MO DIRT: Missourians Doing Impact Research Together

A citizen science project to monitor soil health in the state of Missouri

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The Project

The Project is an educational initiative of the **Missouri Transect,** a $20 million dollar effort supported by the National Science Foundation EPSCoR Program. The Transect focuses on enhancing Missouri's capacity to model and respond to the effects of climate change on plants and communities at a local scale. **MO DIRT – Missourians Doing Impact Research Together,** aims to educate citizens on soil health and reciprocal soil-climate interactions across the state. Four components are being offered to the public: Citizen Science Soil Health Monitoring, K-12 Soil Science Curricula, Research Opportunities for High School Student Scientists and Enrichment Activities. These components are supported by the MO DIRT website and an online data portal (modirt.missouriepscor.org).

Missouri Transect institutional partners include the University of Missouri at Columbia, Kansas City and St. Louis, the Donald Danforth Plant Center, the Saint Louis Science Center, Saint Louis University, Lincoln University, Washington University and Missouri University of Science and Technology.

Specific Goals

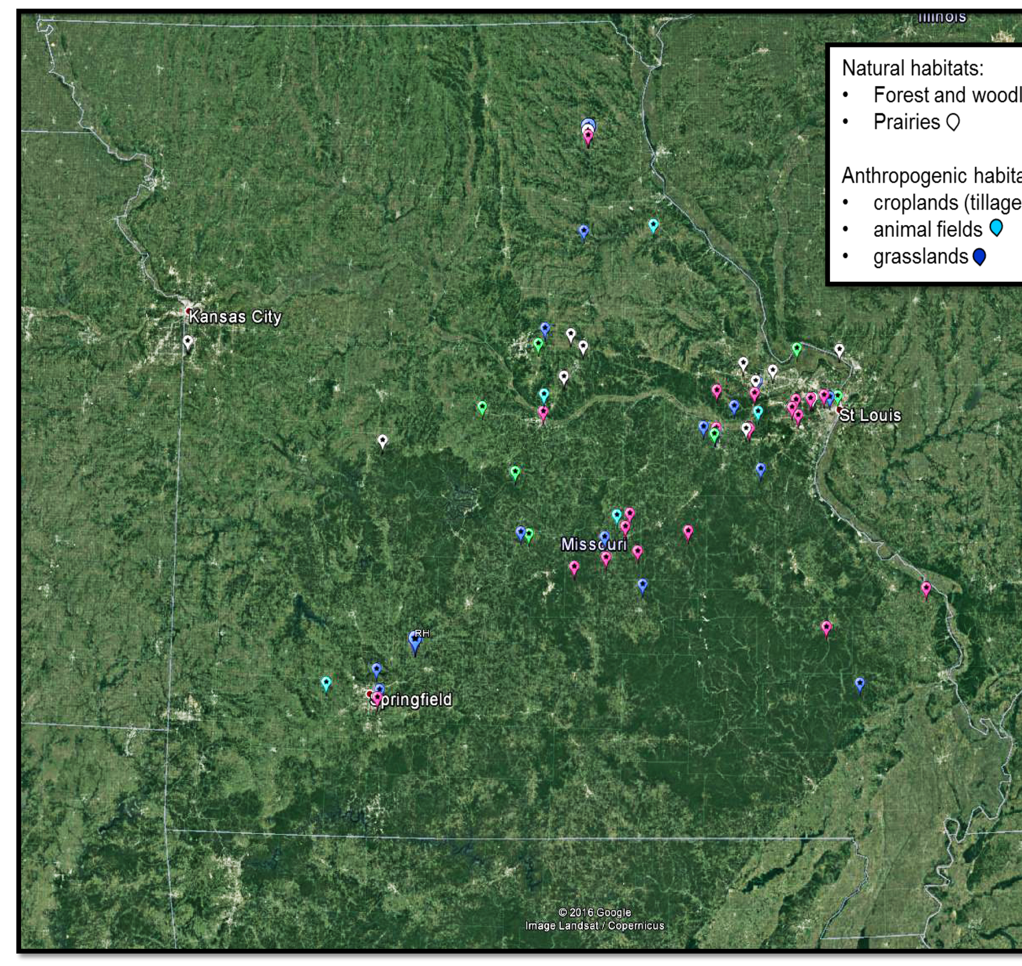
- Create public awareness of soil threats and encourage conservation actions.
- Train citizens on data collection, analysis and reporting of soil properties.
- Conduct soil health surveys with particular emphasis on soil respiration.
- Establish a web portal for MO DIRT participants open to the public.
- Contribute valuable data to scientists involved in the Missouri Transect.

Citizen Science Soil Health Surveys

Citizen Science Soil Health Surveys are conducted by volunteer citizens (e.g. teachers, students, master naturalists, farmers, homeschool families, etc.), to collect and contribute data that will help scientists understand the current status of Missouri soil health. The ultimate goal is to promote a better understanding of soil-climate interactions under climate change. Soil science kits that contain tools and materials needed to measure a set of physical, chemical and biological soil health indicators are given to trained volunteers. The kit includes an 89-page manual with instructions on how to select and set up a site, and collect soil health data.

As of May 2017, 225 state residents have received training on how to conduct soil health surveys. Sixteen sessions have been offered in nine cities. Currently, there are 60 active survey sites and over 700 people have participated in the soil health surveys. The map shows the locations and habitat types of the current soil health survey sites (Figure 1).

Figure 1. Active soil health survey sites in different habitats.



A portal on the MO DIRT website allows participants to enter their soil research data online. Participants choose the level of data sharing among themselves, the public, or only with the EPSCoR scientists. The data collected can be used for teaching purposes, managing lands, and augmenting ongoing Missouri Transect research with the Plant, Climate and Community teams. For example, a professor at Harris-Stowe State University is monitoring a site with his Urban Agriculture students. This group is using the data from other sites to compare results among different habitats and to examine soil health indicators over time.

Soil respiration.

Soil respiration. Of particular interest is an investigation of soil respiration across the state, and how it may change and contribute to the prediction of the effects of climate change on future agricultural productivity and native flora. Soil respiration is the carbon dioxide (CO_2) flux from soils to the atmosphere and it represents one of the largest fluxes in the global carbon cycle (Schindlbacher *et al.*, 2012). Soil respiration results from the biological activity in the soil of micro-organisms, live roots, and macroorganisms (Figure 2). Soils store a vast amount of organic carbon. The decomposition of soil organic matter is temperature-dependent, therefore it is expected that increases in temperatures due to changes in climate will increase soil respiration rates. Consequently, atmospheric CO_2 is expected to be influenced by changes in soil respiration (Schindlbacher *et al.*, 2012). Such changes in soil respiration are significantly influenced by agricultural practices and other human activities.

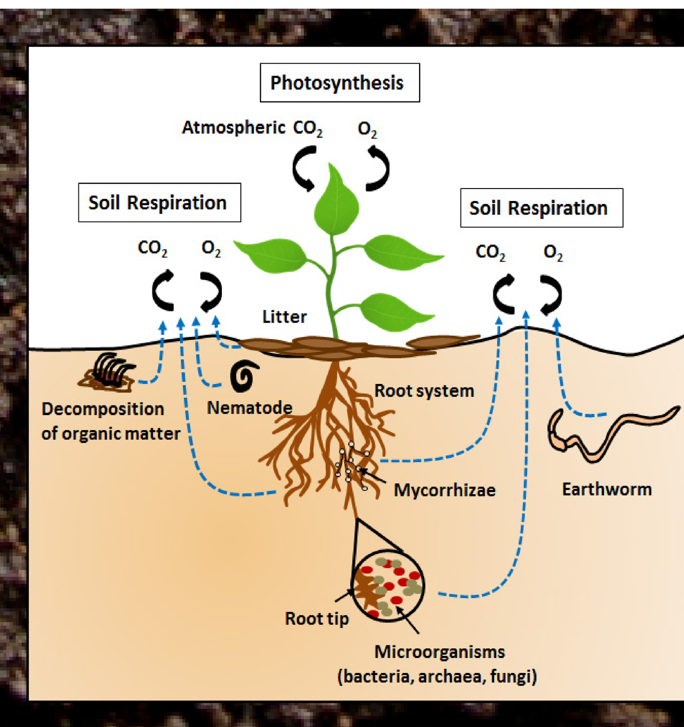


Figure 2. Atmospheric CO_2 is captured by plants through photosynthesis. The CO_2 is transformed into organic forms that are stored in plant tissues or consumed by soil organisms. The stored organic carbon is put back into the atmosphere through CO_2 fluxes from soil respiration. The source of soil respiration is biological activity.

Microbial soil respiration (MSR), as an indicator of biological activity in the soil, was measured once a month using the Solvita method (modirt.missouri epscor.org/soilhealthsurveys/manual). Preliminary results on MSR, expressed as average content of carbon in carbon dioxide (CO_2-C pounds/acre/day), are presented for 2016 in different habitats.

Overall, MSR has a seasonal response with lower values during the cold months and higher values during the warms months picking in July (Figure 3). This is consistent with the findings that MSR has a positive relationship with temperature (Luo & Zhou 2006). When this relationship is examined by site with soil temperature (ST), some sites showed a higher positive correlation than others (Table 1). These differences could be explained by site-specificity related to history of management, habitat area, level of fragmentation, etc. For example, Forest 2 represents a large track of forest while Forest 1 and 6 are forest fragments (Figure 4).

MSR in all habitats behaves similarly over time (Figure 5). However, the level of MSR differed among habitats. Grasslands showed the highest MSR values from April to August, while forests tended to have the highest values during the coldest months. Prairies showed lower values than grasslands and forest, but higher values than animal pastures.

Figure 3. Average microbial soil respiration over time

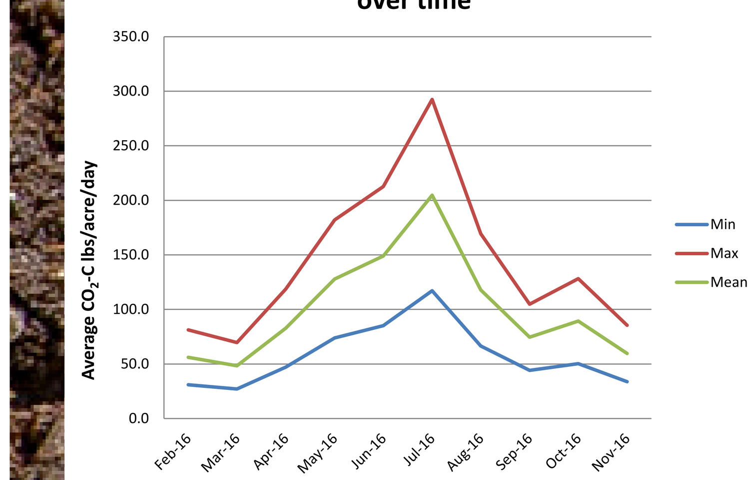


Table 1. Correlation coefficients between soil respiration and soil temperature at different sites.

Sites	Correlation coefficient
Forest 1	0.80
Forest 2	0.99
Forest 6	0.47
Grassland 1	0.53
Grassland 3	0.84
Grassland 4	0.50

Figure 4. Relationship between soil respiration and soil temperature in the Forest 2 site

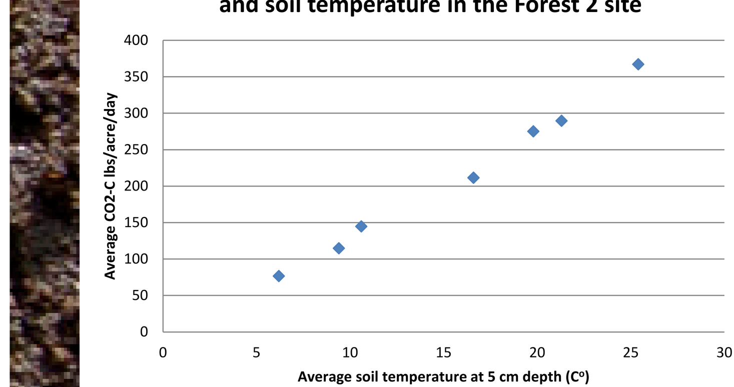
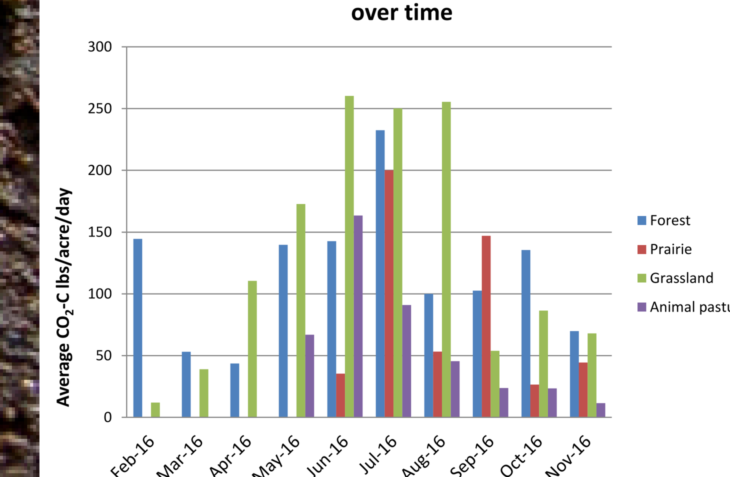


Figure 5. Average microbial soil respiration by habitat over time



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Luo Y, Zhou X, 2006. Soil Respiration and the Environment. Academic Press, London, UK.
Schindlbacher A, Wunderlich S, Borken W, Kitzler B, Zechmeister-Boltenstern S, Jandl R. Soil respiration under climate change: prolonged summer drought offsets soil warming effects. Global Change Biology. 2012;18:2270–2279.

Conclusions.

Conclusions. A larger sample size is necessary to confirm these patterns of MSR and ST among habitats over time. In 2017, more replicate sites per habitat are available, as well as more data per sites, to make yearly comparisons. Future examination of the data will include the relationship of soil respiration with soil water content and nutrient availability. This baseline information will provide an assessment of the status of soil health in the state of Missouri and how climate change might be influenced by soil management through inputs of soil respiration into the atmosphere.

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