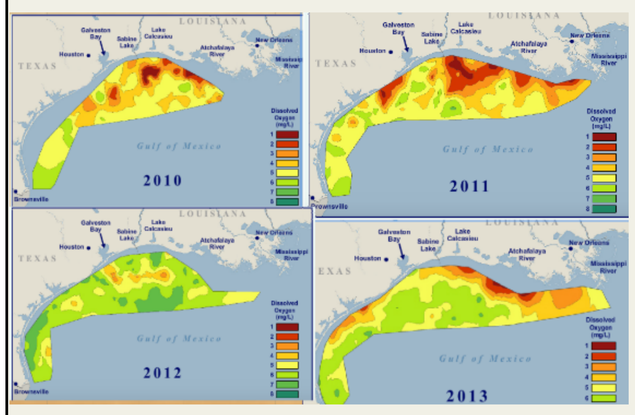


Graphs/figures



This map of known dead zones (white dots) shows how much annual air temperatures are expected to change by 2080-2099 compared with 1980-1999. (Keryn Gedan and Andrew Altieri/Smithsonian)

Graphs/figures



CTD data averages for 2010, 2011, 2012, and 2013.

Images show an anomaly in 2012 with a smaller than normal dead zone area.

Conclusions

The 2012 anomoly was caused by the Midwestern drought. Less runoff was able to reach the Gulf of Mexico due to less precipitation.

Precipitation patterns play a large role in the size of the dead zone

MODIS Aqua Chlorophyll a data provided clear trends of seasonality with the dead zone as it does not appear in the winter season.

Acknowledgements: