

**Advanced biodiversity monitoring for results-based
and effective agricultural policy and transformation**

Deliverable D1.1
Protocols and standards for literature survey

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3.0	09.12.2024	Revised version of D1.1 <ul style="list-style-type: none"> • Chapter 2: Added description of working groups and rationale • Chapter 2.2: Table 1: Adjusted and renamed focus groups into working groups and their alignment with project targets. Added section on synthesis analysis • Chapter 3: Added criteria and information on SOPs • Chapter 4: Inserted Infographic and reference how data requirements align with the DMP in WP7



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Executive summary

This deliverable provides a directory of guidelines and methodological descriptions relevant for BioMonitor4CAP activities. Gathered guidelines and methods are based on two workshops and a systematic acquisition of information through leaders of Task 1.1. The major goal of this document is to support harmonized and standardized work procedures within the multidisciplinary BioMonitor4CAP Consortium and assure high academic standards while gathering and processing data and knowledge.

1. Introduction

This document - D1.1: “Protocols and standards for literature survey” - is an output of Task 1.1: “Developing a tailored framework for data and knowledge collection” and it aims to set quality standards and harmonize procedures.

The document includes:

- A systematic approach and instruments to be used for literature reviews to synthesize knowledge and prepare outputs such as scientific articles or guidelines,
- A library of Standard Operating Procedures (SOPs) to be applied within BioMonitor4CAP,
- A basic data management handbook to define data preparation and storage, which is outlined in more detail in the data management plan (deliverable D7.3).

Thus, this deliverable provides the foundation of standards and guidelines that the BioMonitor4CAP Consortium will apply during literature research and data processing.

2. Systematic literature review

2.1 Systematic review process

The BioMonitor4CAP Consortium follows and applies standards and guidelines during literature research and data processing. The standards and procedures are based on the PRISMA statement (<https://prisma-statement.org>).

Reviewing authors prepare a transparent, complete, and accurate account of why the review was done, what they did (such as how studies were identified and selected), and what they found (such as characteristics of contributing studies and results of meta-analyses).

2.2 Literature review by thematic working groups

In a first step, working groups were built with reference to the conceptual approach outlined in the Grant Agreement (Figure 1.2a). Based on the expertise in the Consortium and in line with the project targets, the BioMonitor4CAP team was divided into six thematic working groups (WGs), namely: Land cover, Policy, Insects, Birds, Soils, and Socioeconomics.



Members in each working group were responsible for determining the main contact institution(s), the proposed outputs, and a list of keywords (see Table 1).

Table 1: Working groups formed around the main research themes within the project. Contact information of all team members will be accessible on the web repository as an internal directory but has been removed from this report due to data protection reasons.

Nr.	Working groups revised	Main contact	Members	Proposed Output	Keywords	Project targets
1	Birds	BTO	BTO, BSPB, CSO, LfU	Biodiversity indicators, scientific output	Ornithology, biodiversity conservation, abundance, species richness, community composition, farmland birds	Measuring ecosystem pressure
2	Insects	ZFMK	ZFMK, CUAS, IBER-BAS, DLG, LUKE, FC.ID (former LUKE)	Biodiversity indicators; scientific article; education / outreach	Pollinator; wild bee; hoverfly; moth; butterfly; grasshopper; integrated pest management; ecosystem services; pest; predator; parasitoid	Monitor ecosystem structure and stability
3	Policy	IRWiR PAN	UH, FE, WSA, NM, F4S	Scientific article, policy brief	CAP, eco-schemes, ecosystem services, agrobiodiversity, policy measures, intervention logic, indicators, policymakers, choice experiments, willingness to pay	Support and implement outcome-oriented policies
4	Land cover	S4G	S4G, F4S, ATB, CUAS, BTO, IBER-BAS, IDMT, SUH	Biodiversity indicators, scientific output	Remote sensing, optical, acoustic, non-invasive, drone, satellite, sensors, biodiversity indicators, ecosystem services, species distribution modeling, essential biodiversity variables, UAV	Large-scale environmental monitoring
5	Socio-economic	UH	UH, F4S, IRWiR PAN	Social indicators, guidelines, policy brief, scientific output	Policies (CAP, Green Deal, Farm2Fork, Biodiversity 2030), rural development, stakeholder, business, company, organization, corporation, society, citizen, farmer, consumer, biodiversity management, biodiversity monitoring, perceptions, norms, values, attitudes, values, motivation, agribusiness, socio-ecological transition, systemic change	Adoption of biodiversity monitoring and good farming practices
6	Soils	NM	UCSUR, NM, F4S, CUAS, UH, DLG, BU	Soil/ Biodiversity indicators, scientific output (report, article)	Soil microbiology, soil nutrition, soil health, soil organic carbon, soil management, soil biodiversity, soil texture, ecosystem services (link to), carbon sink, essential biodiversity variables, Soil physico-chemical properties, Organic Matter, Soil pH, Soil macronutrients, Soil micronutrients	Assessing the health and functionality of an ecosystem

Taxonomic groups, such as soil microorganisms, insects, and birds were chosen due to their indispensable role in ecosystem health. Soil microorganisms recycle nutrients and contribute to soil structure, insects play a key role in pollination and ecosystem equilibrium, while birds regulate insect populations and seed dispersal.



The identification and composition of **land cover categories** using remote sensing data is essential for a comprehensive understanding of biodiversity and ecosystem functioning while increasing the capacity to analyze large areas more effectively.

The **socio-ecologic group** aims to understand how social, economic, and cultural factors influence agriculture's impact on agrobiodiversity, ultimately promoting biodiversity monitoring and sustainable farming practices to farmers.

The **policy group** seeks to ensure that the proposed biodiversity monitoring supports the implementation of outcome-oriented policies. This knowledge will inform the development of effective biodiversity monitoring systems that are both applicable to policymakers and acceptable to farmers.

During the project duration, the working groups will work on their proposed outputs following the steps outlined in Table 2. Documentation will be stored, for internal use only, on the project's web page repository (D6.1).



Table 2 : Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. (2021) The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *PLoS Med* 18(3): e1003583. <https://doi.org/10.1371/journal.pmed.1003583>

Section and topic	Item #	Checklist item
Title		
Title	1	Identify the report as a systematic review.
Background		
Objectives	2	Provide an explicit statement of the main objective(s) or question(s) the review addresses.
Methods		
Eligibility criteria	3	Specify the inclusion and exclusion criteria for the review.
Information sources	4	Specify the information sources (e.g. databases, registers) used to identify studies and the date when each was last searched.
Risk of bias	5	Specify the methods used to assess risk of bias in the included studies.
Synthesis of results	6	Specify the methods used to present and synthesise results.
Results		
Included studies	7	Give the total number of included studies and participants and summarise relevant characteristics of studies.
Synthesis of results	8	Present results for main outcomes, preferably indicating the number of included studies and participants for each. If meta-analysis was done, report the summary estimate and confidence/credible interval. If comparing groups, indicate the direction of the effect (i.e. which group is favoured).
Discussion		
Limitations of evidence	9	Provide a brief summary of the limitations of the evidence included in the review (e.g. study risk of bias, inconsistency and imprecision).
Interpretation	10	Provide a general interpretation of the results and important implications.
Other		
Funding	11	Specify the primary source of funding for the review.
Registration	12	Provide the register name and registration number.

*This abstract checklist retains the same items as those included in the PRISMA for Abstracts statement published in 2013, [54] but has been revised to make the wording consistent with the PRISMA 2020 statement and includes a new item recommending authors specify the methods used to present and synthesise results (item #6).

<https://doi.org/10.1371/journal.pmed.1003583.t002>

To provide a comprehensive overview of biodiversity indicators relevant to assess the impacts of agroecological systems, a review article will be prepared. The review will include an analysis of traditional and novel biodiversity monitoring tools and will develop a framework of assessment to assist prioritising indicators aligned with farmland biodiversity assessment goals.

For the ecological aspects (i.e. land cover, soils, birds and insects), the authors will perform an umbrella review of literature, using two major scientific databases, SCOPUS and Web of Science, and develop a framework of assessment for benchmarking and ranking the most suitable farmland biodiversity indicators. By incorporating the concept of Essential Biodiversity Variable (EBVs), the methodology ensures biodiversity indicators are aligned with our objectives, offering reliable, feasible and consistent tools for monitoring biodiversity state, trends and processes in agricultural areas (Dalton et al., 2023). EBVs provide a standardised, robust and comprehensive framework for assessing biodiversity (Pereira et al., 2013), allowing to categorise indicators per biodiversity class (genetic



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composition, species populations, species traits, community composition, ecosystem structure, and ecosystem function), while ensuring consistent reporting across regions and ecosystems.

Moreover, by using EBVs, we align our methodology with the most updated frameworks and EU-funded projects (e.g., EuropaBON), which laid the groundwork for systematizing biodiversity monitoring systems, aiming to integrate our research efforts with the existing knowledge. This strategic approach offers several advantages, including consistency in data collection and analysis, direct comparison of results, and fostering collaboration among researchers.

Along with EBVs, ecosystem exclusion criteria will enable working on agricultural landscapes, targeting farmland biodiversity and excluding marine and freshwater environments. To identify current research limitations and knowledge gaps, a bibliometric analysis will be conducted to give a comprehensive view of the state of the art respecting the biodiversity indicators research (D 1.2). In this review, all the biodiversity indicators found will be listed and distributed per thematic group and EBV class. A framework of assessment will be developed describing the necessary criteria for selecting and prioritizing relevant, robust, and cost-effective agrobiodiversity indicators. The listed indicators will then be further screened against this framework, resulting in a ranked list of indicators.

For the socioeconomic aspects, an umbrella review of stakeholder's perception of farmland biodiversity will be performed using the scientific databases Web of Science, Scopus, CAB Abstract, and ProQuest, to identify the most studied stakeholders, their perspectives, and limitations of previous studies.

For the policy dimensions, a gray literature review will be performed of relevant EU frameworks and Rural Development Programmes. To achieve our goal, an overview of relevant European policies, aiming to identify knowledge gaps and limitations, address challenges and seek solutions in line with climate objectives and sustainable development goals (SDGs) will be created.

With the outputs of the review on biodiversity indicators, agricultural stakeholders, and policy frameworks, a synthesis analysis will be drawn up taking into account all the dimensions. This synthesis will integrate the results from the entire systematic review and provide a clearer connection to existing EU policies, helping to ensure the relevance and reliability of our findings in the context of CAP.

To summarize, a comprehensive framework for assessing biodiversity in agroecological systems will be created, existing research on ecological and socioeconomic factors affecting farmland biodiversity will be reviewed and work will be aligned with the EBVs framework. By prioritizing relevant indicators and addressing knowledge gaps, the study will contribute to effective biodiversity monitoring and conservation in agricultural landscapes.



3. Library of Standard Operating Procedures

A directory of Standard Operating Procedures (SOP) has been set up as a framework required for T1.2 and other activities of WPs 1, 2, 3, 4, and 5 aiming to gather and process data and knowledge in accordance with widely accepted quality standards. The SOPs were selected by the Consortium members based on their relevance, applicability and for the purpose to harmonize and standardize the methods used in the project.

Criteria for selecting SOPs

- Relevance to BioMonitor4CAP's objectives
 - Topic alignment: The SOP must address themes and tasks of the project.
 - Applicability: It should be appropriate for the specific research questions and methodologies of the project.
- Scientific and methodological quality
 - Peer-reviewed sources: SOPs published in peer-reviewed journals or by reputable institutions offer higher credibility.
 - Recognized standards: Preference should be given to SOPs developed by well-known organizations (e.g., ISO, WHO, EU).
 - Adoption: SOPs frequently cited or used in multiple publications or projects are considered established methods.
- Timeliness
 - Publication date: Newer SOPs reflect current scientific knowledge, technologies, and regulatory requirements.
- Compatibility with resources of BioMonitor4CAP
 - Technical requirements: The SOP should be compatible with the tools, software, and technologies available in the project.
 - Time and personnel: It should be feasible to implement within the project's time and personnel constraints.
- Regulatory compliance
 - Compliance: The SOP must adhere to applicable regulations within the project's context (e.g., EU directives, national laws).
 - Ethics and data protection: If relevant, the SOP should comply with ethical standards and data protection requirements.

Building on existing standards and methodological frameworks, BioMonitor4CAP will develop protocols, where needed, to ensure synchronized agricultural, botanical, zoological, socio-economical, policy, and land-use data for use within and beyond the project. Therefore, standardization of methodological approaches and protocols is anticipated for all Consortium members and stakeholders in preparation for the development of an advanced biodiversity monitoring system. To ensure replication and implementation a guideline will be provided for technical standards and protocols ensuring successful replication of monitoring systems (D3.1 and D3.2).

Table 3 lists links to SOPs in alphabetical order. Each of these SOPs will be made accessible on the project's web page repository (D6.1). This is a living document, proposed changes and additions will be implemented through DLG.



Table 3 : List of protocols to be used within the Biomonitor4CAP project. Contact information of all team members will be accessible on the web repository as an internal directory but have been removed from this report due to data protection reasons.

SOP Title	DOI / ISBN	Source (link)	Main contact	Who will apply this	Interdependencies/ description
A systems approach to literature review	n/a	https://www.cs.ryerson.ca/afeworn/courses/CP8101/CLASSE/ConductingLiteratureReview.pdf	UH	Partners in WP4 & WP5	Literature reviews, stakeholder analysis
An Open Standard for Camera Trap Data	doi:10.3897/BDJ.4.e10197	https://doi.org/10.3897/BDJ.4.e10197	CUAS	Test sites	Data management
Best practice for biodiversity data management and publication	doi:10.1016/j.biocon.2013.10.018	http://dx.doi.org/10.1016/j.biocon.2013.10.018	CUAS	All partners	
Biodiversity assessment scheme (plant species richness and land-use intensity)	https://doi.org/10.1016/j.ecolind.2019.105649	https://www.sciencedirect.com/science/article/pii/S1470160X19306417	UH	Test sites	Biodiversity indicators
Biodiversity indicators for result-based Agri-environmental schemes	https://doi.org/10.1016/j.agsv.2022.103538	https://www.sciencedirect.com/science/article/pii/S0308521X22001743	UH, IRWiR PAN	Partners in WP4 & WP5	Policy analysis, stakeholder analysis
BioMonitor4CAP Field work and sampling protocols, Version 1	n/a	BioMonitor4CAP_Field_Protocol_V1.docx - Google Docs	ZFMK	Test sites	Field protocol for field trial implementation
GIS Protocol / GIS Biodiversity Indicators	https://www.nature.com/articles/s41559-021-01451-x	https://www.nature.com/articles/s41559-021-01451-x	S4G	WP2	Biodiversity Indicators at a landscape level
Corporate measurements of biodiversity	https://doi.org/10.1016/j.iclepro.2022.134798	https://www.financeforbiodiversity.org/wp-content/uploads/Finance-for-Biodiversity_Guide-on-biodiversity-measurement-approaches_2nd-edition.pdf	UH	Partners in WP4 & WP5	Policy analysis, stakeholder analysis
Credit point system for farm scale biodiversity assessment	https://doi.org/10.1016/j.agee.2014.08.008	https://www.sciencedirect.com/science/article/pii/S0167880914003983	UH	Test sites	Biodiversity indicators
Field guide for a biodiversity inventory in the agrarian region Vascular plants, butterflies, grasshoppers and habitat structures	ISBN 978-3-902611-44-4	https://dafne.at/content/publication/74e905fc-6532-4aa2-90ae-bb626756b40b.pdf	CUAS	Working groups on insects and habitats	Field manual for BINATS methodology (agrobiodiversity project), in English
Guidelines for Long-Term Monitoring Protocols	DOI: 10.2307/3784444	https://www.researchgate.net/publication/261826047_Guidelines_for_Long-Term_Monitoring_Protocols	CUAS	NM, ZFMK, DLG	List of SOPs recommended for monitoring program

SOP Title	DOI / ISBN	Source (link)	Main contact	Who will apply this	Interdependencies/ description
Guidelines on social indicators	https://doi.org/10.1111/conl.12397	https://conbio.onlinelibrary.wiley.com/doi/full/10.1111/conl.12397	UH	All partners	Policy guidelines, stakeholder perceptions
Indicators for biodiversity in agricultural landscapes	https://doi.org/10.1111/j.1365-2664.2007.01393.x	https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/j.1365-2664.2007.01393.x	UH	Test sites	Biodiversity indicators
Literature review (in social science)	https://doi.org/10.1111/j.1471-1842.2009.00848.x	https://onlinelibrary.wiley.com/doi/full/10.1111/j.1471-1842.2009.00848.x	UH	Partners in WP4 & WP5	Policy analysis, stakeholder analysis
Manual on field recording techniques and protocols for All Taxa Biodiversity Inventories and Monitoring	n/a	https://biblio.naturalsciences.be/rbins-publications/abc-taxa/abc-taxa-08	CUAS	All partners	Data management, traditional and state-of-the-art collection methodologies for diverse taxa
Passive acoustic monitoring in ecology and conservation (WWF)	n/a	https://repository.oceanbestpractices.org/handle/11329/1370?show=full:https://www.researchgate.net/publication/368683386_Good_practice_guidelines_for_long-term_ecoacoustic_monitoring_in_the_UK	BTO	Test sites	Passive Acoustic Monitoring
New database enhances the accessibility of global biodiversity information for conservation monitoring	doi:10.1017/S0030605322000205	https://www.gbif.org/	IRWIR PAN	All partners	Accessibility of biodiversity information
Agroecosystem services: A review of concepts, indicators, assessment methods and future research perspectives, Ecological Indicators	https://doi.org/10.1016/j.ecolind.2022.109218	https://www.sciencedirect.com/science/article/pii/S1470160X22006902	IRWIR PAN	All partners	Agroecosystem services, assessment methods
Review of the definitions of the existing ecological approaches	https://doi.org/10.5281/zenodo.5075627	https://zenodo.org/record/5075627#.ZD7AOXZBw2w	IRWIR PAN	All partners	Ecological approaches, framework for farm typology
LIFT farm typology developed, tested and revised, and recommendations on data needs	https://doi.org/10.5281/zenodo.5508222	https://zenodo.org/record/5508222#.ZD7ArXZBw2w	IRWIR PAN	All partners	Ecological farm typology, Protocols of farms assessment
Scaling – from “reaching many” to sustainable systems change at scale: A critical shift in mindset	https://doi.org/10.1016/j.agsv.2019.102652	https://www.sciencedirect.com/science/article/pii/S0308521X18314392	IRWIR PAN	WP5	Tools to help frame scaling, scaling-up ecological farming



SOP Title	DOI / ISBN	Source (link)	Main contact	Who will apply this	Interdependencies/ description
					practices, mindset beyond the project.
Pollinator transect counts, vegetation survey and bird counts	https://doi.org/10.1016/j.agee.2021.107698	https://www.sciencedirect.com/science/article/pii/S0167880921004023	UH	Test sites	Biodiversity indicators
Praktische Hinweise und Empfehlungen zur Anwendung von Malaisefallen für Insekten in der Biodiversitätserfassung und im Monitoring	n/a	http://entomologica.org/sn/naturalis2018_1.pdf	CUAS	Working groups on insects and metabarcoding	Setting up, maintaining, collecting samples from Malaise traps (in German)
Protocol for breeding bird monitoring	https://doi.org/10.1038/s41597-021-00804-2	https://www.bto.org/our-science/projects/breeding-bird-survey/research-conservation/methodology-and-survey-design;https://pecbms.info/methods/pecbms-methods/1-national-species-indices-and-trends/1-1-counting-birds/field-methods/	BTO	Major research site partners	
Protocol for European Pollinator Monitoring Scheme	doi:10.2760/881843	https://publications.jrc.ec.europa.eu/repository/bitstream/JRC122225/jrc122225_proposal_for_an_eu_pollinator_monitoring_final_version.pdf	CUAS	Test sites	Ornithology group, soil sample collection
Protocol for soil sample collection: microbiology and biodiversity	n/a	https://dlgev-my.sharepoint.com/:b:/r/personal/n_borchard_dlg_org/Documents/Horizon_BioMonitor4CAP/BioMonitor4CAP%20Project/WP1%20Baseline/SOP%27s/Protocol%20for%20soil%20sample%20collection%20microbiology_NM.pdf?csf=1&web=1&e=oFax6l	NM	Test sites	Soil physico-chemical properties, remote sensing
Protocol for soil sample collection: physico-chemical analysis	n/a	https://dlgev-my.sharepoint.com/:b:/r/personal/n_borchard_dlg_org/Documents/Horizon_BioMonitor4CAP/BioMonitor4CAP%20Project/WP1%20Baseline/SOP%27s/Protocol%20for%20soil%20sample%20collection%20physico%20chemical%20analysis_F4S.pdf?csf=1&web=1&e=vteKbj	F4S	Test sites	Soil microbiology, remote sensing
Publishing Camera Trap Data: A Best Practice Guide	n/a	https://www.gbif.org/document/1o6HNNHuCxKaiAC8vG86gQq/publishing-camera-trap-data-a-best-practice-guide	CUAS	All partners	Data management
Qualitative stakeholder analysis (farmers)	https://doi.org/10.1016/j.landusepol.2013.06.005	https://www.sciencedirect.com/science/article/pii/S0264837713001208?via%3Dihub https://link.springer.com/article/10.1007/s10531-021-02235-2	UH	Partners in WP4 & WP5	Policy analysis, stakeholder analysis
Scoping literature reviews	DOI 10.3233/WOR-2010-0998	https://content.iospress.com/download/work/wor00998?id=work%2Fwor00998	UH	Partners in WP4 & WP5	Literature reviews, stakeholder analysis



SOP Title	DOI / ISBN	Source (link)	Main contact	Who will apply this	Interdependencies/ description
Semi-structured interviews	https://doi.org/10.46743/2160-3715/2011.1070	https://www.scopus.com/record/display.uri?eid=2-s2.0-79952388749&origin=resultslist&sort=r-f&src=s&nlo=&nlr=&nls=&sid=a1e67dd5982cfce25bad1f41d52077e4&sot=a&sdt=cl&cluster=scosrctype%2c%22i%22%2ct%2bscosubtype%2c%22ar%22%2ct%2bscolang%2c%22English%22%2ct&sl=44&s=TITLE=ABS-KEY%28how+AND+conduct+AND+interview%29&relpos=6&citeCnt=171&searchTerm=	UH	Partners in WP4 & WP5	Literature reviews, stakeholder analysis
Stakeholder selection and analysis (simple)	n/a	https://www.amnh.org/content/download/158575/2593966/file/LinC%207_Stakeholder%20Analysis.pdf	UH	Partners in WP4 & WP5	Policy analysis, stakeholder analysis
Standard Methods for the Assessment of Structural and Functional Diversity of Soil Organisms: A Review	DOI: 10.1002/ieam.4046	https://setac.onlinelibrary.wiley.com/doi/abs/10.1002/ieam.4046	CUAS	Working groups on soil and insects	Physicochemical analysis, soil and invertebrate sampling procedures
Studying terrestrial mammals in tropical rainforests A user guide for camera-trapping and environmental DNA	ISBN:978-3-9815637-6-4	https://www.izw-berlin.de/de/userguide.html	CUAS	Test sites	Soil microbiology
Terrestrial ABMI Autonomous Recording Unit (ARU) and Remote Camera Trap Protocols	n/a	https://ftp-public.abmi.ca/home/publications/documents/599_ABMI_2021_TerrestrialARUandRemoteCameraTrapProtocols_ABMI.pdf	CUAS	Test sites	Ornithology group
UAV Remote Sensing Protocol (SOP)	n/a	https://dlgev-my.sharepoint.com/personal/n_borchard_dlg_org/_layouts/15/onedrive.aspx?ga=1&id=%2Fpersonal%2Fn%5Fborchard%5Fd%5F%2FDocuments%2FHORIZON%5FBioMonitor4CAP%2FBioMonitor4CAP%20Project%2FWP1%20Baseline%2FSOP%27s	ATB, CUAS	Major research site partners	Remote sensing, biodiversity indicators



4. Data Management Handbook

The field coordinators of each field site, working groups, work package and task leaders as well as the responsible members from data processing institutions will be responsible for the collection and transfer of data from their own research activities (Figure 1), within the framework of the Data Management Plan (DMP, see D7.3). The BioMonitor4CAP project will generate data varying in type, format, and their origin (see D1.3). While data requirements define the foundation for what data is needed for a project, the DMP outlines how this data will be handled throughout its lifecycle. Together, they ensure the data is collected, managed, and utilized effectively, aligning with project goals and compliance standards.

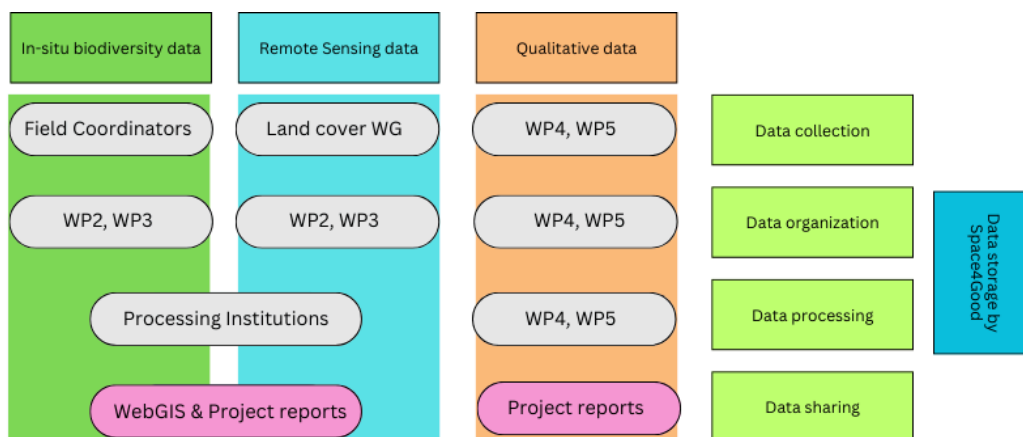


Figure 1. Conceptual data flow from data collection, organization, storing, processing and sharing.

The data will be collected in formats coming from such as satellite imagery, sensor measurements, geospatial datasets, field biodiversity assessments, survey responses, and calculated metrics. Based on the structure of the project, we defined three main datasets and their data requirements that are primarily generated and utilized by specific WPs and thematic working groups:

1. In-situ biodiversity data (WP2 & WP3; thematic working groups: birds, insects, soils)
 - a. Species information: Richness, abundance, diversity, composition, and functional traits
 - b. Habitat characteristics: Quality, structure, and geographic location
 - c. Metadata: Date, time, coordinates, observer information, and sampling methods/protocols
 - d. Data types and formats: audio (e.g. wav), video (e.g. mp4), tabular (e.g. csv), image (e.g. png), molecular (e.g. csv), physico-chemical (e.g. csv)
2. Remote sensing data (WP2 & WP3; thematic working group: land cover)
 - a. Image properties: Spatial, spectral, and temporal resolution
 - b. Land cover/use information: Accurate classification of land cover types
 - c. Biophysical parameters: Vegetation indices and physical properties of the landscape
 - d. Data types and formats: GIS (e.g. shapefile), Orthophotos (e.g. GeoTIFF), Satellite imagery (e.g. GeoTIFF)

3. Qualitative data based on surveys and interviews (WP4 & WP5; thematic working groups: socio-economic, policy)
 - a. Socio-economic factors: Demographics, cultural practices, and perceptions
 - b. Policy and governance: Laws, regulations, institutions, and enforcement
 - c. Stakeholder perspectives: Views, opinions, and concerns
 - d. Methodology: Sampling design, questionnaire design, and data quality control
 - e. Data types and formats: video (e.g. mp4), qualitative textual and tabular data

4.1 Related basic ethical principles

While there can be and are national and disciplinary differences in the way research is organized and conducted, the BioMonitor4CAP consortium will apply the following fundamental ethical principles stated in the Singapore statement on research integrity (www.singaporestatement.org):

1. **Integrity:** Researchers should take responsibility for the trustworthiness of their research.
2. **Adherence to Regulations:** Researchers should be aware of and adhere to regulations and policies related to research.
3. **Research Methods:** Researchers should employ appropriate research methods, base conclusions on critical analysis of the evidence and report findings and interpretations fully and objectively.
4. **Research Records:** Researchers should keep clear, accurate records of all research in ways that will allow verification and replication of their work by others.
5. **Research Findings:** Researchers should share data and findings openly and promptly, as soon as they have had an opportunity to establish priority and ownership claims.
6. **Authorship:** Researchers should take responsibility for their contributions to all publications, funding applications, reports and other representations of their research. Lists of authors should include all those and only those who meet applicable authorship criteria.
7. **Publication Acknowledgement:** Researchers should acknowledge in publications the names and roles of those who made significant contributions to the research, including writers, funders, sponsors, and others, but do not meet authorship criteria.
8. **Peer Review:** Researchers should provide fair, prompt and rigorous evaluations and respect confidentiality when reviewing others' work.
9. **Conflict of Interest:** Researchers should disclose financial and other conflicts of interest that could compromise the trustworthiness of their work in research proposals, publications and public communications as well as in all review activities.
10. **Public Communication:** Researchers should limit professional comments to their recognized expertise when engaged in public discussions about the application and importance of research findings and clearly distinguish professional comments from opinions based on personal views.
11. **Reporting Irresponsible Research Practices:** Researchers should report to the appropriate authorities any suspected research misconduct, including fabrication, falsification or plagiarism, and other irresponsible research practices that undermine the trustworthiness of research, such as carelessness, improperly listing authors, failing to report conflicting data, or the use of misleading analytical methods.
12. **Responding to Irresponsible Research Practices:** Research institutions, as well as journals, professional organizations and agencies that have commitments to research, should have procedures for responding to allegations of misconduct and other irresponsible research practices and for protecting those who report such behavior in good faith. When misconduct or other irresponsible research practice is confirmed, appropriate actions should be taken promptly, including correcting the research record.



13. **Research Environments:** Research institutions should create and sustain environments that encourage integrity through education, clear policies, and reasonable standards for advancement, while fostering work environments that support research integrity.
14. **Societal Considerations:** Researchers and research institutions should recognize that they have an ethical obligation to weigh societal benefits against risks inherent in their work

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