New Environmental Public Health Indicator Linking Organochlorine Compounds and Type 2 Diabetes

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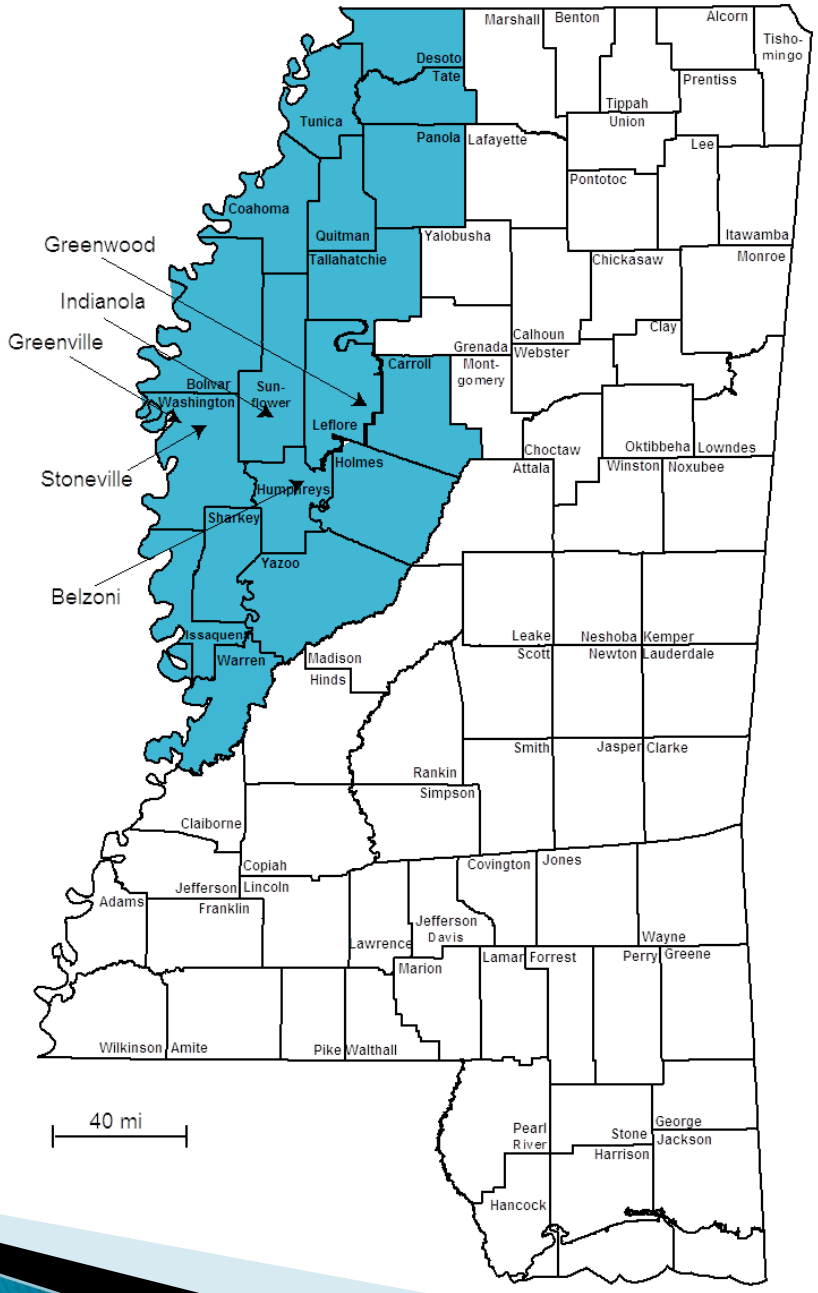
Background

- Diabetes mellitus is defined by hyperglycemia.
- Type 2 diabetes (T2D) comprises 90-95% of all cases.
- US prevalence of T2D: 7.7% (MS 13.1%).
- The prevalence of T2D is increasing; in MS from 2004→2008, 9.5%→12.3%.
- T2D death rate, per 100,000: US, 23.3; MS, 25.6; MS Delta, 49.0.

Mississippi Delta

- Highly rural.
- High poverty; 30.6% below poverty level.
- Most areas are Health Professional Shortage Areas or Medically Underserved Areas.
- African American population, 60%.
- T2D death rate in African Americans 27% higher than in Caucasians.

Mississippi Delta Counties



Organochlorine (OC) Insecticides

- Heavily used agriculturally in 1950's and '60's.
- Millions of lbs of pesticides were used per year in the 1950's and '60's, with over 50% OC's.
- Chlordane used residentially.
- Lipophilic, persistent and bioaccumulative.
- MS is 8th in US in pesticide use, and 32nd in US in geographic area.

OC Compounds and T2D?

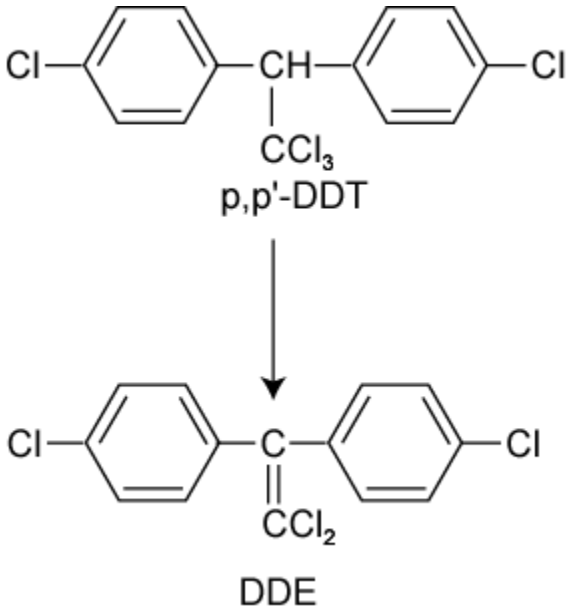
- From NHANES data, OC's higher in those with CVD, T2D, insulin resistance and metabolic syndrome (OC levels were lipid-adjusted) (Lee et al., 2006; Lee et al., 2007)
- Agricultural Health Study in Iowa and North Carolina implicated OC pesticide use with T2D (Montgomery et al., 2008)
- If there is an association between OC compound levels and T2D, then people in Mississippi are very likely to show it.

Recent OC Compound Residues

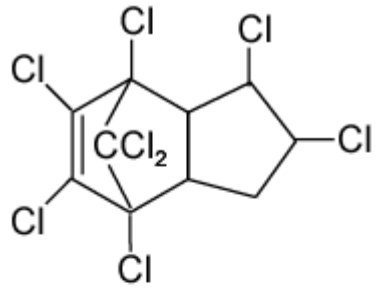
- 2004 study of AL, LA, and TX soil showed measurable levels of DDE in all samples (Bidleman and Leone, 2004)

- Measurable levels in healthy populations
  - Belgium (Charlier and Plomteux, 2001)
    - 82% positive for OC pesticides
  - Spain (Jakszyn et al., 2009)
    - 98% positive for DDE

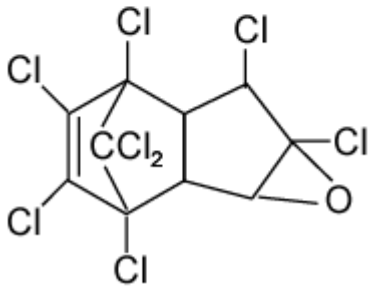
DDT and its Bioaccumulative Metabolite DDE



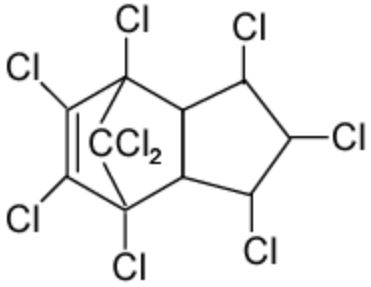
Chlordane and its Metabolite Oxychlordane and *trans*-Nonachlor



chlordane



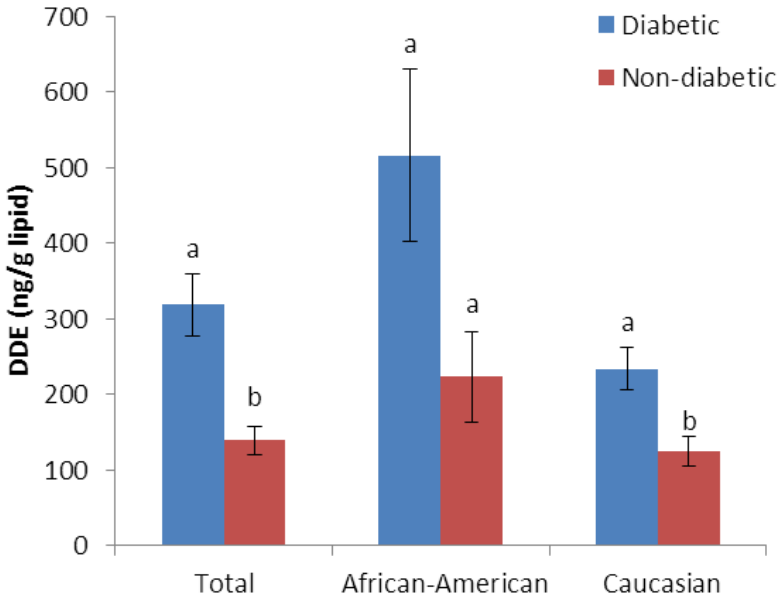
oxychlordane

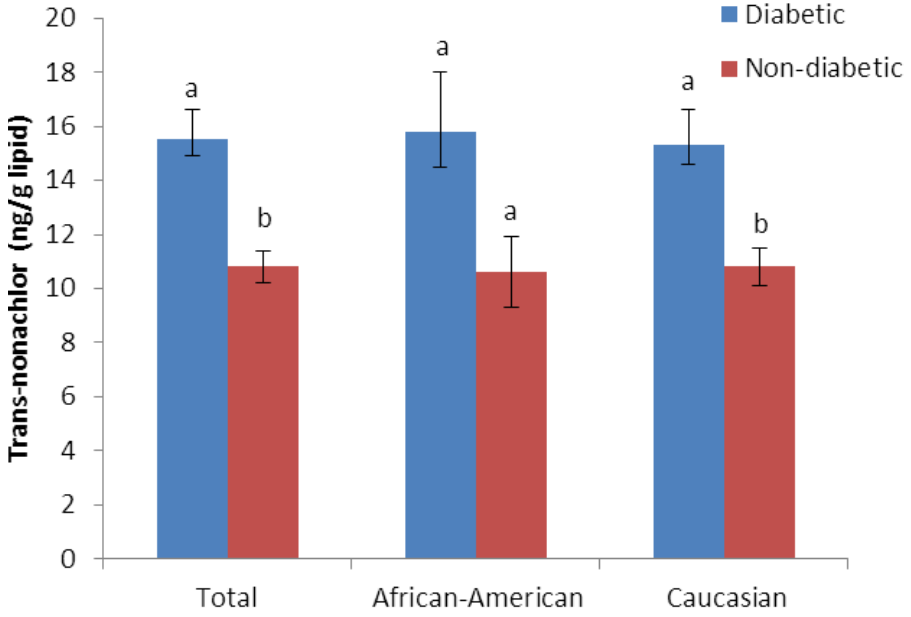


trans-nonachlor

Serum Concentrations of 2 OC Compounds

(subjects from Keesler AFB, Biloxi, MS, and Wright-Patterson AFB, Dayton, OH; 151 non-diabetics, 149 T2D; 68 African Americans, 232 Caucasians)





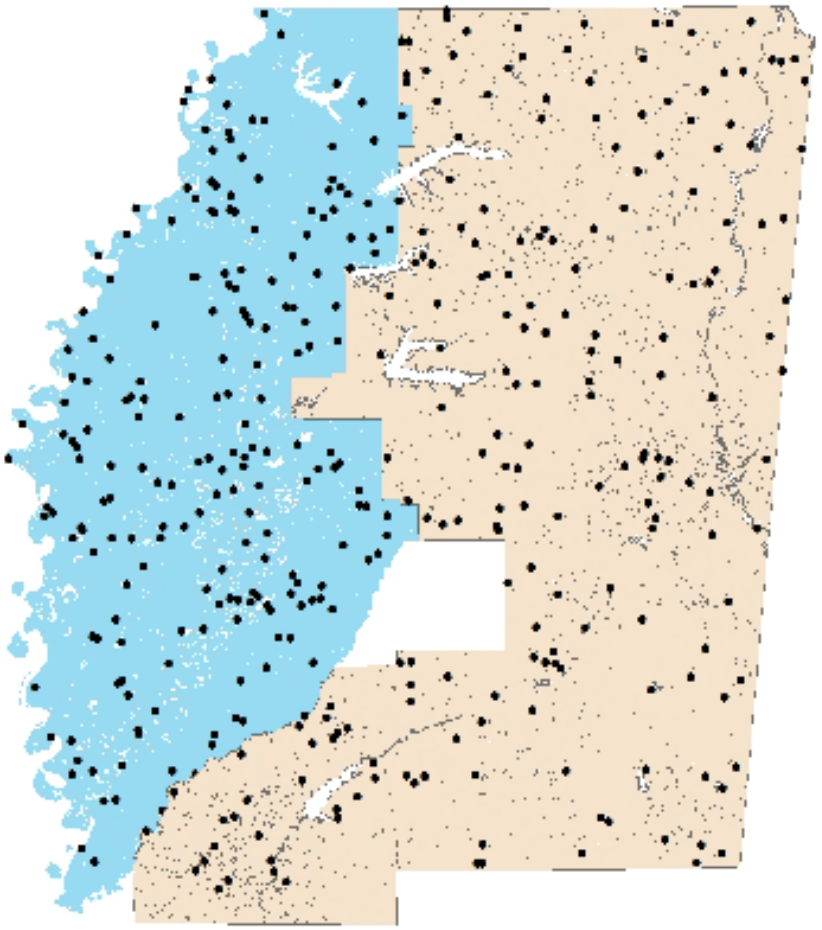
Hypotheses for the Current Project

- 1. Soil levels of OC compounds and serum levels of these compounds in people residing in a region of intense agriculture are greater than levels in soil and people from a less intensely farmed region.
- 2. A quantitative relationship exists between serum levels of OC compounds and the prevalence of endocrine disorders of glucose metabolism (T2D/prediabetes/increased insulin resistance).

Project Design

- Soil samples from 40 Delta (high agriculture) and 40 non-Delta (not high agriculture sites); sampling sites randomly selected.
- Serum, demographic and clinical information (deidentified) from 150 Delta and 150 non-Delta males (at least 45 years of age) from patient pool of Veterans' Administration hospital in Jackson, MS.
- Quantification of *p,p'*-DDE, trans-nonachlor and oxychlordane in soil and serum (and potentially other OC's if high levels in many samples).
- Quantification of serum insulin levels.

Sampling Sites for Delta (blue) and Non-Delta (tan) Counties



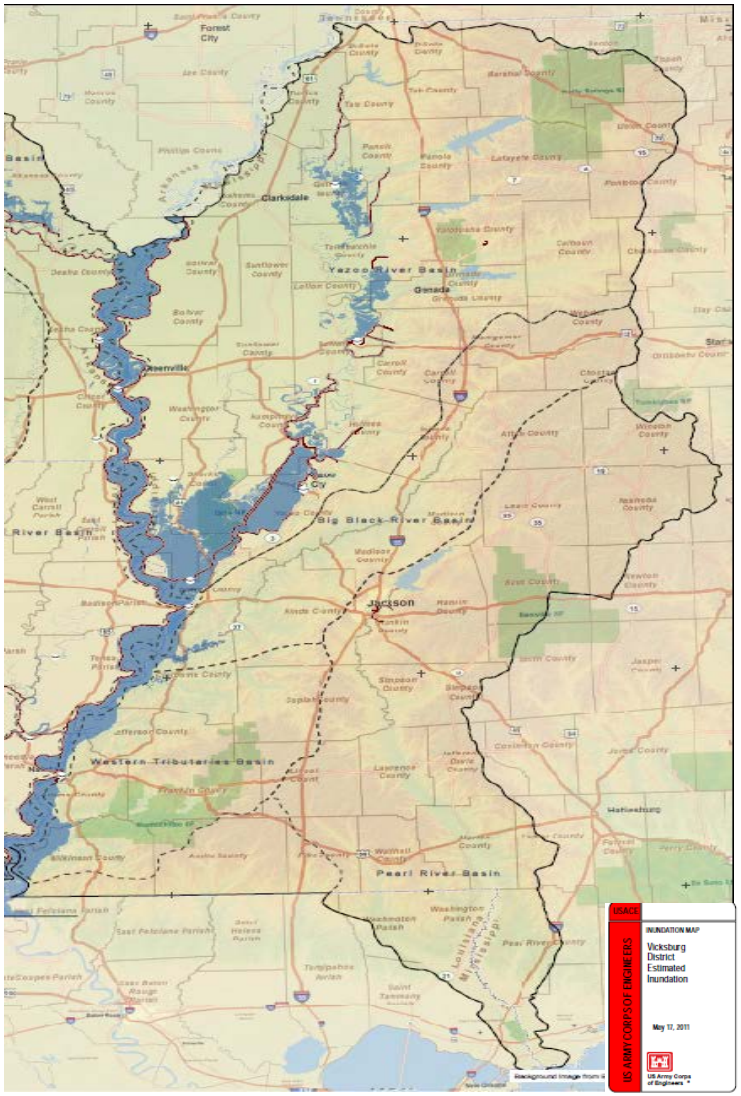
OC Compound Measurement

- *p,p*'-DDE, oxychlordane and trans-nonachlor measured
- Precipitate out proteins with acetonitrile, extract with organic solvent through a solid-phase extraction column, concentrate resultant extract, quantify by gas chromatography/mass spectrometry

Data Analysis

- 1. Soil OC analytes to be compared between the two regions; serum OC analytes to be compared between the two regions.
- 2. Statistical models to be constructed to test for associations between levels of serum OC analytes and the occurrence of disorders of glucose metabolism; explanatory variables to include: age, race, BMI, and region of residence.

April, 2011, Flood: Inundation Maps



Expected Outcomes

- Development of a novel Environmental Public Health Indicator that will link soil and serum levels of select OC compounds with disorders of glucose metabolism.
- The Environmental Public Health Indicator (i.e., serum levels of select OC compounds) can be used to predict risk in vulnerable populations, so that preventions or earlier interventions will be possible.

Acknowledgements

- EPA STAR grant: RD-83479501
- Co-Investigators
  - J. Allen Crow, MD/PhD
  - Matthew Ross, PhD
  - Robert Wills, DVM/PhD
- Additional Researchers
  - Dana Jones, MD (VA)
  - Edward Meek, MS
  - Lauren Mangum, MS
  - Shane Bennett