

# Package ‘ISRaD’

June 20, 2019

**Title** Tools and Data for the International Soil Radiocarbon Database

**Version** 0.1.0.940

**Description** This is the central location for data and tools for the development, maintenance, analysis, and deployment of the International Soil Radiocarbon Database. This database and package have been developed in collaboration between the U.S. Geological Survey Powell Center and the Max Planck Institute.

**Depends** R (>= 3.3.0)

**Imports** shiny, openxlsx, devtools, raster, dplyr, plyr, tidyr, RCurl, ggplot2, ggmap, assertthat, rcross-ref, forecast, SoilR, pangaeear, tidyverse, usethis, stringr

**License** GPL-2

**Encoding** UTF-8

**LazyData** true

**RoxygenNote** 6.1.1

**Suggests** knitr,  
rmarkdown

**VignetteBuilder** knitr

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checkTempletFiles	<i>Check ISRaD Templet files</i>
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## Description

Check that the Templet information file and the templet file match appropriately.

## Usage

```
checkTempletFiles(outfile = "")
```

## Arguments

outfile	file to dump the output report. Defaults to an empty string that will print to standard output.
---------	---

## Value

returns NULL

## Examples

```
## Not run:
checkTempletFiles()

## End(Not run)
```

---

compile	<i>Compile ISRaD data product</i>
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### Description

Construct data products to the International Soil Radiocarbon Database.

### Usage

```
compile(dataset_directory, write_report = FALSE, write_out = FALSE,
        return_type = c("none", "list")[2], checkdoi = F)
```

### Arguments

dataset_directory	string defining directory where completed and QC passed soilcarbon datasets are stored
write_report	boolean flag to write a log file of the compilation (FALSE will dump output to console). File will be in the specified in the dataset_directory at "database/ISRaD_log.txt". If there is a file already there of this name it will be overwritten.
write_out	boolean flag to write the compiled database file as .csv in dataset_directory (FALSE will not generate output file but will return)
return_type	a string that defines return object. Default is "none". Acceptable values are "none" or "list" depending on the format you want to have the database returned in.
checkdoi	set to F if you do not want the QAQC check to validate doi numbers

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graven	<i>Graven dataset for delta delta calculation</i>
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### Description

Data from Graven et al 2017 <https://www.geosci-model-dev.net/10/4405/2017/gmd-10-4405-2017.pdf>

### Usage

```
graven
```

### Format

```
dataframe
```

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ISRaD.build	<i>ISRaD.build builds the database and updates objects in R package</i>
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### Description

Wrapper function that combines tools for rapid deployment of R package data objects. Meant to be used by the maintainers/developers of ISRaD

### Usage

```
ISRaD.build(ISRaD_directory = getwd(), geodata_clim_directory,
            geodata_pet_directory, geodata_soil_directory, citations = T)
```

### Arguments

ISRaD_directory	directory where the ISRaD package is found
geodata_clim_directory	directory where geospatial climate datasets are found. Necessary to create ISRaD_Extra
geodata_pet_directory	directory where geospatial pet dataset is found. Necessary to create ISRaD_Extra
geodata_soil_directory	directory where geospatial soil datasets are found. Necessary to create ISRaD_Extra
citations	T or F. Update citations.

### Value

runs QAQC on all datafiles, moves files that fail QAQC, updates ISRaD\_Data, updates ISRaD\_Extra

### Examples

```
## Not run:
ISRaD.build(ISRaD_directory="~/ISRaD/", geodata_clim_directory="~/geospatial_clim_datasets",
            geodata_pet_directory="~/geospatial_pet_dataset",
            geodata_soil_directory="~/geospatial_soil_datasets")

## End(Not run)
```

---

ISRaD.extra	<i>ISRaD.extra</i>
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### Description

Fills in transformed and geospatial data where possible, generatating an enhanced version of ISRaD.

### Usage

```
ISRaD.extra(database, geodata_clim_directory, geodata_soil_directory,
            geodata_pet_directory)
```

**Arguments**

database            soilcarbon dataset object  
 geodata\_clim\_directory        directory where geospatial climate data are found  
 geodata\_soil\_directory        directory where geospatial soil data are found  
 geodata\_pet\_directory        directory where geospatial pet data are found

**Details**

Fills fraction modern, delta 14C, delta-delta values, profile coordinates, and SOC stocks from entered data; fills soil and climatic data from external geospatial data products

**Value**

returns new ISRaD\_extra object with derived, transformed, and filled columns

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ISRaD.extra.Cstocks	<i>ISRaD.extra.Cstocks</i>
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**Description**

Calculates soil organic carbon stock

**Usage**

```
ISRaD.extra.Cstocks(database)
```

**Arguments**

database            ISRaD dataset object.

**Details**

Function first fills lyr\_bd\_samp and lyr\_c\_org. SOC stocks can only be calculated if organic carbon concentration and bulk density data are available. SOC stocks are then calculated for the fine earth fraction (<2mm).

**Value**

returns ISRaD\_data object with filled columns

**Author(s)**

J. Beem-Miller

---

```
ISRaD.extra.delta_delta
      ISRaD.extra.delta_delta
```

---

### Description

Calculates the difference between sample delta 14C and the atmosphere for the year of collection

### Usage

```
ISRaD.extra.delta_delta(database)
```

### Arguments

database            ISRaD dataset object.

### Details

Creates new column for delta delta value. Observation year and profile coordinates must be filled (use `ISRaD.extra.fill_dates`, and `ISRaD.extra.fill_coords` fxs). Calls `SoilR` for atmospheric d14C data (Hua et al. 2013). Atmospheric data are corrected for the northern hemisphere zone 2 or southern hemisphere zones 1+2, depending on profile coordinates.

### Value

returns `ISRaD_data` object with new delta delta columns in relevant tables

### Author(s)

J. Beem-Miller and C. Hicks-Pries

### References

Hua et al., 2013; Sierra et al., 2014

---

```
ISRaD.extra.fill_14c    ISRaD.extra.fill_14c
```

---

### Description

: Fills delta 14C from fraction modern if delta 14C not reported.

### Usage

```
ISRaD.extra.fill_14c(database)
```

### Arguments

database            ISRaD dataset object.

**Details**

: Warning: xxx\_obs\_date\_y columns must be filled for this to work!

**Value**

returns ISRaD\_data object with filled delta 14C columns

**Author(s)**

: J. Beem-Miller & A. Hoyt

**References**

: Stuiver and Polach, 1977

---

ISRaD.extra.fill\_coords

*ISRaD.extra.fill\_coords*

---

**Description**

Fills profile coordinates from site coordinates if profile coordinates not reported.

**Usage**

```
ISRaD.extra.fill_coords(database)
```

**Arguments**

database          ISRaD dataset object.

**Value**

returns ISRaD\_data object with filled profile coordinates

**Author(s)**

J. Beem-Miller

---

ISRaD.extra.fill\_dates

*ISRaD.extra.fill\_dates*


---

### Description

Fills frc\_obs\_date\_y and inc\_obs\_date\_y columns from lyr\_obs\_date\_y if not reported.

### Usage

```
ISRaD.extra.fill_dates(database)
```

### Arguments

database            ISRaD dataset object.

### Details

This function must be run prior to the ISRaD.extra.fill\_14c, ISRaD.extra.fill\_fm, and ISRaD.extra.delta\_delta for the layer and fraction tables.

### Value

returns ISRaD\_data object with filled obs\_date\_y columns

---

ISRaD.extra.fill\_expert

*ISRaD.extra.fill\_expert*


---

### Description

: Fills in columns of expert-reviewed full data with real data where available, and calculates missing carbon stocks with filled data.

### Usage

```
ISRaD.extra.fill_expert(database)
```

### Arguments

database            ISRaD dataset object.

### Details

:

### Value

returns ISRaD\_data object with the lyr\_xxx\_fill\_extra columns containing both original and filled data



**Author(s)**

: Paul A. Levine

**References**

:

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ISRaD.extra.fill_fm	<i>ISRaD.extra.fill_fm</i>
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---

**Description**

Fills fraction modern from delta 14C if fraction modern not reported.

**Usage**

```
ISRaD.extra.fill_fm(database)
```

**Arguments**

database      ISRaD dataset object.

**Details**

: Warning: xxx\_obs\_date\_y columns must be filled for this to work!

**Value**

returns ISRaD\_data object with filled fraction modern columns

**Author(s)**

: J. Beem-Miller & A. Hoyt

**References**

: Stuiver and Polach, 1977

---

```
ISRaD.extra.fill_soilorders
    ISRaD.extra.fill_soilorders
```

---

### Description

Fills pro\_usda\_soil\_order field from pro\_soil\_taxon field.

### Usage

```
ISRaD.extra.fill_soilorders(database)
```

### Arguments

database            ISRaD dataset object.

### Details

This function is a static conversion script written at the Fall 2018 Powell Center workshop and therefore performance is not guaranteed for new entries.

Back fills pro\_usda\_soil\_order based on USDA classifications

### Value

returns ISRaD\_data object with filled pro\_usda\_soil\_order column

---

```
ISRaD.extra.geospatial.climate
    ISRaD.extra.geospatial.climate
```

---

### Description

Extracts values from gridded (2.5' arc) climate data using ISRaD profile coordinates.

### Usage

```
ISRaD.extra.geospatial.climate(database, geodata_clim_directory,
    geodata_pet_directory)
```

### Arguments

database            ISRaD dataset object.  
geodata\_clim\_directory        directory where geospatial climate datasets are found.  
geodata\_pet\_directory        directory where geospatial pet dataset is found.

**Details**

Adds new climate fields BIO1-BIO19, PET:

BIO1 = Annual Mean Temperature, BIO2 = Mean Diurnal Range (Mean of monthly (max temp - min temp)), BIO3 = Isothermality (BIO2/BIO7) (\* 100), BIO4 = Temperature Seasonality (standard deviation \*100), BIO5 = Max Temperature of Warmest Month, BIO6 = Min Temperature of Coldest Month, BIO7 = Temperature Annual Range (BIO5-BIO6), BIO8 = Mean Temperature of Wettest Quarter, BIO9 = Mean Temperature of Driest Quarter, BIO10 = Mean Temperature of Warmest Quarter, BIO11 = Mean Temperature of Coldest Quarter, BIO12 = Annual Precipitation, BIO13 = Precipitation of Wettest Month, BIO14 = Precipitation of Driest Month, BIO15 = Precipitation Seasonality (Coefficient of Variation), BIO16 = Precipitation of Wettest Quarter, BIO17 = Precipitation of Driest Quarter, BIO18 = Precipitation of Warmest Quarter, BIO19 = Precipitation of Coldest Quarter PET = Potential evapotranspiration, mm/yr (Penman-Monteith method for short-clipped grass w/ worldclim input data)

All BIO## variables are from <http://www.worldclim.org/bioclim> V1.4 at 2.5 resolution and are based on site lat and long

**Value**

An ISRaD\_data object with additional rows containing values from geospatial datasets. See description for details.

**Author(s)**

J. Grey Monroe, Alison Hoyt

**References**

<http://www.worldclim.org/>; PET data from: Kramer, M. and O. Chadwick. 2018. Climate-driven thresholds in reactive mineral retention of soil carbon at the global scale. *Nature Climate Change* 8:1104–1108.

---

ISRaD.extra.geospatial.soil

*ISRaD.extra.geospatial.soil*

---

**Description**

Function to download and extract soil data from ISRIC spatial data products. WARNING: downloads large data files (>15 GB total)

**Usage**

```
ISRaD.extra.geospatial.soil(database, geodata_soil_directory)
```

**Arguments**

database           ISRaD dataset object.

geodata\_soil\_directory

directory where geospatial soil datasets are found, or to which can be downloaded.

## Details

Uses site and profile latitude and longitude to extract soil classifications and characteristics from .tif geospatial files acquired from ISRIC (<https://www.isric.org/explore/soilgrids>). Currently includes USDA soil classifications and soil organic carbon to 100 cm, with new columns added at profile level for SOC at surface (0cm), 5, 15, 30, 60, and 100 cm depth. Points that are very near water bodies tend to produce NA values due to grid cell classification as water (which contains no data). All data are currently from 250 m grid cells.

## Author(s)

Shane Stoner [sstoner@bgc-jena.mpg.de](mailto:sstoner@bgc-jena.mpg.de)

## References

Hengl, T., Mendes de Jesus, J., Heuvelink, G. B.M., Ruiperez Gonzalez, M., Kilibarda, M. et al. (2017) SoilGrids250m: global gridded soil information based on Machine Learning. PLoS ONE 12(2): e0169748. doi:10.1371/journal.pone.0169748. Hengl T, de Jesus JM, MacMillan RA, Batjes NH, Heuvelink GBM, et al. (2014) SoilGrids1km — Global Soil Information Based on Automated Mapping. PLoS ONE 9(8): e105992. doi:10.1371/journal.pone.0105992. Shangguan, W., Hengl, T., de Jesus, J. M., Yuan, H. and Dai, Y. (2016), Mapping the global depth to bedrock for land surface modeling. J. Adv. Model. Earth Syst. doi:10.1002/2016MS000686.

---

ISRaD.flatten

*ISRaD.flatten*


---

## Description

: Joins tables in ISRaD based on linking variables and returns "flat" dataframes

## Usage

```
ISRaD.flatten(database, table)
```

## Arguments

database	ISRaD dataset object: e.g. ISRaD_data, or ISRaD_extra
table	ISRaD table of interest ("flux", "layer", "interstitial", "fraction", "incubation"). Must be entered with "".

## Details

: ISRaD.extra.flatten generates flat files (2 dimensional matrices) for user specified ISRaD tables by joining higher level tables (metadata, site, profile, layer) to lower level tables (layer, fraction, incubation, flux, interstitial).

## Value

returns a dataframe with nrow=nrow(table) and ncol=sum(ncol(meta),ncol(site),ncol(profile),...,ncol(table))

## Author(s)

: J. Beem-Miller

**References**

:

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ISRaD.getdata	<i>ISRaD.getdata</i>
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---

**Description**

ISRaD.getdata

**Usage**

```
ISRaD.getdata(directory = getwd(), dataset = "full", extra = F)
```

**Arguments**

directory	location of ISRaD_database_files folder. If not found, it will be download. The default is the current working directory.
dataset	Specify which data you want. Options are c("full", "flux", "interstitial", "incubation", "fraction", "layer")
extra	T or F. If T, the ISRaD_extra object will be returned. If F, ISRaD_data will be returned. Default is F.

**Value**

ISRaD data object

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ISRaD.save.xlsx	<i>ISRaD.save.xlsx</i>
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---

**Description**

saves data object as xlsx file in ISRaD template format

**Usage**

```
ISRaD.save.xlsx(database, template_file, outfile)
```

**Arguments**

database	ISRaD dataset object.
template_file	path and name of template file to use.
outfile	path and name to save the excel file

**Author(s)**

J Grey Monroe

---

ISRaD.shiny

*ISRaD.shiny*


---

**Description**

generate reports of ISRaD data

**Usage**

ISRaD.shiny()

---

ISRaD\_data

*ISRaD database object*


---

**Description**

Complete database object compiled for ISRaD diamonds.

**Usage**

ISRaD\_data

**Format**

A list of data frames. The names of the data frames and their columns reflect the structure of the ISRaD data master template.

---

ISRaD\_extra

*ISRaD extra database object*


---

**Description**

Complete database object compiled for ISRaD. Includes extra variables calculated using ISRaD.extra function. diamonds.

**Usage**

ISRaD\_extra

**Format**

A list of data frames. The names of the data frames and their columns reflect the structure of the ISRaD data master template. Additional columns have been added and certain variables have been filled in when possible.

---

QAQC	<i>QAQC</i>
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---

**Description**

Check the imported soil carbon dataset for formatting and entry errors

**Usage**

```
QAQC(file, writeQCreport = F, outfile = "", summaryStats = T,
      dataReport = F, checkdoi = T)
```

**Arguments**

file	directory to data file
writeQCreport	if TRUE, a text report of the QC output will be written to the outfile. Default is FALSE
outfile	filename of the output file if writeQCreport==TRUE. Default is NULL, and the outfile will be written to the directory where the dataset is stored, and named by the dataset being checked.
summaryStats	prints summary statistics. Default is TRUE
dataReport	prints list structure of database. Default is FALSE
checkdoi	set to F if you do not want the QAQC check to validate doi numbers

---

read_Treat2016	<i>Read in data for Treat 2016.</i>
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---

**Description**

Currently doesn't work and is under development

**Usage**

```
read_Treat2016(download = T, downloadDir = "temp",
                convertedDir = "~/Dropbox/USGS/ISRaD_data/Compilations/Treat/converted/")
```

**Arguments**

download	boolean, if T the Treat datasets will be downloaded from pangea. Otherwise, they files in downloadDir will be used.
downloadDir	directory where data files will be downloaded
convertedDir	directory where data files that are converted to ISRaD template will be saved

**Value**

writes out files for individual data objects

---

read_YujiHe2016	<i>Read He 2016</i>
-----------------	---------------------

---

**Description**

Read in the data from Yuji He's 2016 Science paper as a raw csv file

**Usage**

```
read_YujiHe2016(Yujie_file = NULL)
```

**Arguments**

Yujie_file	The raw csv data
------------	------------------

**Value**

ISRaD compliant file structure with only columns that overlap with original data

---

reports	<i>reports</i>
---------	----------------

---

**Description**

generate reports of ISRaD data

**Usage**

```
reports(database = NULL, report = "count_data")
```

**Arguments**

database	ISRaD data object
report	Parameter to define which type of report you want. The default is "count_data" other options include "entry_stats" and "site_map".

---

rep_count_data	<i>rep_count_data</i>
----------------	-----------------------

---

**Description**

generate a count of observations for each level of the database

**Usage**

```
rep_count_data(database = NULL)
```

**Arguments**

database	ISRaD data object
----------	-------------------



---

rep_entry_stats	<i>rep_entry_stats</i>
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---

**Description**

generate report of entry statistics

**Usage**

```
rep_entry_stats(database = NULL)
```

**Arguments**

database	ISRaD data object
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---

rep_frc_data	<i>rep_frc_data</i>
--------------	---------------------

---

**Description**

generate a count of fractionation observations including scheme and property

**Usage**

```
rep_frc_data(database = NULL)
```

**Arguments**

database	ISRaD data object
----------	-------------------

---

rep_site_map	<i>rep_site_map</i>
--------------	---------------------

---

**Description**

generate a world map with site locations plotted

**Usage**

```
rep_site_map(database = NULL)
```

**Arguments**

database	ISRaD data object
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