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Editors(s): Barnett, C.L., Howard, B.J.

Contributors: Barnett, C.L., Howard, B.J., Beresford, N.A., Chaplow, J., Wells, C.

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Executive Summary

Data needs to be maintained in a form which it is available in a sustainable format supported by good quality meta data. There is an EC requirement to make spatial data available within the [INSPIRE directive](#).

The transparency and provenance of data derived and collated has been enhanced and made more accessible to the wider community during STAR. A STAR member's data holdings wiki has been implemented from which information collated was used to populate the [radioecology data catalogue](#). The catalogue currently provides access to radioecology data held by partners and further data produced during STAR will be added to the catalogue as it is published. Some INSPIRE compliant data has also been made available via the [NERC Environmental Information Data Centre](#) (EIDC); more will be made available in the near future.

Some of the databases held in the catalogue have been used within STAR refereed publications. The data have also been useful in identifying independent data to validate models (which is a particular problem for many modellers) thus improving model credibility.

STAR has provided guidance on how to curate and make data available at meetings and at an international "making data available" STAR workshop. Workshops have been held on radioecological data; two on Kd, and one on 'making data available'. The outputs from these workshops are accessible from: <https://wiki.ceh.ac.uk/x/u4XXD>.

STAR has pioneered mechanisms to improve the transparency of radioecological data. The approaches developed within STAR are leading the community at international level via the interaction with IAEA MODARIA programme where STAR partners chair four of the working groups. Examples of enhancing the availability and transparency of some major international data sets are being taken forward in co-operation with the IAEA MODARIA programme; e.g. soil and freshwater partition coefficients (Kd), biological half-life values for wildlife and animal product transfer parameter values.

Improving current practices of data curation, availability and transparency makes national and international data sets more accessible and greatly facilitates more frequent updates of key databases such as radioecological parameter values. An overall aim of good data curation is to underpin sustainability which is a key issue for European platforms such as the ALLIANCE.

List of Acronyms and Abbreviations

ALLIANCE:	European Radioecology Alliance. A European Research Platform, in accordance with relevant European Union policies which coordinates and promotes research on radioecology
COMET:	Coordination and iMplementation of a pan-European instrument for radioecology. An EC-funded project designed to further the work of STAR and to bring radioecology within the OPERRA radiation protection programme established by the EC's next funding framework: Horizon2020
DOI:	Digital Object Identifier
DoW:	Description of Work
EC:	European Commission
EIDC	Environmental Information Data Centre
IAEA:	International Atomic Energy Agency
INIS:	International Nuclear Information System
INSPIRE	Infrastructure for spatial information in the European Community
Kd:	partition coefficient
MODARIA:	Modelling and Data for Radiological Impact Assessments. IAEA Programme on radioecological assessment and modelling
NoE:	Network of Excellence
OPERRA:	Open Project for European Radiation Research Area
STAR:	Strategy for Allied Radioecology. An EC-funded Network of Excellence in radioecology under the Radioecology Alliance framework
TRS:	Technical Report Series
UK:	United Kingdom
WG:	Working Group
WP:	Work Package
BfS:	German Federal Office for Radiation Protection, Germany
CIEMAT:	Research Centre in Energy, Environment and Technology, Spain
IRSN:	French Institute of Radiation Protection and Nuclear Safety, France
NERC-CEH:	Natural Environment Research Councils Centre for Ecology & Hydrology, United Kingdom

NRPA: Norwegian Radiation Protection Authority, Norway
NMBU: Norwegian University of Life Sciences, Norway
SCK•CEN: Belgian Nuclear Research Centre, Belgium
STUK: Radiation and Nuclear Safety Authority, Finland
SU: Stockholm University, Sweden
SUNY: State University of New York, United States of America
TU: Tokai University, Japan

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1 Introduction

This deliverable summarises the activities conducted during the STAR project related to data. As the majority of the information is available from the Radioecology Exchange or the STAR project website this deliverable is deliberately brief and provides hyperlinks to the relevant information. Some of the text has been taken (or modified) from other STAR project documents and deliverables.

2 Data related activities in STAR

2.1.1 Planned activities

The exploitation of results and spreading of excellence were considered important to the success of the STAR Network of Excellence (NoE). A strategic goal of STAR was to build on the foundation of the considerable resources and expertise of the NoE partners to develop the capability to provide open access to high quality compiled data and knowledge.

To achieve this aim STAR WP7 (in collaboration with WP2) intended to design data cataloguing and searchable databases (with geospatial display). These databases would allow the wider community to interrogate/summarise key data and provide users with the functionality to add data under a quality assurance (QA) procedure (to be developed by WP2). The databases would provide open access to data produced during STAR (specifically all of the data generated by work packages 3-5 (and that for the Observatory sites). Once established, these databases would also allow STAR, to develop an online database for empirical and mechanistic transfer parameter values that are used in radioecological models for both humans and wildlife which could be updated by online input from the radioecological community and would provide continually improving summary tables of data for general usage by radioecologists and other disciplines. Moreover, in collaboration with WP3 STAR planned to investigate how databases for human and wildlife assessments can be combined (e.g. currently, freshwater databases are developed separately to those for human foodstuffs and wildlife transfer).

WP2 (in collaboration with WP7) were to set up a Virtual Laboratory to host information and data related to best practice for experimental, analytical and field methods. WP6 (in collaboration with WP7) were to set up the Training and Education platform to host information (which may include data) related to training and education.

A number of workshops were planned to facilitate the transfer of information and data; these were:

- WP3: an international workshop on state-of-the-art dosimetry methods for non-human species
- WP4: four workshops to interact with invited experts from fields of (chemical) multi contaminants
- WP4/5: two workshops devoted to discussion of Dynamic Energy Budget Model development and systems ecotoxicology
- WP6: two consultation workshops to discuss training and education needs and supply.
- WP7: two workshops to inform the wider community on the dissemination activities of STAR and explore how they may disseminate their outputs via the webportal (e.g. database entries).

Publications are also an important data dissemination activity and STAR planned to develop a publication strategy to ensure a high quality output in the referred scientific literature. Partners

agreed to endeavour, where available, to secure rights for open access to the publication and WP7 was also to explore the possibility of publishing STAR data in an open-access journal. A grey literature archive was also to be established.

2.1.2 Amendments to planned activities

The issue of data availability for some STAR partners has meant that data focused workshops based on data being provided by STAR partners were not appropriate. Instead, three international workshops with invited speakers were arranged which focused on data and discussion (see section 4 and <https://wiki.ceh.ac.uk/x/u4XXD> for more information).

2.1.3 STAR data dissemination Strategy

All STAR data was to be made openly available under the terms of the contract.

3 Making data available

3.1.1 Why and How

There is a need to disseminate data to comply with current European legislation and, in some countries, governmental guidance on the management and distribution of environmental information, i.e. the INSPIRE directive, Freedom of Information (FOI), Environmental Information Regulations (EIR). The [INSPIRE directive](#) came into force in 2007 with the aim to create a European Union (EU) infrastructure for spatial data. This would enable information sharing among public sector organisations, facilitate public access to spatial information across Europe and assist in policy-making across boundaries. INSPIRE will be introduced in various stages and should be fully implemented by 2019. INSPIRE is based on a number of common principles:

- Data should be collected only once and kept where it can be maintained most effectively.
- It should be possible to combine seamless spatial information from different sources across Europe and share it with many users and applications.
- It should be possible for information collected at one level/scale to be shared with all levels/scales; detailed for thorough investigations, general for strategic purposes.
- Geographic information needed for good governance at all levels should be readily and transparently available.
- It should be easy to find what geographic information is available, how it can be used to meet a particular need, and under which conditions it can be acquired and used. In addition, many researchers must comply with their funder requirements.

For instance in the UK, the [NERC Data Policy](#) and [Defra Open data Strategy](#) both require that grant recipients make their data openly available. The benefits of data dissemination include ensuring continued availability of environmental data of long-term value for research, teaching and wider exploitation (by individuals, government and business). Making data available during the lifetime of a project is good practice and stops the loss of data due to staff moving on to new projects or leaving the organisation (e.g. students, retirements). It is possible to gain credit for depositing data through Digital Object Identifier (DOI) mechanism (e.g. Barnett et al. 2013; Feinstein & Blackwood 2013; Hill 2015). This can benefit (and motivate) staff who work on data, but are often not listed as an author on resultant journal papers, or can be a way of making

datasets available you would not otherwise publish (e.g. Barnett et al. 2015). In addition, a DOI can help in formal publication of data sets, enabling the tracking of their usage through citation and data licences. Depositing your data to obtain a DOI allows hand-over of the responsibility for long-term management of data and ensures data are secure, well documented, easy to discover, access and use in future. This system supports the integrity, transparency and openness of the research. It is becoming increasingly common for journals to ‘strongly recommend’ that data and related metadata are deposited in an appropriate data repository e.g. PlosOne (<http://www.plosone.org/static/publication>) suggest depositing with Dryad (see later) and request a Data Availability Statement (includes name of repository and list of data DOI’s) (e.g. Quinto et al. 2015). There are also now journals specialising in the publication of data. Relevant journals include Earth System Science Data (<http://www.earth-system-sciencedata.net/>) and Scientific Data, a Nature Publishing on-line publication (<http://www.nature.com/sdata/>). Earth System Science Data is now included in Thomson Reuters Web of Science and has been used for at least one radioecological publication (Chaplow et al. 2014a).

There are currently a variety of ways to disseminate data: as supplementary information to a journal paper, depositing in line with journal requirements, putting on your own website, payment to a repository to deposit the data, and use of a data centre. Supplementary data and journal appendices do not allow for staff to gain credit (i.e. as for the DOI mechanism) for data products and access is often restricted to those subscribing to the journal. Making available through the authors website makes the data available to all, but, gives no credit to the originators, is likely to lack some of the control of the data repositories protocols and relies upon the website remaining in place (this is often not the case for project websites). Such approaches mean that data may be made available without detailed metadata recorded in line with data standards and will not be available to data catalogues, repositories and search engines (e.g. www.data.gov.uk). By depositing data with a data centre or repository, a DOI can be obtained for the data. However, data ownership can be lost and costs can be incurred. For example data deposited with the [Dryad](#) and [Figshare](#) digital repositories is open access but there are associated costs to the depositor (Dryad data publishing charge US\$80-90 and Figshare costs are tailored to organisations). The Dryad Digital Repository is a curated resource that makes the data underlying scientific publications discoverable, freely reusable, and citable. Dryad provides a general-purpose home for a wide diversity of datatypes. Figshare allows users to upload any file format to be visualised in the browser so that figures, datasets, media, papers, posters, presentations and file sets can be disseminated in a way that the current scholarly publishing model does not allow. Some journals now have supported data repositories, for instance, Elsevier [lists 43 data repositories](#) (e.g. Oak Ridge National Laboratory Distributed Active Archive Center, Natural Environment Research Council data centres, Atmospheric Radiation Measurement (ARM) Data Archive, PANGAEA and GenBank).

3.1.2 An example data centre: the NERC Environmental Information Data Centre

STAR experience of depositing data and the DOI mechanism is with the Natural Environment Research Council (NERC) Environmental Information Data Centre (EIDC; <http://eidc.ceh.ac.uk/>) hosted by the Centre for Ecology and Hydrology (CEH). The EIDC is a NERC designated data centre whose area of interest is terrestrial & freshwater science, hydrology and bioinformatics data. The EIDC has a [data catalogue](#) that allows the public to discover and view data and download data from the EIDC. The EIDC currently hosts 277 datasets, has more than 3400 registered users (registration is open to anybody and is required for delivery of requested datasets) and there have been >6300 data downloads since 2010 (the

year the EIDC was established). Data deposited with the EIDC must comply with UK Gemini 2 (GEO-spatial Metadata INteroperability INitiative) specification for metadata describing geospatial data resources for discovery purposes. Gemini 2 enables users to capture metadata which conforms to the INSPIRE implementing rules. This has been adopted by UK Location Programme (UKLP) as the UK standard for discovery metadata. Compliance with Gemini 2 enables metadata entered on the EIDC data catalogue to be accessible to other Gemini 2 implemented portals (e.g. www.data.gov.uk). NERC has a further six data centres that deal with data from atmospheric science, earth sciences, earth observation, marine science, polar science and solar terrestrial physics and chemistry. To assign a DOI, a data centre or repository applies to a [DOI registration agency](#)); the EIDC works with DataCite. The following criteria are required by the EIDC so that a DOI can be assigned:

- DOI request must come from an author of the dataset.
- Dataset must be stable and complete (i.e. no more additions or changes expected), permanent, of good technical quality, in an appropriate format (EIDC uses CSV (comma separated values) files as these are better future proofed than many other formats (e.g. MSExcel™).
- Additional metadata may be required. Additionally, decisions on data licensing (e.g. Open Government Licence) and terms and conditions will be required.

The author can request that data be embargoed by a data centre before publication; in this way publication can coincide with that of an accompanying journal paper. The EIDC can embargo for a period of up to 2 years from completion of data deposit. A DOI can be cited before data is publicly available via a link to an embargo statement (e.g. ‘Data under embargo. The data resource you are trying to access will become available by dd/mm/yy’). A DOI cannot be assigned until the data has been deposited and the authorship, title and year of publication of the data has been resolved (e.g. see Chaplow et al. (2014b)).

An example of collaborative doi is the wildlife biological half-life database which is being created as part of the [IAEA MODARIA](#) programme, largely led by STAR partners (Beresford in press^a & ^b). Another example will be the IAEA farm animal transfer database which is expected to be published (in stages) in late 2015 or early 2016.

3.1.3 An example of a ‘data paper’

STAR has been at the forefront of considering how to implement data publication and has published the very first open access radioecological data paper (Chaplow et al. 2015^a) with an associated data set with its own doi: Chaplow et al. 2015^b.

4 Data related information on the Radioecology ‘Information Exchange’

The Radioecology ‘[information exchange](#)’ is a key area on the Radioecology Exchange website. It gathers together a wide range of material related to radioecology (not just data) that is useful to a broad spectrum of stakeholders.

4.1.1 Radioecology data catalogue

STAR WP7 designed and set up a ‘data holdings’ wiki to collate information on data held by STAR partners that they wished to make publically available on the Radioecology Exchange. A standardised template was used that asked for the following information:

- Title of data

- Abstract - short description of data
- Name of the STAR partner holding the data
- Type of data – select from a drop down list e.g. research data, parameter database
- Number of samples
- Quality of the samples
- Are the data spatial referenced
- Ecosystem type the data are from – select from a drop down list e.g. terrestrial, marine
- Sample type – select from a drop down list e.g. soil, vegetation, animal
- Year or years over which samples collected
- Languages
- Status (e.g. are the samples from an on-going programme)
- Are the data already available on-line – if so, provide link
- Key reference for data (if applicable)
- If data are NOT currently available on-line would you like it to be - – select from a drop down list e.g. yes, no, discuss
- Do you want to make use of the 'Spatial Gateway'
- Who owns the data
- What is the current format of the data
- Are the samples from the study archived and available to be used by STAR partners
- Contact email address
- Is likely that you will need to update this entry in the future? If YES - what needs to be updated and when?
- Comments

The information collated using this form was then used to populate the [radioecology data catalogue \(Fig. 1\)](#).

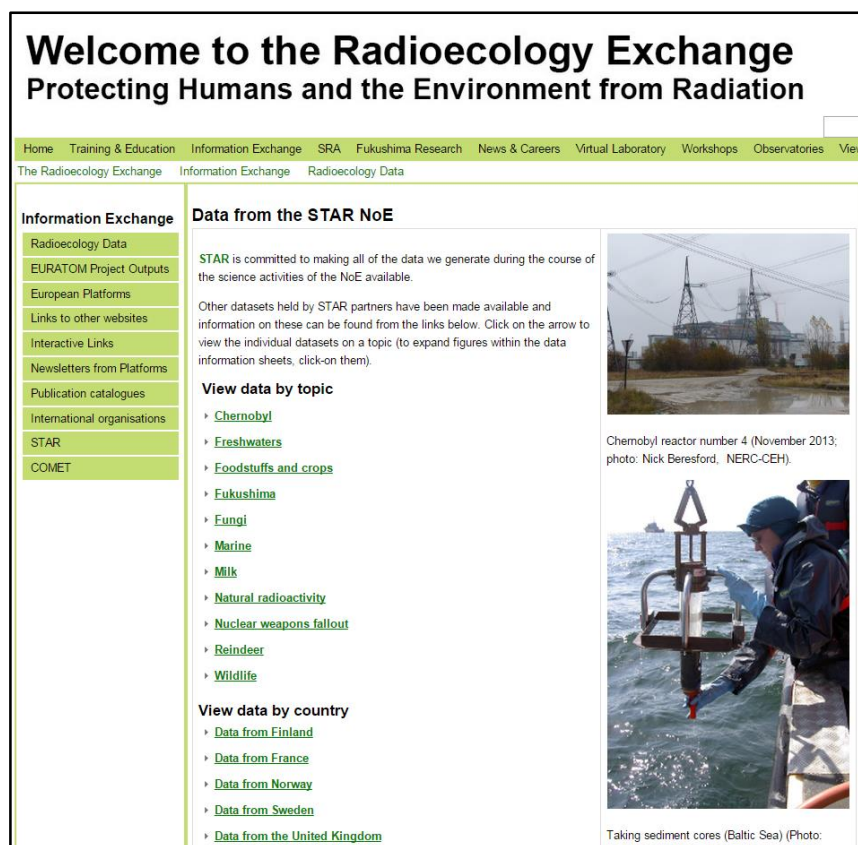


Figure 1: The Radioecology Data Catalogue hosted on the Radioecology Exchange
Data in the catalogue can be viewed by topic (Fig 2; also see Fig. 1 for the list of topics).

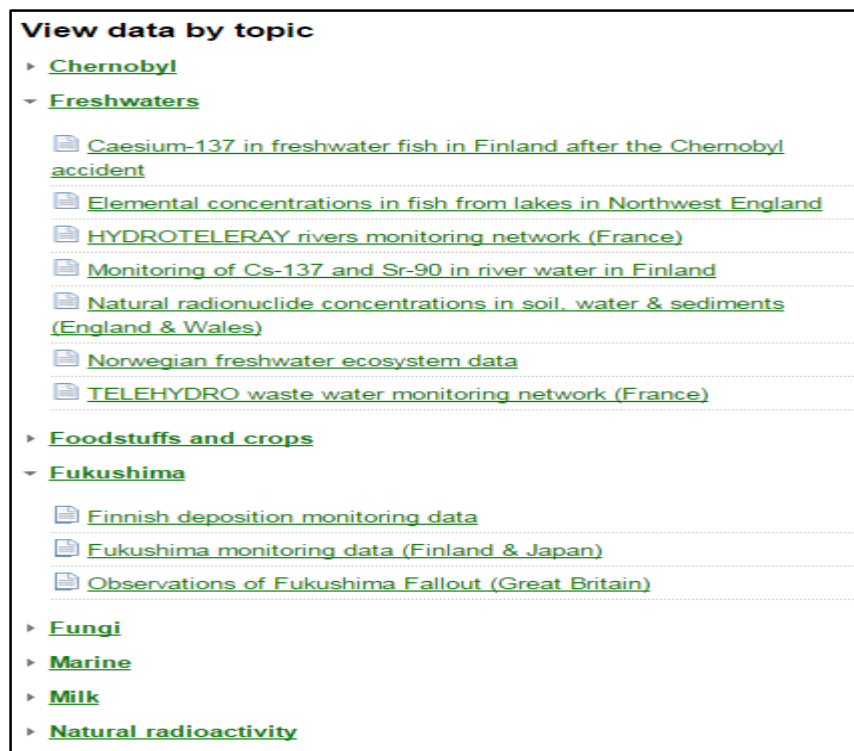


Figure 2: An example of some 'Freshwaters' and 'Fukushima' related datasets hosted on the radioecology data catalogue

Data can also be viewed by country (Fig 3; also see Fig. 1 for list of countries).



Figure 3: An example of data from Finland and France hosted on the radioecology data catalogue

It is also possible to use the keyword 'search' function on the Radioecology Exchange website to identify specific datasets as each one had been 'labelled' with a number of appropriate keywords (Fig 4).

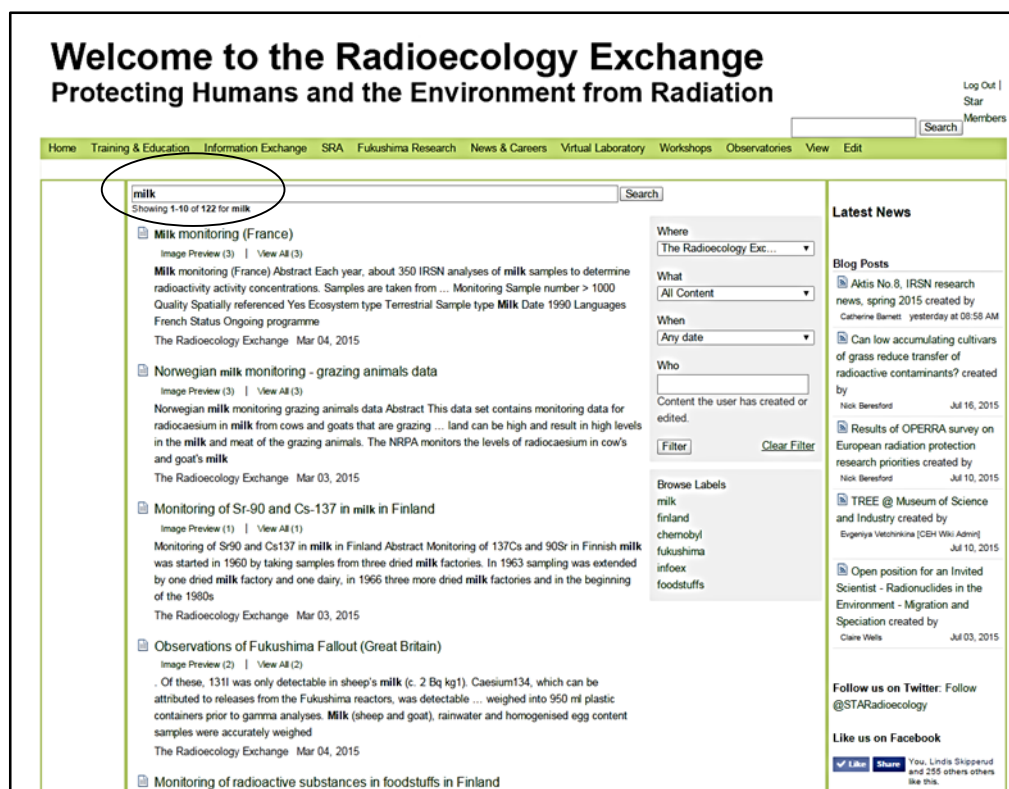


Figure 4: An example of data identified on the Radioecology data catalogue using the keyword search term ‘milk’

4.1.2 The NERC Environmental Information Data Centre

Some STAR Partners have also agreed to use the [NERC Environmental Information Data Centre](#) to provide access (fig. 5) to radioecological data which is compliant with the European [INSPIRE Directive](#). Metadata and, in some instances, data can be accessed using the search term STAR NoE.

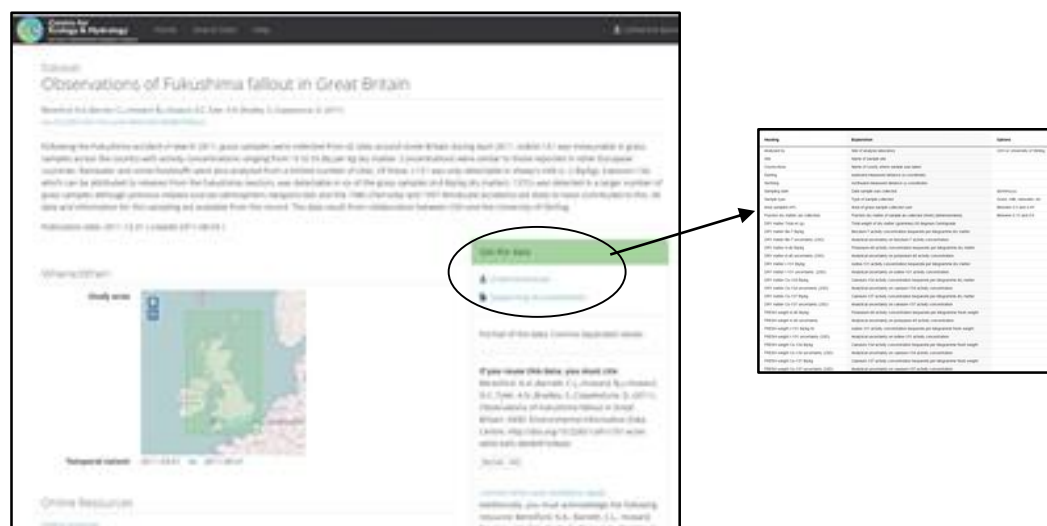


Figure 5: An example of data available to order from the NERC Environmental Information Data Centre

STAR has contributed to the publication of some data with doi's on INSPIRE compliant servers.

4.1.3 Publications from the STAR project

Information on, and in some cases full text of, [deliverables, papers and conference proceedings](#) published during STAR can easily be accessed from the Radioecology Exchange and the STAR project websites. More information and hyperlinks will be added as scientific papers reporting STAR research activities are published.

4.1.4 EURATOM project outputs

The EURATOM and other European Commission (EC) programmes (e.g. INCO-Copernicus, ECP) have supported many radioecology related projects over the last three decades. However, the outputs of these projects had not been catalogued to make them openly accessible. STAR has collated and made available outputs of many of the EC funded projects, starting with projects with active involvement of STAR members (the collation largely starts with the 5th Framework Programme although a few earlier projects are included). Brief overviews of the projects and their outputs have been provided on the Radioecology Exchange here: <https://wiki.ceh.ac.uk/x/RYFsD>.

For ease of presentation the various projects have been categorised according to topics:

- [Behaviour of radionuclides in the aquatic environment](#)
- [Behaviour of radionuclides in the terrestrial environment](#)
- [Education, training and cross-cutting studies](#)
- [Emergency preparedness and remediation](#)
- [Human epidemiology and low dose effects](#)
- [Monitoring and analytical procedures](#)
- [Radiation protection of the environment](#)

In addition, STAR has arranged for publications from EC funded projects related to radioecology to be made available through the searchable International Nuclear Information System ([INIS](#)) of the International Atomic Energy Agency.

Further information and documents (final reports and summary reports of some projects by topic area) can also be found from the documents and publications link on the [EC EUROPA](#) website.

4.1.5 STAR partner publication catalogues

Many STAR partners have created publication catalogues which collate all their publications into documents or on websites. Access to these catalogues has been made easier by collating access to them all via this page: <https://wiki.ceh.ac.uk/x/zoDzC> located on the STAR project website but also accessible via the Radioecology information exchange.

4.1.6 USDOE and IAEA publication catalogues

The US Department of Energy (DOE) Scientific and Technical Information service provides free public access to over 285,000 full-text documents and bibliographic citations of DOE via its [Information bridge](#).

[NUCLEUS](#) provides access to over 130 IAEA scientific, technical and regulatory resources. This includes databases, websites, applications, publications, safety standards, training material and more.

The International Nuclear Information System ([INIS](#)) hosts one of the world's largest collections of published information on the peaceful uses of nuclear science and technology. It offers online access to a unique collection of non-conventional literature. The IAEA Library also offers access to many databases, journals and other resources.

These resources have been made more easily accessible by providing links to them from the Radioecology information exchange here: <https://wiki.ceh.ac.uk/x/xQOKDg>

4.1.7 STAR (& COMET) partner contributions to Fukushima research

Some STAR (and COMET) partners have produced publications related to their activities following the Fukushima Dai-ichi accident. To ensure these documents can be more easily accessed their details (and in some cases links to the full text) have been collated onto a single web page: <https://wiki.ceh.ac.uk/x/AgGKDg> which is hosted on the Radioecology Exchange. Another web page: <https://wiki.ceh.ac.uk/x/NAGKDg> has also been created to collate some journal ‘special issues’ related to Fukushima.

4.1.8 The Virtual Laboratory

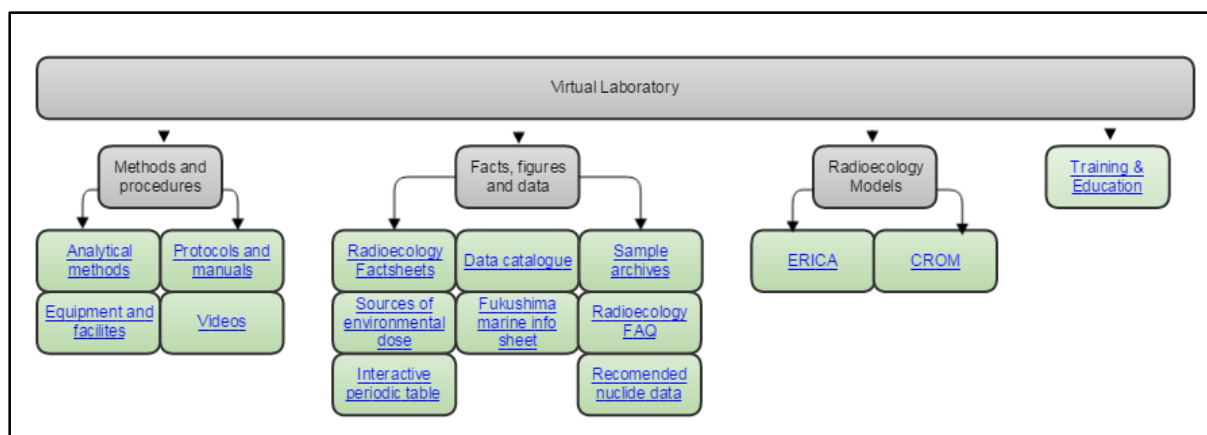


Figure 6: The Virtual Laboratory

The [Virtual Laboratory](#) on the Radioecology Exchange website provides: access to a number of analytical methods, best practices and protocols and manuals used in STAR (and COMET); information on the basic radioecology of a 20 radionuclides via ‘factsheets’; access to key radioecological databases (via the data catalogue; see section 5.1.1); brief instructions on how to use two common ‘radioecological’ models and summaries of the information about the equipment, facilities and sample archives held by STAR and COMET partners.

4.1.9 Workshops

Workshops have been discussed in detail in section 6. The agendas, abstracts, presentations and available workshop reports can be found here: <https://wiki.ceh.ac.uk/x/RYFsD>.

4.1.10 Data related to the Radiological Observatory sites

[Web pages](#) have been created on the Radioecology Exchange to host information and data from the observatory sites as it becomes available. These pages currently contain descriptions of the

sites but it is envisaged more data and information will be added to them as the COMET project develops.

5 Data produced during the STAR project

Data produced by STAR will largely be published as supplementary information with scientific papers. Access to the data will also be made via the [data catalogue](#) (see section 6.1.1) on the Radioecology Exchange after publication in the scientific literature. Details of these publications will be made available via the STAR project website on the [STAR publications](#) page which is also accessible via the [Information Exchange tab](#) on the Radioecology Exchange.

6 STAR Workshops related data

The STAR data related workshops below attracted many relevant members of the research community. Information on the workshops is available from: <https://wiki.ceh.ac.uk/x/u4XXD>.

- Three international workshops on radioecological data – two on Kd (in collaboration with IAEA MODARIA WG4) and one on data availability (related to MS 7.7 and MS 7.10). Outputs are accessible from: <https://wiki.ceh.ac.uk/x/u4XXD>.

6.1.1 Kd (partition coefficient) workshops

The first Kd workshop was held in May 2014 in and the second meeting was held in Monaco in April 2015. The main objectives of the Kd work were to:

- Conduct a critical review of literature of soil and freshwater Kd values to describe Kd variability.
- Develop a common dataset structure that can be used by modellers to estimate Kd values and Kd variability in soil, freshwater, and marine systems.
- To assess the use of different methods to estimate element Kd values for which there is little or no information.
- Develop/identified approaches to describe and reduce uncertainty of Kd values based on the enhanced datasets.
- Identify additional data needs.

Co-operation between STAR and IAEA MODARIA WG4 has facilitated the enhancement and improvement of Kd values, which are relevant for both human and environmental assessments. STAR has provided support for these workshops to discuss a wide range of issues connected with what needs to be improved, how can it be done and the needs of the user community. MODARIA WG4 brought together an international community which has provided substantial amounts of new data from various member states to revise the Kd datasets. The focus of the MODARIA WG4 has been on soil and freshwater. A STAR partner, IRSN, has been responsible for the freshwater dataset kindly provided by EDF (originators of Kd data in TRS 472; IAEA, 2010) and the University of Barcelona (MODARIA WG4 participant) for soil (also holders of the TRS 472 dataset). The presentations, report from the group discussions and the minutes from the workshop held in Oslo can be found on the [MODARIA website](#) with hyperlinks provided to the site from the Radioecology Exchange.

The meeting hosted by the IAEA in Monaco enabled the STAR and MODARIA WG4 participants to discuss the development and maintenance of databases and discuss whether there was a need for revision of the current marine Kd values in TRS 422; IAEA, 2004. Presentations

from the meeting are being will be uploaded onto the MODARIA WG4 website. Discussion during the meeting of the methods of derivation of the marine Kd values in TRS 422 identified a number of assumptions which would lead to overestimation of the Kd values reported in TRS 422. Data presented also showed that some generic assumptions used in deriving Kd values in TRS 422 for all radionuclides were not appropriate when tested using Japanese sediments.

The improved datasets constitute a significant improvement of a key international Kd database which will ultimately be published by the IAEA, as well as in a summarised format (yet to be agreed) on the Radioecology Exchange website.

6.1.2 Making data available workshop

The workshop on making data available was held in Vienna in April 2015. The meeting was attended by 32 scientists from 11 countries and the IAEA; the majority of attendees were not involved in the STAR NoE. The aims of this workshop which was organised by STAR in collaboration with [working groups 4 and 8 of the IAEA MODARIA](#) programme were to:

- Discuss best practice for making data available
- Consider why we should make data available
- Review Japanese sources of Fukushima related data
- Communicate the evolution of international data sets
- Present analyses of international data sets
- Discuss data sets which may be published
- Present on-going IAEA modelling activities

Abstracts and presentations are available from on the Radioecology Exchange (see <https://wiki.ceb.ac.uk/x/jgLoDQ>). The workshop report (Beresford et al. 2015) documents the discussions following each presentation.

An aim of the workshop was to communicate good practice in data curation and to highlight why ‘raw’ data needs to be made available. This prompted much discussion with some attendees returning to their institutes to review their practices. The workshop discussions also prompted some attendees to offer data for international datasets and model validation; these are currently being collated into spreadsheets supplied. Since the workshop the organiser has been approached by attendees with suggestions for/advice on publishing data papers.

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