

FAIR research data for agrosystems Driver for soil health and sustainable crop production

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Data Scientist BonaRes project



Project Manager FAIRagro project



Imagine...

you have finished a long measure campaign in the field and in the lab;

spent many hours in cleaning, preparing and analysing your data;

spent even more time in writing a paper,

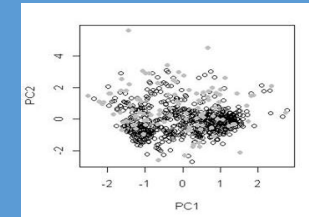
spent even more energy until the paper was finally published in a high-ranking journal;

can't wait to hear your colleagues' responses and be cited.....but....

USE CASE 1
(researcher)



```
1010010100
1010100101
0100101010
1001010110
0100100101
100010010
```



something is missing;

Whats about your valuable datasets? Are they findable, accesible and reusable for your colleagues?

Wouldn't it be fair to spread your findings and increase your and your research visibility?

USE CASE 2
(modeller for a food company)



...and imagine

your task is to model soil fertility and a crop scenario in a certain region;

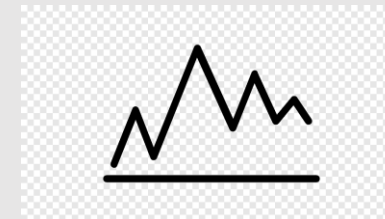
spent many hours in reading papers, extract tables and figure values to feed you models;

but the data are too patchy and the uncertainty is too high for good predictions;

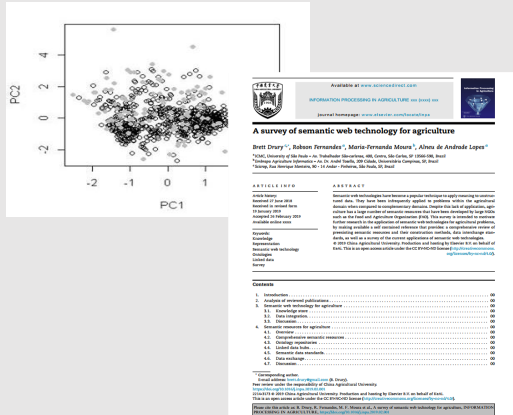
you try to get in contact with (paper) authors to get access to measured data;

some authors vanished, other respond and send you data in different formats, file types described by none /sparse metadata;

finally you give up and work with low quality model outcomes.



Wouldn't it be fair to get permanent access to data and base knowledge from public research?



The FAIR data principles can help...

Published soil- and agricultural research data, should

- ✓ be visible and findable for others
- ✓ be accessible
- ✓ be legally sound (authors rights respected)
- ✓ aggregates data usefully
- ✓ be quality assured, and
- ✓ be internationally harmonized, and
- ✓ reusable in a user-friendly way

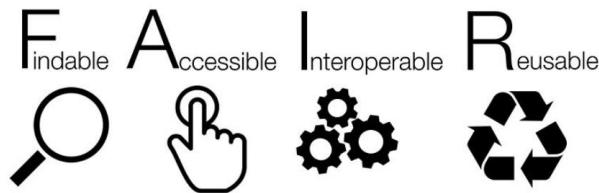
Findable

Accessible

Interoperable

Reusable

→ FAIR Data Principles

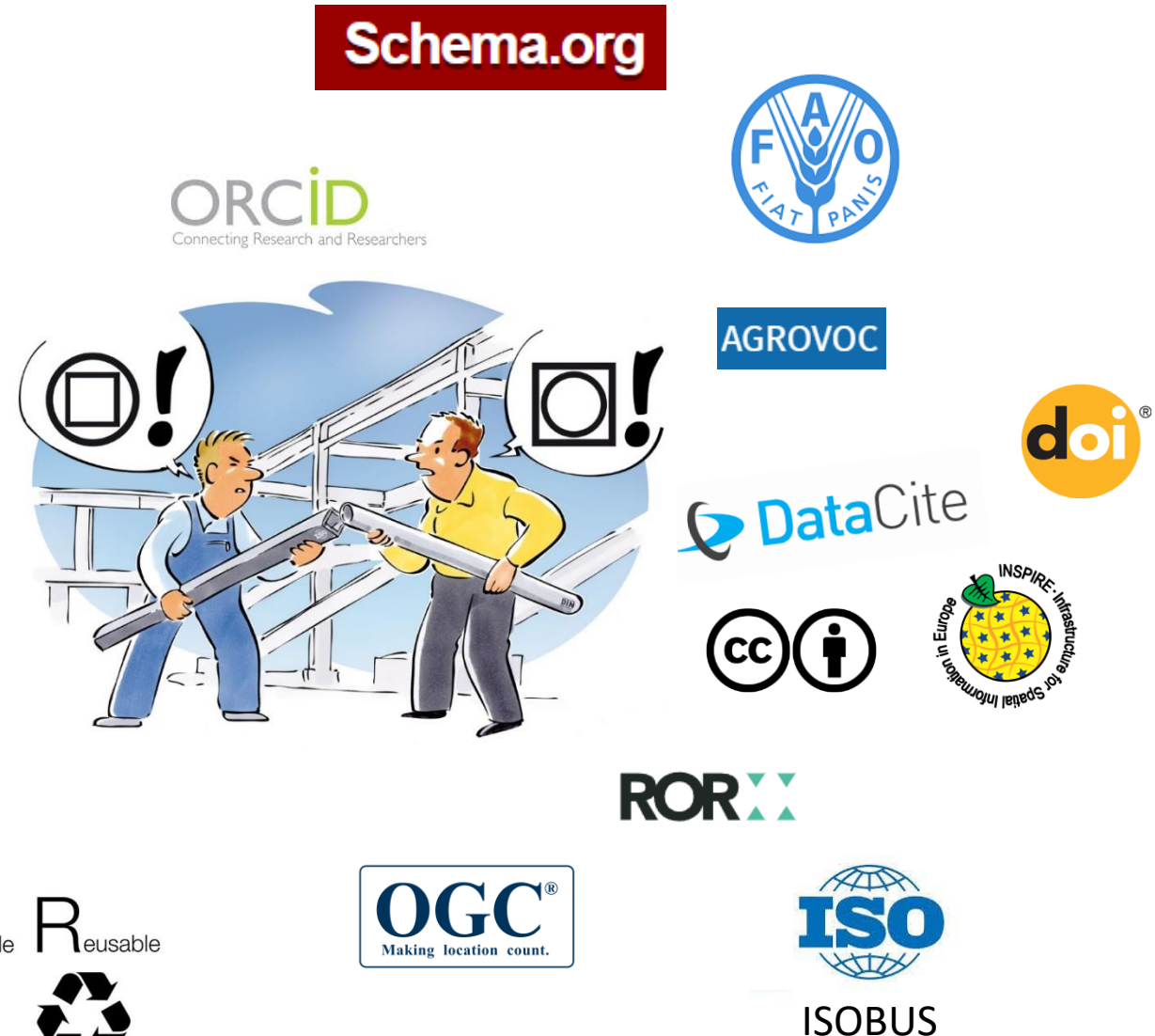
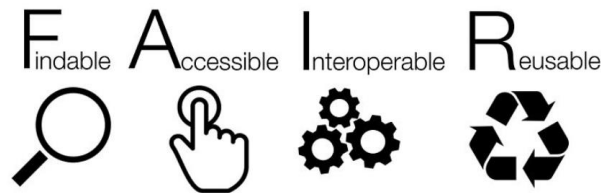


Standards

Open community standards
(freely available and widely accepted)

- ✓ Metadata elements (e.g. schema.org, DataCite)
- ✓ PIDs (e.g. ORCID, RoR)
- ✓ Thesauri (e.g. AGROVOC)
- ✓ Geodata (OGC)
- ✓ Crop & variety codes (e.g. ICC, FAO)
- ✓ Soil classification (WRB)
- ✓ Methods (e.g. ISO)
- ✓ Licencing (Creative Commons)

→ FAIR Data Principles



How to handle field data?

Most important: Metadata!

	A	B	C	D	E	F	G	H	I	J	K
1	Sites	Year	Dates	Plot_Nr	Landuse	Plot	CO2	CH4	WFPS	Soil_Temp	NH4
2	Dornburg	2019/2020	2020-02-05T00:00:00	17	MC	DR1	16,15248907	2,014537418	66,3090727	2,8	0,353873015
3	Dornburg	2019/2020	2020-02-05T00:00:00	18	MC	DR2	21,57602373	-17,58430694	70,1414122	3,2	0,27466504
4	Dornburg	2019/2020	2020-02-05T00:00:00	19	MC	DR3	14,23285353	-6,55049326	60,0252173	3,9	0,323489214
5	Dornburg	2019/2020	2020-02-05T00:00:00	20	MC	DR4	7,668587595	1,369836777	71,1751839	3,8	0,151494886
6	Wendhauser	2018/2019	2018-04-07T00:00:00	1	AF_T	WT1	17,38527193	-9,029799495	67,4452373	5,2	3,629601916
7	Wendhauser	2018/2019	2018-04-07T00:00:00	5	AF_T	WT2	26,09982689	-2,861573591	65,086966	8,5	7,95840662
8	Wendhauser	2018/2019	2018-04-07T00:00:00	9	AF_T	WT3	23,7712574	-6,790432495	60,4034525	5,3	4,797791461
9	Wendhauser	2018/2019	2018-04-07T00:00:00	13	AF_T	WT4	64,91581054	10,12928832	76,5546381	7,2	6,295071121
10	Wendhauser	2018/2019	2018-04-07T00:00:00	2	AF_1	WA1	24,20015152	-3,926820399	54,907974	5,6	10,99501079
11	Wendhauser	2018/2019	2018-04-07T00:00:00	6	AF_1	WA2	24,14647683	-5,825871517	49,639882	8,5	4,156102935
12	Wendhauser	2018/2019	2018-04-07T00:00:00	10	AF_1	WA3	14,63899374	3,577959891	60,1435066	5,8	2,551189552
13	Wendhauser	2018/2019	2018-04-07T00:00:00	14	AF_1	WA4	47,62797412	-11,38352577	41,1809805	9,8	14,50451548

Metadata

= “data about data”, your data label

- **essential “partners”** for field and research data
- Link to keywords, ontologies
- **Standardised** and structured information
- Subset of **documentation**: describes, explains, locates, makes it easier to retrieve, use, manage an information resource
- **Human- and machine-readable**



WHO generated the data?
HOW was it generated and processed?
WHAT is the content of the data?
WHY was the data generated?
WHEN was the data generated?
WHERE was the data generated?

How to handle field data?

Metadata: what does the data mean? (the whole table but also each column):

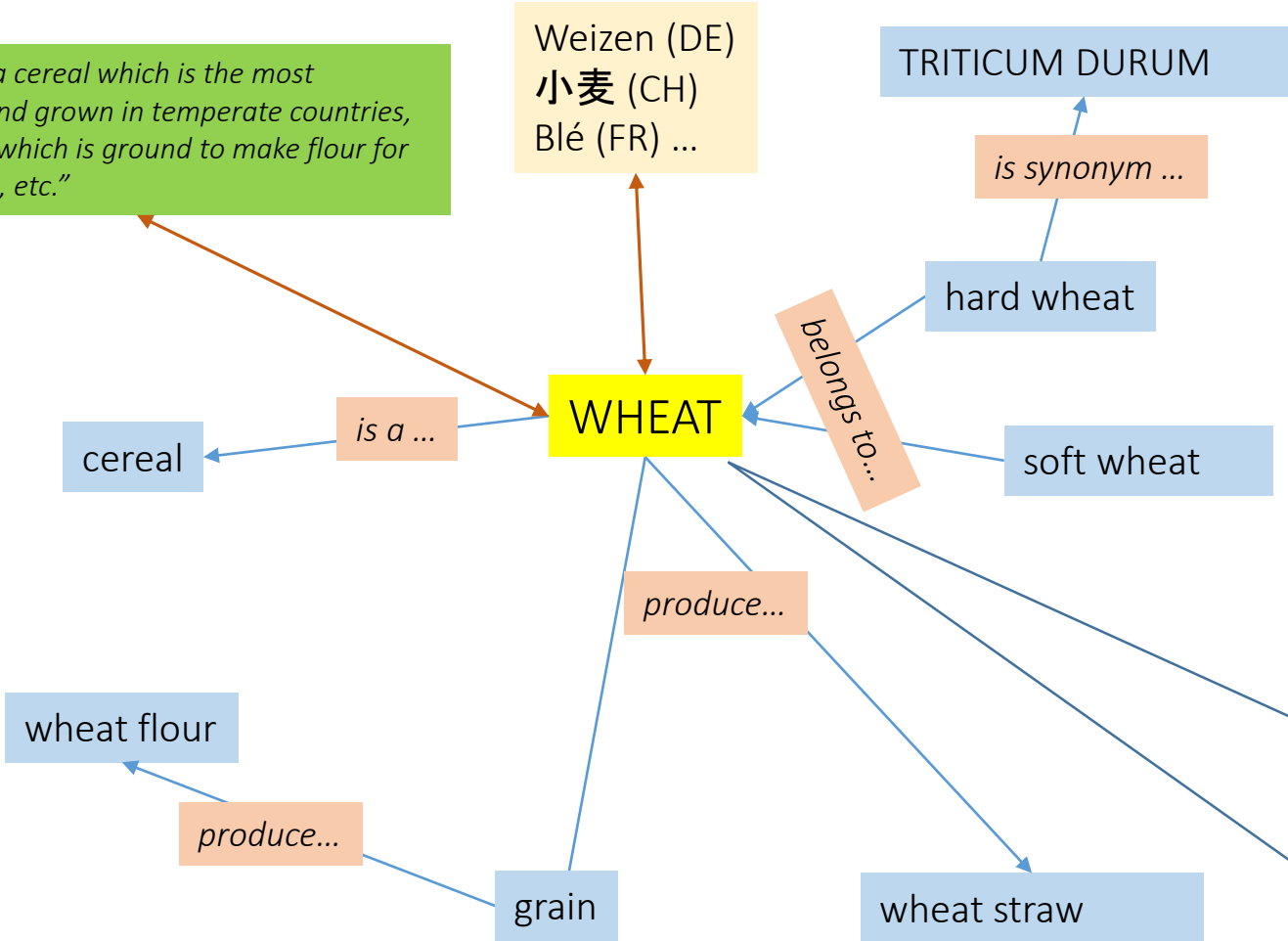
	A	B	C	D	E	F	G	H	I	J	K	L
1	Sites	Year	Dates	Plot Nr	Landuse	CO2	CH4	WFPS	Soil Temp	NH4	NO3	TN
2	Dornburg	2019/2020	2020-02-05T00:00:00	17	MC	16,15248907	2,014537418	66,3090727	2,8	0,353873015	0,46275702	0,816630035
3	Dornburg	2019/2020	2020-02-05T00:00:00	18	MC	21,57602373	-17,58430694	70,1414122	3,2	0,27466504	0,461671024	0,736336064
4	Dornburg	2019/2020	2020-02-05T00:00:00	19	MC	14,23285353	-6,55049326	60,0252173	3,9	0,323489214	0,515707443	0,839196658
5	Dornburg	2019/2020	2020-02-05T00:00:00	20	MC	7,668587595	1,369836777	71,1751839	3,8	0,151494886	0,891353629	1,042848515
6	Wendhauser	2018/2019	2018-04-07T00:00:00	1	AF_T	17,38527193	-9,029799495	67,4452373	5,2	3,629601916	1,434083606	5,063685522
7	Wendhauser	2018/2019	2018-04-07T00:00:00	5	AF_T	26,09982689	-2,861573591	65,086966	8,5	7,95840662	0,293077602	8,251484222
8	Wendhauser	2018/2019	2018-04-07T00:00:00	9	AF_T	23,7712574	-6,790432495	60,4034525	5,3	4,797791461	1,400722357	6,198513817
9	Wendhauser	2018/2019	2018-04-07T00:00:00	13	AF_T	64,91581054	10,12928832	76,5546381	7,2	6,295071121	0,516688818	6,811759939
10	Wendhauser	2018/2019	2018-04-07T00:00:00	2	AF_1	24,20015152	-3,926820399	54,907974	5,6	10,99501079	26,41516858	37,41017937
11	Wendhauser	2018/2019	2018-04-07T00:00:00	6	AF_1	24,14647683	-5,825871517	49,639882	8,5	4,156102935	21,50699185	25,66309479
12	Wendhauser	2018/2019	2018-04-07T00:00:00	10	AF_1	14,63899374	3,577959891	60,1435066	5,8	2,551189552	16,90446657	19,45565613
13	Wendhauser	2018/2019	2018-04-07T00:00:00	14	AF_1	47,62797412	-11,38352577	41,1809805	9,8	14,50451548	21,30786544	35,81238093
14	Wendhauser	2018/2019	2018-04-07T00:00:00	3	AF_7	10,57714943	-1,483721103	51,1511745	5,4	28,55933033	30,83149728	59,39082761

+ general: research question, provenance, authors contact.....

Semantics:

Teach a machine (search engine): What is „wheat“?

Definition: "a cereal which is the most important kind grown in temperate countries, the grain of which is ground to make flour for bread, pasta, etc."



Meaning & annotation to data
Ambiguous ID: c_8373
AGROVOC Multilingual Thesaurus

provide „controlled“ keywords

AGROVOC Multilingual Thesaurus

AGROVOC Multilingual Thesaurus

Alphabetical Hierarchy Groups

A Å B C Ç D E F G H I J K L M
N O P Q R S Ş T U V W X Y Z
0-9

A horizons
Aptosyax grypus
Aaron's rod → Verbascum
ABA
abaca
abachi → Triplochiton scleroxylon
Abalistes stellaris
abalone culture
abalone fisheries → gastropod fisheries
abalone viral ganglioneuritis
abalones
abamectin

entities > soil types > genetic soil types > World Reference Base soil types > Chernozems

PREFERRED TERM

① **Chernozems**

DEFINITION

① Chernozems accommodate soils with a thick blackish mineral surface layer that is rich in organic matter. The Russian soil scientist V.V. Dokuchaev coined the name Chernozem in 1883 to denote the typical soils of the tall-grass steppes in continental Russia. Many Chernozems correspond to Kalktschernoseme (Germany), Chernosols (France), Eluviated black soils (Canada) and Chernossolos (Brazil). In the United States of America they were formerly called Calcareous black soils and belong now to several Suborders (especially Udolls) of the Mollisols.

(en)

① Orta kuşağın yarı nemli alanlarında uzun boylu çayır vejetasyonu altında gelişmiş olan topraklar.

(tr)

BROADER CONCEPT

World Reference Base soil types (en)

ENTRY TERMS

① *black soil* (en)

IN OTHER LANGUAGES

- | | |
|---------------|-----------|
| ① تشيرنوزيم | Arabic |
| ① 黑钙土 | Chinese |
| ① černozeň | Czech |
| ① Chernozem | French |
| ① ჩერნოზომები | Georgian |
| ① Tschernosem | German |
| ① Schwarzerde | |
| ① चेर्नोजम | Hindi |
| ① csernozjom | Hungarian |

AGROVOC

operated by FAO, open access

~42.000 concepts (terms)

>100.000 alternative concepts

~45 languages

machine readable

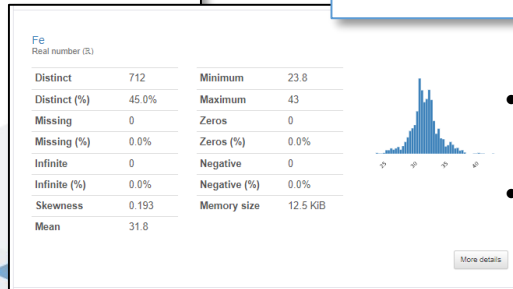
Data quality (DQ KIT)

Overview

Overview Alerts 3 Reproduction

Dataset statistics

Number of variables	6
Number of observations	1583
Missing cells	0
Missing cells (%)	0.0%
Duplicate rows	0
Duplicate rows (%)	0.0%
Total size in memory	74.3 KiB
Average record size in memory	48.1 B

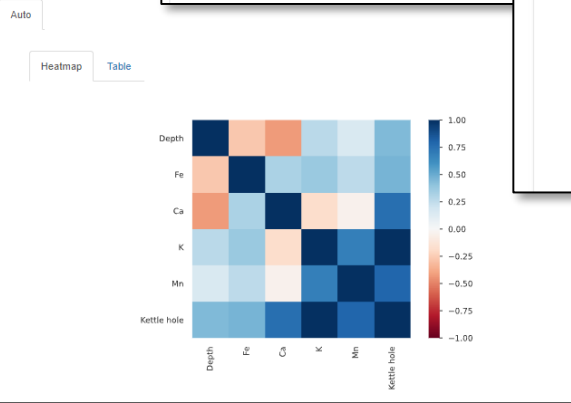


Alerts

- K is highly overall correlated with Kettle hole High correlation
- Kettle hole is highly overall correlated with K High correlation
- Mn is highly skewed ($\gamma_1 = 1.156465686$) Skewed

pdf download DQ report (supplement. material)
results to be stored in metadata

Correlations



	A	B	C	D	E	F	G	H	I	J	K
	Sites	Year	Dates	Plot_Nr	Landuse	Plot	CO2	CH4	WFPS	Soil_Temp	NH4
1	Dornburg	2019/2020	2020-02-05T00:00:00	17	MC	DR1	16,15248907	2,014537418	66,3090727	2,8	0,3538730
2	Dornburg	2019/2020	2020-02-05T00:00:00	18	MC	DR2	21,57602373	-17,58430694	70,1414122	3,2	0,274665
3	Dornburg	2019/2020	2020-02-05T00:00:00	19	MC	DR3	14,23285353	-6,55049326	60,0252173	3,9	0,3234892
4	Dornburg	2019/2020	2020-02-05T00:00:00	20	MC	DR4	7,668587595	1,369836777	71,1751839	3,8	0,1514948
5	Wendhauser	2018/2019	2018-04-07T00:00:00	1	AF_T	WT1	17,38527193	-9,029799495	67,4452373	5,2	3,6296019
6	Wendhauser	2018/2019	2018-04-07T00:00:00	5	AF_T	WT2	26,09982689	-2,861573591	65,086966	8,5	7,958406
7	Wendhauser	2018/2019	2018-04-07T00:00:00	9	AF_T	WT3	23,7712574	-6,790432495	60,4034525	5,3	4,7977914
8	Wendhauser	2018/2019	2018-04-07T00:00:00	13	AF_T	WT4	64,91581054	10,12928832	76,5546381	7,2	6,2950711
9	Wendhauser	2018/2019	2018-04-07T00:00:00	2	AF_1	WA1	24,20015152	-3,926820399	54,907974	5,6	10,995010
10	Wendhauser	2018/2019	2018-04-07T00:00:00	6	AF_1	WA2	24,14647683	-5,825871517	49,639882	8,5	4,1561029
11	Wendhauser	2018/2019	2018-04-07T00:00:00	10	AF_1	WA3	14,63899374	3,577959891	60,1435066	5,8	2,5511895
12	Wendhauser	2018/2019	2018-04-07T00:00:00	14	AF_1	WA4	47,62797412	-11,38352577	41,1809805	9,8	14,504515



dqkit.bonares.de



How to handle field data?

	A	B	C	D	E	F	G	H	I	J	K
1	Sites	Year	Dates	Plot_Nr	Landuse	Plot	CO2	CH4	WFPS	Soil_Temp	NH4
2	Dornburg	2019/2020	2020-02-05T00:00:00	17	MC	DR1	16,15248907	2,014537418	66,3090727	2,8	0,353873015
3	Dornburg	2019/2020	2020-02-05T00:00:00	18	MC	DR2	21,57602373	-17,58430694	70,1414122	3,2	0,27466504
4	Dornburg	2019/2020	2020-02-05T00:00:00	19	MC	DR3	14,23285353	-6,55049326	60,0252173	3,9	0,323489214
5	Dornburg	2019/2020	2020-02-05T00:00:00	20	MC	DR4	7,668587595	1,369836777	71,1751839	3,8	0,151494886
6	Wendhauser	2018/2019	2018-04-07T00:00:00	1	AF_T	WT1	17,38527193	-9,029799495	67,4452373	5,2	3,629601916
7	Wendhauser	2018/2019	2018-04-07T00:00:00	5	AF_T	WT2	26,09982689	-2,861573591	65,086966	8,5	7,95840662
8	Wendhauser	2018/2019	2018-04-07T00:00:00	9	AF_T	WT3	23,7712574	-6,790432495	60,4034525	5,3	4,797791461
9	Wendhauser	2018/2019	2018-04-07T00:00:00	13	AF_T	WT4	64,91581054	10,12928832	76,5546381	7,2	6,295071121
10	Wendhauser	2018/2019	2018-04-07T00:00:00	2	AF_1	WA1	24,20015152	-3,926820399	54,907974	5,6	10,99501079
11	Wendhauser	2018/2019	2018-04-07T00:00:00	6	AF_1	WA2	24,14647683	-5,825871517	49,639882	8,5	4,156102935
12	Wendhauser	2018/2019	2018-04-07T00:00:00	10	AF_1	WA3	14,63899374	3,577959891	60,1435066	5,8	2,551189552
13	Wendhauser	2018/2019	2018-04-07T00:00:00	14	AF_1	WA4	47,62797412	-11,38352577	41,1809805	9,8	14,50451548

- ✓ described by metadata
- ✓ annotated controlled keywords
- ✓ **data quality approved**

Data submission (BonaRes Repository)

Upload tool

- Submission of QA and structured data
- Add metadata
- Easy editorial (ticket) system → status of submitted data
- Feedback (Data Stewards)
- Published (DOI!, FAIR!)

Upload-Tool of the BonaRes Repository
A portal for soil and agricultural research data

The [BonaRes Repository](#) provides access to German national and international soil and agricultural research data and data series from agricultural long-term field experiments (LTFE). All data are described with elements from the [BonaRes Metadata Schema](#) and licensed according to [Creative Commons](#). Additionally, datasets are described by keywords from the multilingual [AGROVOC](#) thesaurus (FAO) and get a persistent [DOI](#) which enables easy citation of research data.

The BonaRes Repository supports the [FAIR principles](#) for research data.

How to publish a dataset in the BonaRes Repository?

- 1. Dataset submission**
First you submit your dataset preferably as csv, excel or zip-file. We analyse your dataset and integrate it into our repository.
[Submit new dataset](#)
- 2. Edit metadata**
We send you a metadata xml file that you have to upload and complete in our [Metadata Editor](#). Then, we will review your metadata to ensure high data reusability.
- 3. Publication**
Your dataset will be published in the [BonaRes Repository](#) and provided with a DOI.

Dataset submission

- [Upload-Tool](#)
- [My submissions](#)
- [Submit new dataset](#)

Links

- [How to edit metadata?](#)
- [BonaRes Data Guideline](#)
- [Need help?](#)

BonaRes Data Centre

The [BonaRes Data Centre](#) manages the [BonaRes Repository](#) and is part of the research project 'Soil as a sustainable resource for the bioeconomy' (BonaRes), which is funded by the German...

BonaRes Repository - Dataset submission

Dataset title *

Provide a meaningful title for your dataset.

Short description

A brief description of the dataset.

Project *

Other

Select a project from this list. If nothing applies, please select 'Other'

Research domain *

Select one category of the listed research domains that are based on the [DFG subject classification system](#).

A	B	C	D	E	F	G	H		
Sites	Year	Dates	Plot_Nr	Landuse	Plot	CO2	CH4		
1	Dornburg	2019/2020	2020-02-05T00:00:00	17	MC	DR1	16,15248907	2,014537418	
2	Dornburg	2019/2020	2020-02-05T00:00:00	18	MC	DR2	21,57602373	-17,58430694	
3	Dornburg	2019/2020	2020-02-05T00:00:00	19	MC	DR3	14,23285353	-6,55049326	
4	Dornburg	2019/2020	2020-02-05T00:00:00	20	MC	DR4	7,668587595	1,369836777	
5	Wendhauser	2018/2019	2018-04-07T00:00:00	1	AF_T	WT1	17,38527193	-9,029799495	
6	Wendhauser	2018/2019	2018-04-07T00:00:00	5	AF_T	WT2	26,09982689	-2,861573591	
7	Wendhauser	2018/2019	2018-04-07T00:00:00	9	AF_T	WT3	23,7712574	-6,790432495	
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9	Wendhauser	2018/2019	2018-04-07T00:00:00	2	AF_1	WA1	24,20015152	-3,926820399	
10	Wendhauser	2018/2019	2018-04-07T00:00:00	6	AF_1	WA2	24,14647683	-5,825871517	
11	Wendhauser	2018/2019	2018-04-07T00:00:00	10	AF_1	WA3	14,63899374	3,577959891	
12	Wendhauser	2018/2019	2018-04-07T00:00:00	14	AF_1	WA4	47,62797412	-11,38352577	
13							49,639882	8,5	4,156102935
							60,1435066	5,8	2,551189552
							14,1809805	9,8	14,50451548

upload.bonares.de



BonaRes Repository

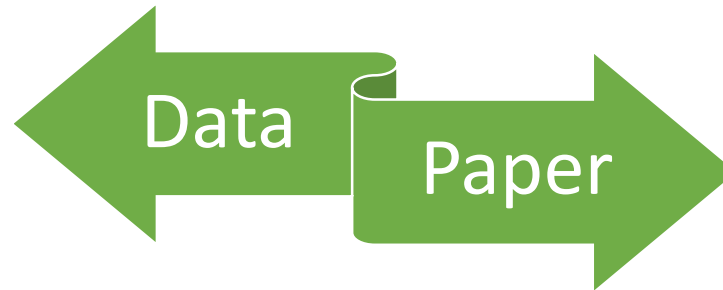
My dataset submissions [Submit new dataset](#)

Ticket	Title	Submitted	Status	Tools
#2630	IOSDV Rauschholzhausen	15.04.2020	Canceled	
#1989	Mycorrhiza colonization of Bittenfelder apple roots bio test 2017 with Ruthe soil	15.04.2020	Published	
#2606	R script to reproduce "Improved normalization of species count data in ecology by scaling with ranked subsampling (SRS): application to microbial communities"	06.04.2020	Published	

Data publication (BonaRes Repository)

The powerful DOI to connect data and paper

doi.org/10.20387/BonaRes-PDY6-HHGS



doi.org/10.5194/soil-4-23-2018

	A	B	C	D	E	F	G	H	I	J	K
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5	Dornburg	2019/2020	2020-02-05T00:00:00	20	MC	DR4	7,668587595	1,369836777	71,1751839	3,8	0,151494886
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9	Wendhauser	2018/2019	2018-04-07T00:00:00	13	AF_T	WT4	64,91581054	10,12928832	76,5546381	7,2	6,295071121
10	Wendhauser	2018/2019	2018-04-07T00:00:00	2	AF_1	WA1	24,20015152	-3,926820399	54,907974	5,6	10,99501079
11	Wendhauser	2018/2019	2018-04-07T00:00:00	6	AF_1	WA2	24,14647683	-5,825871517	49,639882	8,5	4,156102935
12	Wendhauser	2018/2019	2018-04-07T00:00:00	10	AF_1	WA3	14,63899374	3,577959891	60,1435066	5,8	2,551189552
13	Wendhauser	2018/2019	2018-04-07T00:00:00	14	AF_1	WA4	47,62797412	-11,38352577	41,1809805	9,8	14,50451548

- ✓ described by metadata
- ✓ annotated controlled keywords
- ✓ data quality approved
- ✓ **published/accessible (DOI)**



Search and find FAIR and quality assured soil/agri data

Field data: maps.bonares.de/mapapps/?lang=en

Long-term experiments: lte.bonares.de

Soil profiles: tools.bonares.de/bp_db/



- Different search options (map, AGROVOC keywords; DataCite,)
- Different download formats and coordinate systems
- No registration needed
- Rich metadata (CC-0; as XML or pdf)
- Re-use research data – open (CC-BY)

The screenshot displays the BonaRes Repository interface. At the top, there is a search bar with the text "What do you want to do?" and "Enter search term...". Below the search bar, there are several panels. The "Extended Search" panel is active, showing a search for "biomass production" using AGROVOC keywords. The search results show "Search result: found 1 Concepts" with a checkbox next to "biomass production". A "Download" dialog box is open, allowing users to select datasets for download. The dialog shows a list of datasets, with "Cropland Agroforestry 2017 and 2018" selected. Users can choose the destination format (Microsoft Excel (xlsx)) and the destination coordinate system (WGS84 datum, Latitude-Longitude). There is also a field for an email address. The background shows a map of the region around the Black Sea, with labels for countries like Turkey, Georgia, and Azerbaijan.

NFDI – connect database „silos“



NFDI (=National Research Data Infrastructure)

- 28 consortia (from Agriculture to Zoology)
- cooperation not competition
- ethical aspects, industry involvement...
- 10 years financed, up to 900 M€
- national response to commercial “data players”, e.g. Google
- international harmonization

nfdi
Nationale
Forschungsdaten
Infrastruktur

FAIRragro – connect agricultural database „silos“



Soil-Agrosystem data networks



Research data management (RDM) networks



2023 - 2028



FAIRragro

FAIRragro – organisation

29 national partners
(universities, research
institutes, associations...)

Support &
Training

IT Services
and
Standards

Agrosystem Community
(what are your demands?)



Goal: Set up a FAIRragro Portal to provide access all soil/agri data

Data Steward
Service Center

Guidelines

Education &
Training

Networked
RDIs

Search &
Inventory

DQ and
Plausibility

Terminology

DQ Metrics

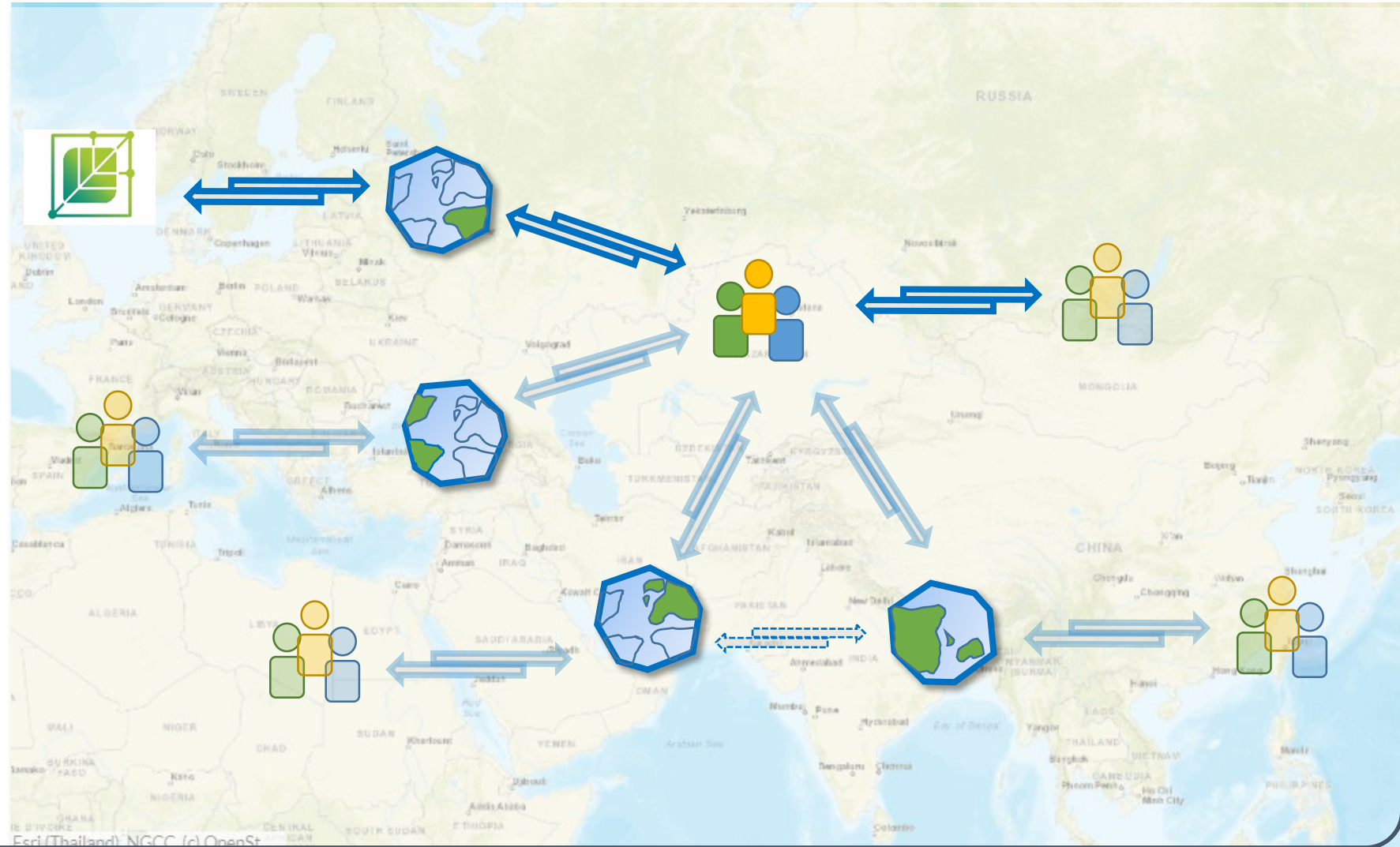
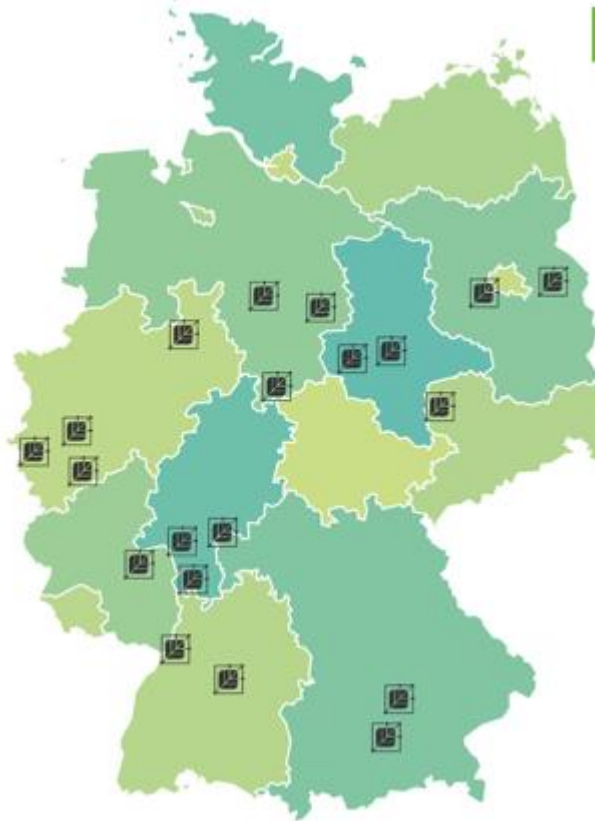
Legal Framework



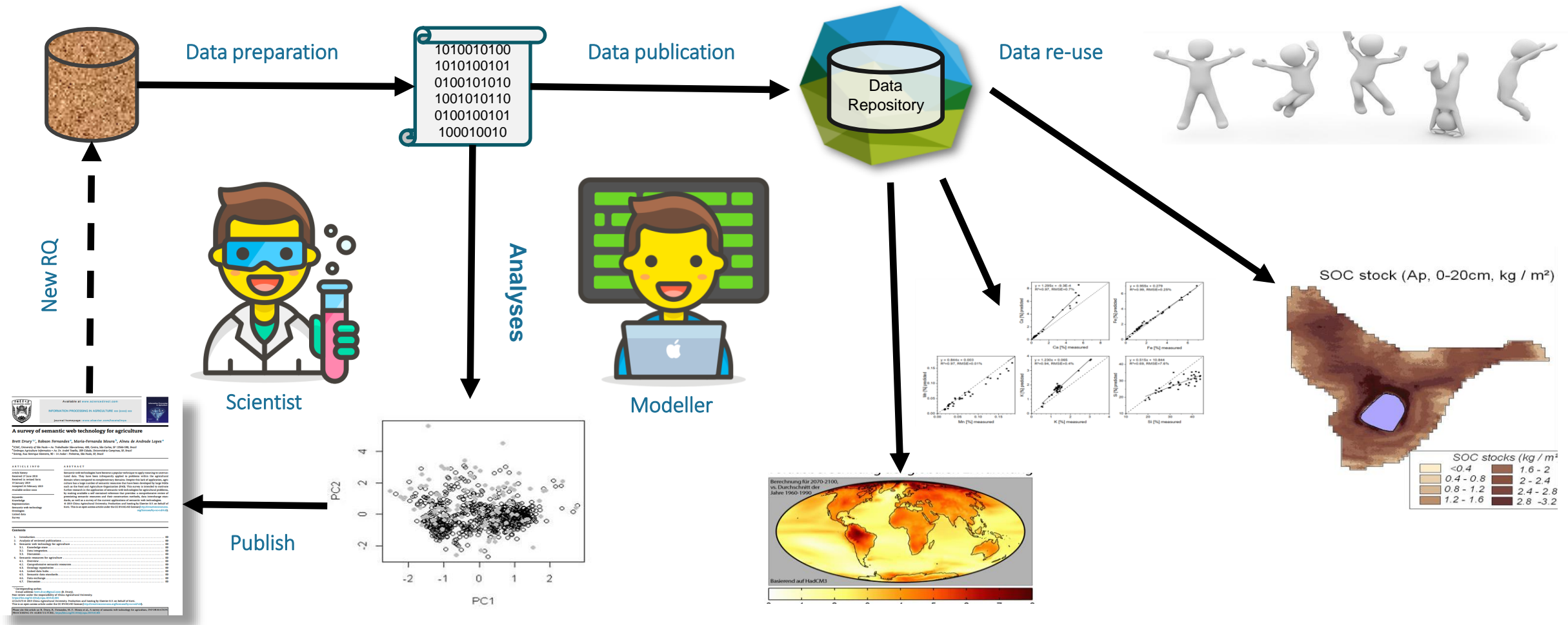
FAIRragro

FAIRragro – One Portal for all

Goal: Set up a FAIRragro Portal to provide access all soil/agri data



Our use case from the beginning...



Thank you
Danke
Xie xie

for your attention!

(Black soil in South Germany)



Find a browse (meta)data

LTE Overview map

- Agricultural long-term experiments (LTE)
- answer research questions of climate change, ecosystem services, nutrient cycles, agri. yield,...
- LTE definition: >20 years
- LTE data/contact often difficult to find / access

BonaRes product: map with metadata of ~ 570 LTE

- ✓ 30 countries
- ✓ metadata harmonization
- ✓ different display and filter functions
- ✓ open infrastructure
- ✓ international cooperation (GLTEN, EJP Soil)

Overview of Long Term Exp

This LTE overview map contains information about long-term experiments (LTE) included: EJP SOIL (European Joint Programme for Soil Science Research) and IOSDV (International Organic Nitrogen Fertilization Experiment).

(You can get easy access to your LTE of interest)

Search experiments, e.g. 'Sweden', 'Edinburgh', '10'

List Map

Metadata Details

Trial Name	LTE Brody, Tillage experiment
Trial Site	Brody
Country Name	Poland
Start of the Trial	1999
End of the Trial	undefined
Trial Holder Name	University of Life Sciences in Poznan (LSU Poznan)
Website	https://puls.edu.pl/en/u

DOI: [link]

Research Theme

Type of Land Use

General

LTE Description

LTE Name	LTE Brody, Tillage experiment
Location	Brody
Country	Poland
LTE Start Date	1999
Status	Ongoing
Project Duration	23 Years
LTE Institution	University of Life Sciences in Poznan (LSU Poznan)
Institution Category	University / University of applied sciences
DOI	[link]

Research Information

Land Use Type	Arable land
Research Theme	Impact of periodic interruption of direct sowing by plowing or shallow cultivation tillage on yield, soil properties and weeds

lte.bonares.de

