D3.2 Documentation for working with species occurrence cubes

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Key takeaway messages

- **Centralized knowledge hub:** The B-Cubed documentation website (docs.b-cubed.eu) provides unified access and search functionality to guides, documentation and tutorials developed for the B3 project (even if those are maintained elsewhere).
- **Easy maintenance**: The website uses a static website generator to convert source files maintained on GitHub to a HTML website hosted on GitHub Pages. It also includes workflows to pull externally hosted tutorials. This setup is easy to maintain long-term.
- **Peer-reviewed quality**: All content is peer-reviewed through GitHub Pull Requests, ensuring high editorial and technical quality.
- **Long-term sustainability:** The website contributes to the long-term sustainability of B3 outputs, making sure these remain accessible beyond the project's 2026 conclusion.

Executive summary

The B3 (Biodiversity Building Blocks for Policy) project addresses the need for rapid, repeatable monitoring of biodiversity to inform policy decisions. This deliverable specifies the design, purpose and development process of the public, searchable and peer-reviewed documentation website for the B3 project (https://docs.b-cubed.eu/). The website serves as the central access point for tutorials, workflows and technical specifications, enabling the wider community to integrate the output developed in B3 into their research.

Work on the documentation website began in February 2024. Content and configuration files are maintained in a public repository on GitHub, enabling versioning, transparency, security and collaboration. The open source Astro/Starlight framework converts these files to a static HTML website hosted on GitHub Pages. The website features easy navigation, a mobile-friendly layout using the B3 style guide, and full text search. Automated workflows ensure that tutorials and documentation maintained in external repositories, can be incorporated seamlessly, keeping the website current with minimal manual intervention. All contributions undergo peer-review through GitHub pull requests before being merged, ensuring high quality and accuracy. The website is a substantial component of the B3 sustainability strategy.

Non-technical summary

The B3 project has developed a public documentation website (https://docs.b-cubed.eu/) that serves as the central hub for sharing knowledge, tutorials and guidance on how to use the project's tools and results. The website makes it easy for researchers, practitioners and other users to discover and apply B3 outputs in their own work.

The website was first set up in early 2024 and has since been expanded and refined. It now offers a clear design, a sidebar and search function for easy navigation and includes detailed information on B3's data cubes, software and workflows. It is maintained openly on GitHub, ensuring transparent version control, efficient collaboration and peer review of all contributions to guarantee accuracy and quality. A key feature is the ability to automatically integrate tutorials and documentation from partner repositories, which keeps the site up to date with minimal manual effort. The result is a sustainable, community-driven resource that improves the visibility, usability and reusability of B3 outputs.

List of abbreviations

EU	European Union
B3	Biodiversity Building Block for Policy
CI/CD	Continuous Integration / Continuous Deployment
GBIF	Global Biodiversity Information Facility

1. Introduction

This report describes the **B-Cubed documentation website**, which is the deliverable for Task 3.2, described in the proposal as:

> We will create a public, searchable and peer-reviewed documentation website for the B3 toolbox, so that it can be used by the wide community. It will include descriptions of the accessible APIs, facilitating integration with external systems and services. In order to ensure the cloud agnostic character of B3, detailed instructions will be provided on how to use occurrence cubes on different cloud providers. Integration of species occurrence cubes with environmental layers already available on cloud providers will be documented. Finally, knowledge gained in WP4-6 regarding the use of occurrence cubes to calculate specific data products will be captured in exemplar workflows. Much of the documentation will take form as tutorials, written in English as literate programming documents (e.g. Jupyter notebooks), but also included as source code snippets. This allows readers to easily test and adapt the described workflow for their needs. The documentation website will be versioned and an automated testing mechanism will be set up to guarantee that provided documentation works for a specific release of the B3 toolbox.

2. Content

The content of the B-Cubed documentation website consists of guides, tutorials and technical documentation produced for the B3 project. It is organized as:

- **Guides**: Specifications and best practice documents developed for B3.
- **Software**: Documentation and tutorials for B3 software, specifically R packages.
- **Infrastructure**: Documentation for the GBIF SQL Download API that was developed as part of B3.
- **Tutorials**: Tutorials created by B3 partners that are not directly linked to a B3 software tool.

Each tutorial/documentation has its own page on the website, allowing a single access point and search functionality across all content. Depending on how the source file for a page is maintained, we have two types of pages: **source pages and external pages**.

2.1 Source pages

Source pages are maintained in the documentation website code repository on GitHub as **markdown files**. All guides on the website are maintained as such, including the [B-Cubed software development guide](#) (Huybrechts et al. 2024). These are licensed under the [Creative Commons Attribution 4.0 International License](#).

The following instructions are provided in the [README](#) of the repository to add or update a source page:

1. Browse to the markdown file for the page (in `src/content/docs/<page-type>/`). You can reach the markdown file directly by clicking the Edit page link at the bottom of every page on the website.
2. Make changes in the markdown file (either in your browser or locally).
3. Commit your changes to a new branch (and push).
4. Create a pull request and assign a reviewer.
5. Once accepted and merged, your changes will go live on the site.

Does your page contain images or data? Place them in `public/<page-type>/<name-of-page>/`. It's best to do this locally on your new branch. To refer to images in markdown, use `![Short description](/<page-type>/<name-of-page>/<name-of-image>.png)`

2.2 External pages

External pages are documentation or tutorials maintained elsewhere, for example with the source code for the software they describe. This approach is better from a maintenance perspective, because the software and tutorials are maintained together, keeping them in sync. For B3, the main source for this type are tutorials associated with R packages called "vignettes" as well as their README files. Both are maintained as **R Markdown files**. These are licensed under the same license as the open source software they belong to ([MIT license](#)). We created a semi-automated workflow to include external pages into the documentation website (see [further](#)).

The following instructions are provided in the [README](#) of the repository to add or update an external vignette:

1. Clone this repository.
2. Check if vignette is listed in [vignettes.yml](#) (organized by R package). If not, add it (use the other vignettes as examples).
3. Open documentation.Rproj in R Studio and open [rmd_to_md.Rmd](#).
4. Select the package and run all code. Thanks to [b3doc](#), this will rebuild all vignettes and put the markdown and images files in the appropriate folders.
5. Check if you encountered any errors. If yes, fix and rebuild again.
6. Commit your changes to a new branch (and push).
7. Create a pull request and assign a reviewer.
8. Once accepted and merged, your changes will go live on the site.

The R packages developed for B3 form a toolbox of interoperable software called "b3verse". It includes eleven packages, nine of which have tutorials on the documentation website at the time of writing (Langeraert et al. 2025).

3. Technical implementation

The B-Cubed documentation website uses a static website generator to convert source files maintained on GitHub to a HTML website hosted on GitHub Pages. This setup enables versioning, peer-review, and minimal maintenance.

3.1 Source files

The source files for the B-Cubed documentation website consist of content (i.e. markdown files, see above), static files (e.g. figures) and configuration files for the static website generator (see Figure 1). These are maintained in a public repository on GitHub (https://github.com/b-cubed-eu/documentation).
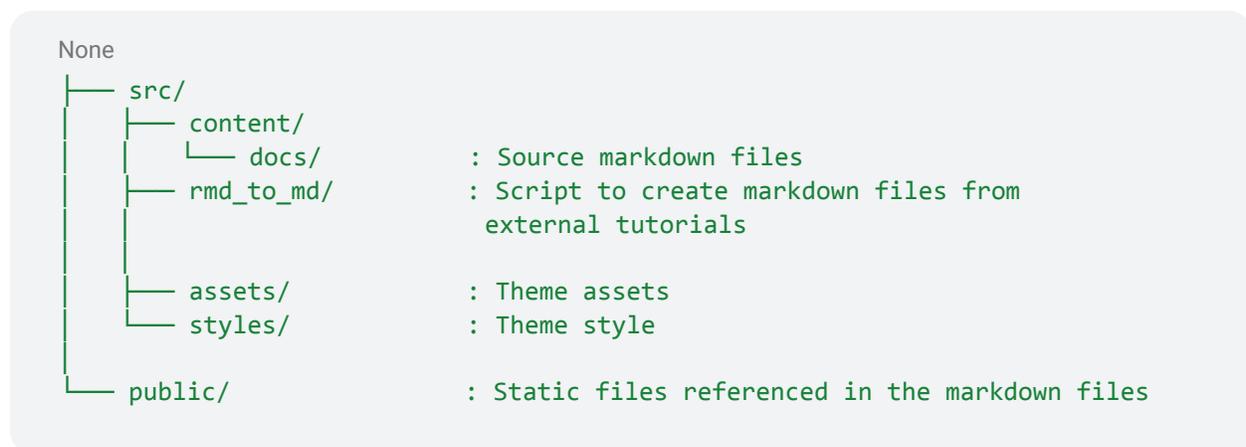
```
None
├── src/
│   ├── content/
│   │   └── docs/           : Source markdown files
│   ├── rmd_to_md/          : Script to create markdown files from
│   │                         external tutorials
│   │
│   ├── assets/             : Theme assets
│   └── styles/             : Theme style
│
└── public/                 : Static files referenced in the markdown files
```

Figure 1: Repository structure for the B-Cubed documentation website.

3.2 Static website generator and customization

The source files are converted to a HTML website by a static website generator. This technology is apt for content that only changes occasionally, such as tutorials and documentation here. The same approach is used for B3 R packages, which use pkgdown as a static website generator. Here, we adopted the static website generator Astro and Starlights (a documentation theme for Astro), because it is well-suited for a documentation website, has a mobile-friendly design with dark/light mode and built-in search functionality, can run locally and using CI/CD workflows, allows customization and is open source and well-documented.

We customized the configuration for Starlights to create a design that follows the B3 style guide, a custom homepage (see Figure 2) and a sidebar for navigation (see Figure 4). The search bar is prominent, allowing users to search across all B3 documentation hosted on the website (see Figure 3).
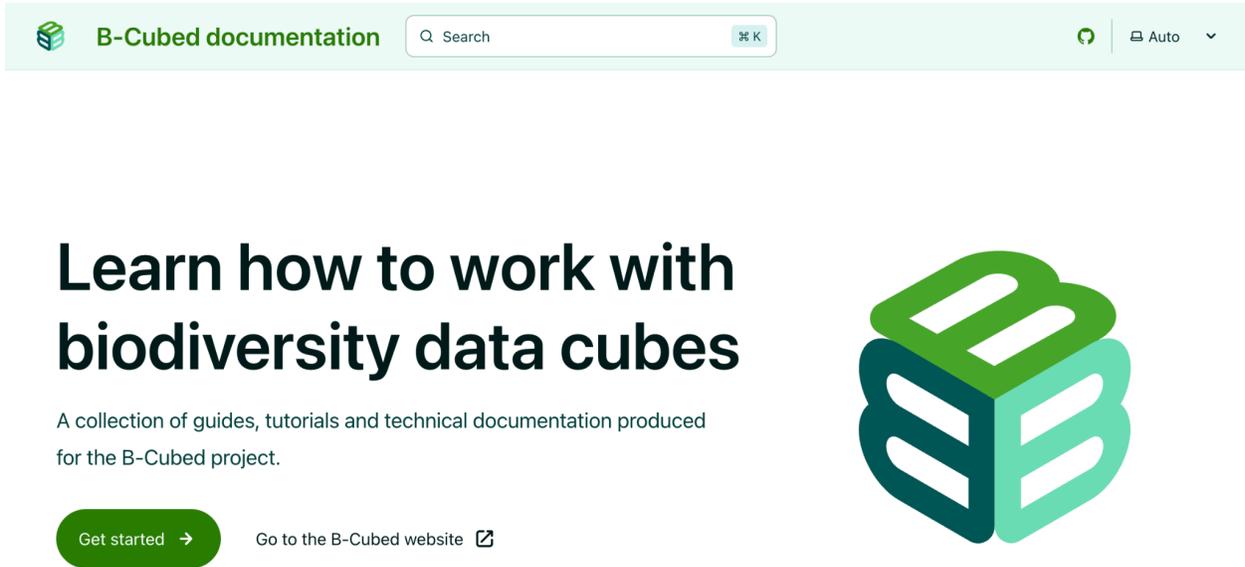
Figure 2: Screenshot of the homepage of the B-Cubed documentation website.
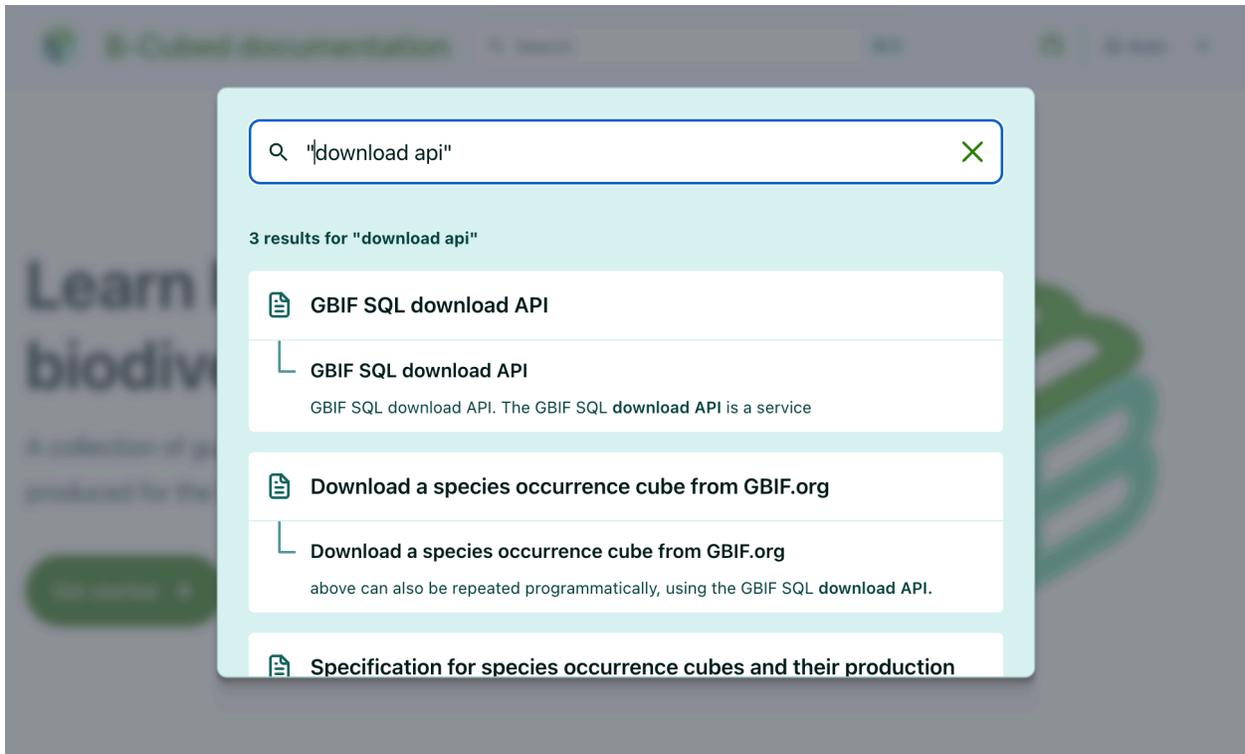

Figure 3: Screenshot of the search functionality of the B-Cubed documentation website.

3.3 Hosting

The website is hosted on GitHub Pages, a free service provided by GitHub. Since the generated website does not use an underlying database, but only consists of static files (i.e. html, css, js, png files), it is very secure and easy to host. We also enabled a custom domain https://docs.b-cubed-eu, which is shorter and easier to remember than the default https://b-cubed-eu.github.io/documentation.

3.4 Automated builds

Since the website is served as a static website, it needs to be rebuilt every time the underlying source files change. While this can be done locally and pushed to GitHub, it is a lot more efficient to do this automatically. We therefore set up a CI/CD approach using GitHub Actions, that rebuilds the entire website for every commit pushed to the main branch.

The website can also be previewed locally for testing purposes, with the following commands:

- `npm install`: install dependencies.
- `npm run dev`: start a local development server at localhost:4321 to preview the site.

3.5 Syncing external pages

Since many of the tutorials are externally-maintained vignettes (see above), we created a semi-automated workflow to include or update them in the documentation website. The core functionality is provided by the b3doc R package (Govaert et al. 2025) that we developed for this purpose.

A vignette is maintained as a R Markdown file, containing narrative text and executable code (i.e. a literate programming approach). By running the code, you can create an output file (html, pdf, markdown) that contains the text, code and output of that code (e.g. function responses, tables, figures). b3doc's main function rmd_to_md() will take the URL of a R Markdown file, run it and create a ready-to-publish markdown page with the necessary metadata for the static website generator.

In the repository for the documentation website we maintain a list of vignettes to consider and a build script using b3doc to convert them to markdown pages and associated figures. This setup allows us to add new vignettes or update existing vignettes with minimal manual effort. The resulting pages have the same look-and-feel as the source pages (see Figure 4).

Figure 4: Screenshot of a vignette from the gcube R package included in the B-Cubed documentation website.

4. Peer-review and quality control

In addition to file versioning, hosting and CI/CD workflows, GitHub also enables peer-review. Rather than changing content (e.g. a new tutorial) directly, a contributor (often the author of a tutorial) must make these changes through a **pull request**. The pull request is then assigned to another contributor (often a maintainer of the documentation website), who will review the changes, make suggestions and/or approve (see Figure 5). Only once these are resolved (by either contributor) can the changes be incorporated into the main branch from which the site is generated. The step-by-step instructions for contributors are described above.

This process assures that tutorials are of high quality and have the necessary metadata for inclusion into the website. For vignettes, this process is taken even further, since the reviewer also runs the tutorial on their computer (using b3doc), making sure that it can be replicated (including the installation of dependencies) by someone else than the author.

Figure 5: Screenshot of a pull request, illustrating the peer-review process.

5. Sustainability

The documentation website is a core component of the Sustainability report (Depecker et al. 2025), which contains a long-term strategy to keep B3 outputs accessible and impactful beyond 2026. The website was developed with this goals in mind, including:

- **Content maintenance:** All tutorials go through peer-review using pull requests. Once included, a tutorial is a static document that does not rely on external services. It can be updated from its source periodically or upon request, using a semi-automated workflow.
- **Technical maintenance**: Technical maintenance is minimal. As a static website, it is very secure and easy to host.
- **Open source**: All content on the website is licensed under the permissive MIT and CC BY 4.0 licenses. The static website generator is open source as well (MIT).
- **Portability**: While the website relies heavily on GitHub, it can be ported to other services that support version control (e.g. GitLab), CI/CD (e.g. GitLab or Jenkins) and static website hosting (any file server). The domain name of the site does not have to change if the underlying services do.

- **Archiving**: A version 1.0 of the documentation website will be archived on Zenodo in March 2026.

6. Conclusion

The B-Cubed documentation website is a sustainable, community-driven resource that improves the visibility, usability and reusability of B3 outputs. It achieves the goals set forth in task 3.2 (Table 1).

Table 1: Overview of the goals of B3 task 3.2 and how these were achieved.

Goal	Implementation
We will create a public, searchable and peer-reviewed documentation website for the B3 toolbox, so that it can be used by the wide community.	The documentation website is public at https://docs.b-cubed.org. It has search functionality (see Figure 3) and peer-review is implemented via GitHub Pull Requests.
The website includes descriptions of accessible APIs facilitating integration with external systems and services.	The GBIF SQL download API is described as well as the software tools that support it.
In order to ensure the cloud agnostic character of B3, detailed instructions will be provided on how to use occurrence cubes on different cloud providers.	E.g. Converting GBIF data cubes in cloud-native data formats.
Integration of species occurrence cubes with environmental layers already available on cloud providers will be documented.	E.g. An introduction to ecological modelling with Google Earth Engine
Finally, knowledge gained in WP4-6 regarding the use of occurrence cubes to calculate specific data products will be captured in exemplar workflows.	Much of this knowledge is provided as "b3verse", a set of interoperable R packages (with tutorials). These are included on the documentation website.
Much of the documentation will take form as tutorials, written in English as literate programming documents (e.g. Jupyter notebooks), but also included as source code snippets.	Almost all tutorials are written as RMarkdown, which are literate programming documents. These include code snippets.
This allows readers to easily test and adapt the described workflow for their needs.	Peer-review ensures that at least one user (the reviewer) can test the described workflow.
The documentation website will be versioned and an automated testing mechanism will be set up to guarantee that provided documentation works for a specific release of the B3 toolbox.	The documentation website is versioned through GitHub. Testing is set up for the individual R packages, the "b3verse" R-universe (https://docs.b-cubed.eu/guides/b3verse/) and through peer-review.

7. Acknowledgements

We thank all B3 partners for their contributions to the documentation website.

8. References

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