MO DIRT: Missourians Doing Impact Research Together
A project to examine the soil-climate interface with citizen scientists

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THE BIG PICTURE

The **Missouri Transect** project was established through a $20 million National Science Foundation EPSCoR grant in 2014 (www.epscormissouri.org; award IIA-1355406). This project aims to study and predict the impact of climate change on agricultural productivity in Missouri, and how communities are likely to be affected by and respond to the challenges of a changing climate. The lead institution of this project is the University of Missouri with the following partners: Donald Danforth Plant Center, Saint Louis Science Center, Saint Louis University, Lincoln University, Washington University, University of Missouri Science and Technology and the University of Missouri at Columbia, Kansas City and St. Louis.

WHAT IS MO DIRT?

MO DIRT, Missourians Doing Impact Research Together, is part of the Missouri Transect project. Citizens will be educated on soil health as well as on the reciprocal soil-climate interactions across the state. Of particular interest is an investigation of soil respiration seasonally 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. This project will kick off at an appropriate time, as 2015 is the International Year of Soils.

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 microorganisms, live roots, and macroorganisms (Figure 1). 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.

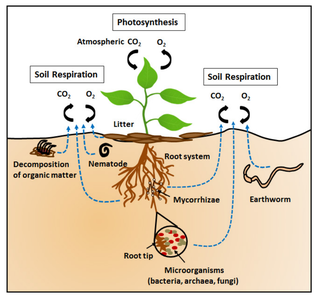

Figure 1. Atmospheric CO_2 is captured by plants through photosynthesis. The CO_2 is transformed into organic forms that are stored in plant tissues or consumed by soil organisms. The stored organic carbon is put back into the atmosphere through CO_2 fluxes from soil respiration. The source of soil respiration is biological activity. Adapted from the Meteorological Research Institute.

Collaborators:

- David Skaer, soil scientist, Natural Resources Conservation Service (NRCS), US Department of Agriculture (USDA).
- Ross Braun, NRCS-USDA (retired); Missouri Master Naturalist, MO Department of Conservation.

References:

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SPECIFIC GOALS

- To educate citizens on soil science, soil-climate interactions and the soil-plant interface
- To create public awareness of soil threats and conservation actions
- To train citizens on data collection, analysis, and reporting of soil properties
- To conduct soil surveys with particular emphasis on soil respiration
- To maintain a web-based portal for MO DIRT participants
- To contribute valuable data to scientists involved in Missouri Transect research.

Earthworm

HOW DOES MO DIRT WORK?

The project has three components:

- **Soil science curricular elements and enrichment activities** will be offered to citizens, particularly K-12 students, to learn about soil science and to understand that healthy soils are living, breathing entities. Education leaders will be trained in implementing, monitoring, and evaluating the program.

- **Soil surveys** will be conducted by individuals and groups, equipped with training, guidelines and soil quality test kits, to collect data on soil properties including soil respiration. These groups are expected to continue monitoring their working sites for at least five-years.

- **Data management** will be done through a web-based portal for participants to access educational and training material, to post their experiences with MO DIRT, and to enter their collected data. Validation and analysis of the scientific data will be a joint venture between participants and scientists. The public will have open-access to the data.

EXPECTED RESULTS AND PROJECT PROGRESS

- A **plan** has been developed to cover specific subjects and conduct related activities for the soil science curriculum and the soil surveys (Table 1) (SSSA 2014).

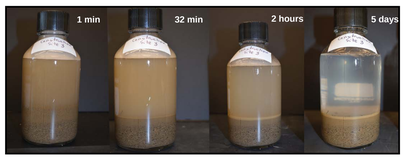
Table 1. The proposed soil science curriculum (Learn About Soils) and the soil surveys (Describe Your Soil).

LEARN ABOUT SOILS	DESCRIBE YOUR SOIL
Introduction - The functions of the soil	**What variables are we going to measure?**
What is soil? - Physical properties	Soil color
What is the soil made up of?	Soil texture
Soil texture	Soil pH
Soil - water interactions	Soil temperature
Soil profile	Soil moisture
Soil formation	Topography
What is soil? – Biological properties	Soil compaction
Who lives in the soil and what are their jobs?	Electrical conductivity (salt concentration)
How do soil organisms interact?	Macronutrients content (ion capacity)
How do roots work?	Soil respiration/decomposition
Root tropisms	**How are we going to collect the data?**
The vegetation above the soil	Equipment
Organic matter	Methods
What is soil? – Chemical properties	Forms
Chemical components of the soil	**How are we going to process the data?**
The colors of the soil	What is data and how is data taken and recorded?
How acidic is the soil?	Validity of data
Soil fertility and plant growth	Entering data
Carbon cycle	Analyzing data
Nitrogen cycle	Interpretation of data
The healthy soil	Reporting data
How beneficial is the soil?	
Can water damage the soil?	
Can wind damage the soil?	
Other soil threats	
What can we do to help the soil?	
Soil-climate interactions	
Climate and weather	
Climate changes	
Human influences	
Impact of climate change on soil	
What can we do?	

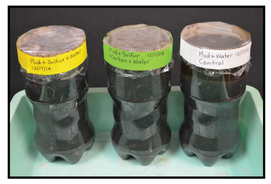
Soil beetle larva

- **Manuals and training** will be provided to educational leaders to guide them in teaching the soil science curriculum and participating in the soil surveys. Figure 2 shows some of these activities. The curriculum will be launched in the Greater St. Louis area with later expansion to other locations. Initially, about 50 institutions will participate, including public and private schools, and youth groups. By the end of the 5th year, it is expected that about 6000 participants will have benefitted from MO DIRT.

A. Qualitative methods to determine soil texture. The ability to make a ball or ribbon indicates higher content of clay.



B. Quantitative method to determine soil texture. Soil particles settled down by size. Top layer is clay, middle layer is silt, and bottom layer is sand and gravel.



C. Winogradsky columns. Different types of bacteria grow in the soil depending upon oxygen levels and food sources (paper: carbon and egg yolk: sulfur).

Figure 2. Curricular activities on the physical properties (A, B) and biological properties (C) of soil.

- **Soil surveys.** A soil kit is being assembled and tested (Figure 3). The main variable to be examined is the rate of soil respiration (Figure 4) along with other soil properties (e.g. color, texture, pH, temperature, moisture, compaction, electrical conductivity, macronutrients content) (NRCS 2014). Sampling sites will include agricultural lands as well as natural habitats.

Figure 3. Soil kit to conduct soil surveys.

Figure 4. Measuring soil respiration in the field (Draeger tubes) and the lab (Solvita probes).

- **Data management.** A web-based portal is being built with three components: educational and training guidelines, project experiences, and soil survey information.

- **Community Outreach.** World Soil Day (Dec. 5, 2014) was celebrated through beautiful posters. In the Roots and Shoots Blog of the Danforth Plant Science Center, MO DIRT was announced along with World Soil Day and the 2015 International Year of Soils (www.danforthcenter.org/news-media/roots-shoots-blog/blog-item/citizen-science-project-focuses-on-neglected-resource). Other public events will be held including field days with the Natural Resources Conservation Service and Department of Conservation. Planned events at the Saint Louis Science Center will introduce MO DIRT to the public.

EVALUATION OF MO DIRT

The evaluation design includes: Pre-surveys, and formative and summative evaluations.

- The Pre-surveys will inform the project designers on the level of interest and base knowledge of the program participants, as well as what they expect to learn and accomplish.
- The Formative evaluation (internal) will be used at designated times to further shape, and refine the project (Table 2). The Summative evaluation (internal and external) will be used to judge the overall success, merit and significance of the project.

Table 2. MO DIRT Evaluation Methodology Matrix

Program Element	Data Sources	Indicators
Science curriculum	- Educator training workshops: pre- and post-surveys - Student activity worksheets: section "Checking Your Knowledge"	- Educator's level of understanding on the implementation of the soil curriculum - Participant's level of knowledge on soil science - Quality of experience
Soil surveys	- Educator training workshops: pre- and post-surveys - Data collected from soil surveys	- Participant's level of understanding on the implementation of soil surveys - Quality of experience - Quality of data: accurate, standard, consistent - Quality of experience
Data management	- Project information entered in the web-based portal: soil survey data, and project information (photos, figures, tables, etc.).	- Number of surveys - Number of participants - Number of participant postings - Data: validation, curation, analysis, and reporting - Quality of experience
Advancing interest	- Post-surveys, interviews, round –table discussions	- Recruitment of students into soil, plant, and climate careers - Public attitudinal change and action regarding soil conservation issues