ISRaD Toolkit

ISRaD Toolkit is a lightweight, user-friendly application for filtering, visualizing, and downloading data from the International Soil Radiocarbon Database (ISRaD). Built using R and Shiny, the toolkit is designed to make ISRaD data accessible to researchers, students, and professionals regardless of their technical background.

What is ISRaD?

The **International Soil Radiocarbon Database (ISRaD)** is an open-access scientific database that compiles soil radiocarbon data from over 400 sites across the globe. It was developed by and for the soil science research community with the following objectives:

- To improve scientific understanding of radiocarbon dynamics in soil carbon cycles.
- To serve as a platform for sharing peer-collected and published soil data.
- To provide researchers with accessible tools for data exploration, visualization, and analysis.

What is Soil Radiocarbon?

Soil radiocarbon (^{14}C) refers to the radioactive isotope of carbon found naturally in the environment. In the context of soil science, radiocarbon is used as a tracer to understand carbon turnover, persistence, and movement in soils. By measuring the ^{14}C content of soil carbon, scientists can determine how long carbon has been stored and how it cycles through soil systems.

Purpose of the Toolkit

The **ISRaD Toolkit** was created to simplify access to ISRaD data, making it easier for users to:

- Find specific data relevant to their research.
- Visualize spatial and tabular patterns in the dataset.
- Download custom datasets for further analysis.

Application Features

The ISRaD Toolkit application is organized into five interactive sections:

1. Filter Tab

This tab allows users to apply filters across multiple data tables. Users can select specific site attributes, environmental variables, or data types to narrow down the dataset. Advanced filtering options are available for the Layer and Fraction tables, which include detailed measurements of soil components.

2. Map Tab

This tab provides an interactive world map that displays all sites matching the current filter selections. Users can further refine their selection by clicking on map points, drawing custom polygons, entering specific coordinates, or selecting countries of interest.

3. Summary Tab

This tab offers a real-time summary of data entries in each ISRaD table based on the active filters and map selections. It helps users understand the scope of their current dataset before downloading or exploring it further.

4. Download Tab

This tab allows users to preview the filtered data, apply additional constraints (such as variable ranges or categories), perform keyword searches, and export the final selection as a CSV file. This enables seamless data integration into external tools for analysis.

5. Display Tab

This tab presents the selected dataset in a tabular format. Data displayed is dynamically updated in response to filter and map selections, allowing users to examine individual records in detail.

ISRaD Database Structure

ISRaD data is organized hierarchically to ensure scientific rigor and consistency. The structure includes five primary levels and eight core tables:

- **Metadata**, **Site**, and **Profile** tables contain information about who collected the data, when, and where.
- **Flux** and **Interstitial** tables are dependent on Profile-level data.
- **Layer**, **Fraction**, and **Incubation** tables are dependent on specific soil layers.

This modular structure allows for both broad and detailed analysis across various dimensions of soil carbon data.

Future Development

Although the current version of the ISRaD Toolkit is fully functional, several enhancements are planned to support a growing research community:

- Additional visualizations such as time series plots, histograms, and spatial heatmaps.
- Options for users to save and share custom filters or spatial selections.
- Support for collaborative data querying and exploration workflows.

Technologies Used

The ISRaD Toolkit is built using the following tools and libraries:

- **R** – Primary programming language for application logic.
- **Shiny** – Framework for building interactive web applications.

- **sf** – Library for spatial data processing and mapping.
- **Leaflet** – JavaScript library used (via R interface) for rendering interactive maps.