How to setup a Biodiversity Information System (BIS) for South Sumatra

A guideline

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About this document

This guideline is a result of the collaborative work of the University of Srivijaya, Palembang, Indonesia, and the University of Hamburg, Hamburg, Germany, within the "Biodiversity and Carbon Monitoring Project in South Sumatra" (BiCaMSu). The BiCaMSu project was funded by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) through the GIZ BioClime project[1]. The aim of the BioClime project is to "preserve biodiversity and the carbon sequestration capacity of selected forest ecosystems of South Sumatra as a contribution to the implementation of Indonesia's emission reductions target". One of the main objectives of the BiCaMSu project was to set–up a Biodiversity Information System (BIS) for South Sumatra. The BIS should enable stakeholders to share knowledge and exchange information about biological diversity in South Sumatra. This document provides guidance on how such a system might be put in place.

In Chapter 1 (Section 1.1) of this guideline we provide a brief overview about the biological diversity that can be found in Indonesia and South Sumatra. We also outline the challenges Indonesia and South Sumatra are currently facing regarding the conservation and sustainable use of this diversity (Section 1.2). In response to the rapid loss of biological diversity Indonesia has developed a national biodiversity strategy and action plan. In Section 1.3 we show how Indonesia is reporting on the progress of implementing this plan. Reporting requires the availability of data and information. The challenges Indonesia and South Sumatra are facing when data and information about biological diversity is concerned are also described in Section 1.3.

In Chapter 2 (Section 2.1) we outline the general structure of the proposed BIS and in subsequent sections we describe the different components of the system. The proposed system includes a component that provides general information about biodiversity in Indonesia and South Sumatra (Section 2.2.1), a "Resources" component (Section 2.2.2), including a species list, a sub–component that will provide data and information related to biodiversity in South Sumatra, guidelines on how to pre–process and manage these types of datasets, a component "Map of protected areas" (Section 2.2.3), a "Documents and links" component (Section 2.2.4), and a component on (biodiversity and forest degradation) indicators that might be used to "measure" biodiversity and forest degradation (Section 2.2.5). In Section 2.2.6 we introduce another component "About BIS". This component provides information about the Biodiversity Information System, including its partner organizations. In the last part of this document (Section 2.3) we provides various hints on technical aspects that should be considered when setting–up the BIS. However, the focus of this guideline is on the conceptual framework of the BIS

[1]See: http://www.bioclime.org/index.php/en/

rather than on the technical implementation. Moreover, the BIS we propose here is not "cast–in–stone"; instead the system is deliberately kept open to changes such it can be adapted to the different needs and requirements of the organization implementing the system.

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Acronyms

AIA Advance Informed Agreement.

BAPI Biodiversity Action Plan for Indonesia.

BCH Biosafety Clearing–House.

BIS Biodiversity Information System.

CBD Convention on Biological Diversity.

CHM Clearing House Mechanism.

CIFOR Center for International Forestry Research.

CMS Content Management System.

COP Conference of the Parties.

FAO Food and Agriculture Organization of the United Nations.

FMU Forest Management Unit.

IBSAP Indonesian Biodiversity Strategy and Action Plan.

ILCs Indigenous and local communities.

ITTO International Tropical Timber Organization.

LMOs Living Modified Organisms.

NBSAP National Biodiversity Strategy and Action Plan.

SCBD The Secretariat of the Convention on Biological Diversity.

UNESCO United Nations Educational, Scientific and Cultural Organization.

1 Background

1.1 Biodiversity in Indonesia and South Sumatra

Indonesia — one of the 17 “megadiverse” countries identified by Conservation International — belongs to the most biodiversity rich nations in the world. Two of the world’s 34 biodiversity “hotspots” can be found in Indonesia and it is estimated that the 17,000 islands of the Indonesian archipelago are home to roughly 12% of the world’s mammals, 16% of the world’s reptiles and amphibians, 17% of the world’s birds and 25% of global fish populations[1]. Indonesia is also home to about 10% of the world’s flowering plants of which many are endemic. As Indonesia harbours vast areas of forests, many of these species can be found within forested areas

A wide variety of forest types occur in Indonesia and include, among others, low–land, mountain, swamp, peat, and mangrove forests. These forest types can also be found in the Province of South Sumatra (Provinsi Sumatera Selatan). The lowland rainforests of South Sumatra are among the biologically most diverse forest types on earth and are home to animals such as the Sumatran tiger (*Panthera tigris sumatrae* POCOCK), the Sumatran elephant (*Elephas maximus sumatranus* TEMMINCK), or the clouded leopard (*Neofelis nebulosa* GRIFFITH). Most of these species can be found in protected areas of which there are ten in South Sumatra, including the Sembilang National Park and the Kerinci National Park. The latter is part of the United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage “Tropical Rainforest Heritage of Sumatra”.

Indonesia’s rainforests are not only home to some of the highest levels of biological diversity in the world, they also sequester and store large amounts of carbon. Peatland forests in Indonesia and South Sumatra, for example, are among the largest near–surface reserves of terrestrial organic carbon [Page *et al.*, 2002]. These forests play, thus, an important role in the global carbon cycle. To the concern of many, the area covered by forests is decreasing rapidly in Indonesia, resulting in large amounts of carbon released to the atmosphere. The Food and Agriculture Organization of the United Nations (FAO) states that Indonesia lost about 24% of its forest area between 1990 and 2005. Globally almost one fifth of the annual CO_2 emissions are forest related, i.e., deforestation and forest degradation. The share of forest related emissions on total emissions in Indonesia is expected to be much higher than the global average.

Forests in South Sumatra also undergo rapid changes. Estimates of changes of forest cover at the provincial level are, however, often highly uncertain. Prasetyo *et al.* [2014] cites estimates of forest cover in South Sumatra from two different sources: the Provincial

[1]See: `http://www.fauna-flora.org/explore/indonesia/`

Spatial Plan of 1994 states that about one third of the provincial area was covered by forests (4.3 million hectares). The second source, Alikodra *et al.* [2013], estimated a forest area of 3.7 million hectares in 2012. In South Sumatra the main forces for the loss of forest area are (man–made) forest fires, forest conversion for estate crops (e.g., oil palm), unsustainable levels of timber harvest, illegal logging activities and the expansion of mining and farming areas, as well as the development and expansion of settlements and infrastructure.

Not only in Indonesia but also in many other tropical countries, forests are an important livelihood source for people living in around the forest. Data at the provincial level showed an inversely proportional relationship between population density and areas covered by forest [Indrarto *et al.*, 2012]. Given the rapid population growth in many parts of South Sumatra, large areas of forest are expected to disappear in the future.

Deforestation and forest degradation often go hand in hand with the loss of (forest) biodiversity. Many plant and animal species are now threatened by extinction in South Sumatra. As forests are cleared (planned or unplanned) for e.g., palm oil plantations and fiber production, habitats are lost for many species.

1.2 Biodiversity conservation in Indonesia and South Sumatra

In 1993 the National Development Planning Agency of Indonesia published its first Biodiversity Action Plan for Indonesia (BAPI). The plan outlined measures for the *in* and *ex situ* conservation of threatened plant and animal species in Indonesia. In 1994 Indonesia ratified the Convention on Biological Diversity (CBD). Nine years after ratification, Indonesia published its first Indonesian Biodiversity Strategy and Action Plan (IBSAP) for 2003 to 2020. The main five goals of the IBSAP were: 1) to encourage changes in attitude and behavior of Indonesian individuals and society, as well as in existing institutions and legal instruments, so as to increase concern about conservation and utilization of biodiversity, for the welfare of the community, in harmony with national laws and international conventions; 2) to apply scientific and technological inputs, and local wisdom; 3) to implement balanced conservation and sustainable use of biodiversity; 4) to strengthen institutions and law enforcement; and 5) to resolve conflicts over natural resources[2].

National Biodiversity Strategy and Action Plans (NBSAPs) (see Section 1.2.4) are the principle instruments of the CBD to implement the Convention. They have to be prepared by each party (or country) that ratified the CBD The main goal of NBSAPs is that countries set targets — in accordance with the Aichi Biodiversity Targets[3] — for the conservation and sustainable use of biodiversity. Moreover, parties are requested to mainstream their strategies into the planning and activities of the various sectors that have an impact (positive or negative) on biodiversity. Recently Indonesia published its updated NBSAP, i.e., the Indonesian Biodiversity Strategy and Action Plan (IBSAP), in which the country laid out their strategies and targets for the periode2015–2020. In

[2]See: `https://www.cbd.int/countries/profile/default.shtml?country=id`

[3]See: `https://www.cbd.int/sp/targets/`

the following we will provide a detailed overview of the CBD and its programmes and components.

1.2.1 Convention on Biological Diversity (cbd)[4]

The Convention on Biological Diversity (cbd) is an international legally–binding treaty with three main goals: conservation of biodiversity; sustainable use of biodiversity; and the fair and equitable sharing of the benefits arising from the use of genetic resources. Its overall objective is to encourage actions which will lead to a sustainable future.

The CBD covers biodiversity at all levels: Ecosystems, species and genetic resources. It also covers biotechnology through the Cartagena Protocol on Biosafety. In fact, it covers all possible domains that are directly or indirectly related to biodiversity and its role in development, ranging from science, politics and education to agriculture, business, culture and much more. The governing body of the CBD is the Conference of the Parties (COP). This ultimate authority of all governments (or Parties) that have ratified the treaty meets every two years to review progress, set priorities and commit to work plans. In 2010, Parties to the CBD adopted the Strategic Plan for Biodiversity 2011–2020, a ten–year framework for action by all countries and stakeholders to safeguard biodiversity and the benefits it provides to people.

The Secretariat of the Convention on Biological Diversity (SCBD) is based in Montreal, Canada. Its main function is to assist governments in the implementation of the CBD and its programmes of work, to organize meetings, draft documents, and coordinate with other international organizations and collect and spread information. The Executive Secretary is the head of the Secretariat. For further information see `https://www.cbd.int/`.

1.2.2 Cartagena Protocol[5]

The Cartagena Protocol on Biosafety is an additional agreement to the Convention on Biological Diversity. It aims to ensure the safe transport, handling and use of Living Modified Organisms (LMOs) resulting from modern biotechnology that may have adverse effects on biodiversity, also taking into account risks to human health. The Protocol establishes procedures for regulating the import and export of LMOs from one country to another.

There are two main sets of procedures, one for LMOs intended for direct introduction into the environment, known as the Advance Informed Agreement (AIA) procedure, and another for LMOs intended for direct use as food or feed, or for processing (LMOs–FFP).

Under the AIA procedure, a country intending to export an LMO for intentional release into the environment must notify in writing the Party of import before the first proposed export takes place. The Party of import must acknowledge receipt of the notification within 90 days and must communicate its decision on whether or not to import the LMO within 270 days. Parties are required to ensure that their decisions

[4]Text source: `https://www.cbd.int/undb/media/factsheets/undbfactsheet-cbd-en.pdf`
[5]Text source: `https://www.cbd.int/undb/media/factsheets/undb-factsheet-biosafety-en.pdf`

are based on a risk assessment of the LMO, which must be carried out in a scientifically sound and transparent manner. Once a Party takes a decision on the LMO, it is required to communicate the decision as well as a summary of the risk assessment to a central information system, the Biosafety Clearing–House (BCH).

Under the procedure for LMOs–FFP, Parties that decide to approve and place such LMOs on the market are required to make their decision and relevant information, including the risk assessment reports, publicly available through the BCH[6].

1.2.3 Nagoya Protocol[7]

The fair and equitable sharing of the benefits arising out of the utilization of genetic resources is one of the three objectives of the Convention on Biological Diversity. At the tenth Conference of the Parties, held in Nagoya, Japan, in October 2010, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization was adopted. It is a new international agreement which aims at sharing the benefits arising from the utilization of genetic resources in a fair and equitable way, thereby contributing to the conservation and sustainable use of biodiversity. The Nagoya Protocol further builds on the access and benefit–sharing provisions of the CBD by creating greater legal certainty and transparency for both providers and users of genetic resources. It does this by establishing more predictable conditions for access to genetic resources and helping to ensure benefit– sharing when genetic resources leave the contracting Party providing the genetic resources.

Genetic resources, whether from plant, animal or micro–organisms, are used for a variety of purposes ranging from basic research to the development of products. In some cases, traditional knowledge associated with genetic resources that comes from Indigenous and local communities (ILCs), provides valuable information to researchers regarding the particular properties and value of these resources and their potential use for the development of, for example, new medicines or cosmetics. Users of genetic resources include research and academic institutions, and private companies operating in various sectors such as pharmaceuticals, agriculture, horticulture, cosmetics and biotechnology.

When a person or institution seeks access to genetic resources in a foreign country, it should obtain the prior informed consent of the country in which the resource is located; this is one of the fundamental principles of access and benefit–sharing. Moreover, the person or institution must also negotiate and agree on the terms and conditions of access and use of this resource. This includes the sharing of benefits arising from the use of this resource with the provider as a prerequisite for access to the genetic resource and its use. Conversely, countries, when acting as providers of genetic resources, should provide fair and non–arbitrary rules and procedures for access to their genetic resources.

The Nagoya Protocol will enter into force 90 days after the deposit of the 50th instrument of ratification. The list of signatories of the Nagoya Protocol is available at at the CBD website. In order to become Parties to the Nagoya Protocol, Parties to the Convention that have signed the Nagoya Protocol may then proceed to take steps at the

[6] See: `http://bch.cbd.int/protocol`
[7] Text source: `https://www.cbd.int/undb/media/factsheets/undb-factsheet-nagoya-en.pdf`

domestic level that would lead to depositing their instruments of ratification, acceptance or approval with the Depositary. Parties to the Convention that were not be able to sign the Nagoya Protocol by 1 February 2012, but still wish to become Parties, may accede to the Protocol by depositing an instrument of accession with the Depositary. Ratification, acceptance, approval and accession have the same legal effect. For further information see `https://www.cbd.int/abs/`.

1.2.4 National Biodiversity Strategy and Action Plans (NBSAP)[8]

The Convention on Biological Diversity calls for each Party to develop a National Biodiversity Strategy and Action Plan (NBSAP) to guarantee that the objectives of the Convention are fulfilled in each country (Article 6 of the Convention). The national biodiversity strategy reflects the country's vision for biodiversity and the broad policy and institutional measures that the country will take to fulfill the objectives of the Convention, while the action plan comprises the concrete actions to be taken to achieve the strategy. The strategy should include ambitious but realistic and measurable national targets developed in the framework of the Strategic Plan for Biodiversity 2011–2020, and its twenty Aichi Targets (https://www.cbd.int/sp/targets/) adopted at the tenth meeting of the Conference of the Parties. The strategy and action plan are developed by each Party in accordance with national priorities, circumstances and capabilities.

It is essential that all sectors whose activities impact on biodiversity, and those societal groups who depend on biodiversity, be brought into the NBSAP process early. This engenders a broad ownership of the NBSAP whereby all stakeholders in biodiversity are engaged in its development and implementation. It also enables mainstreaming, which means the integration of biodiversity considerations into relevant legislation, plans, programmes and policy, such as National Development Plans; National Strategies for Sustainable Development; Poverty Reduction Strategy Papers; Strategies to achieve the Millennium Development Goals; National Programmes to Combat Desertification; National Climate Change Adaptation or Mitigation Strategies; and relevant private–sector policies.

While the NBSAP can take the form of a single biodiversity planning document, it can also be conceived as comprising a "basket" of elements on, for example, laws and administrative procedures; scientific research agendas, programmes and projects; communication, education and public awareness activities; forums for inter–ministerial and multi–stakeholder dialogue– which together provide the means to meet the three objectives of the Convention, thereby forming the basis for national implementation. The NBSAP should be a living process by which increasing information and knowledge, gained through the monitoring and evaluation of each phase of implementation, feed an ongoing review and improvement.

Indonesia's Biodiversity Strategy and Action Plan, as well as information about NBSAPs and the Aichi Targest can be downloaded from the CBD website[9].

[8] Text source: `https://www.cbd.int/undb/media/factsheets/undb-factsheet-nbsap-en.pdf`
[9] See: `https://www.cbd.int/`

1.2.5 CBD National Reports[10]

How is biodiversity doing in a country? What is the country doing for biodiversity? How effective are these actions in protecting and sustaining our biodiversity? The national reports compiled by CBD member parties may provide answers to all these questions.

Countries have much to gain by writing national reports. These documents show the current status of biodiversity and implementation of the Convention on Biological Diversity at the national level, and they identify what else needs to be done. National reports are available to the public. Anyone can access them on the Convention website, on the National Clearing–House Mechanism for Biodiversity, or on relevant national government websites.

National reports are an important communication tool for increasing public awareness, conveying the urgency of the situation, and for taking action and mobilizing support from all sectors of society. They're also very useful to intergovernmental agencies, NGOs and scientists while designing and implementing strategies and programmes to assist governments addressing biodiversity issues.

The fifth national reports provide countries an opportunity to undertake a mid–term review of progress in the implementation of the Strategic Plan for Biodiversity 2011–2020 and in achieving relevant goals and targets of the Millennium Development Goals. So the information from the fifth national report is essential to the successes of the Strategic Plan and the Convention as a mid–term review and decisions to be made on that basis will boost their implementation. As a communication tool, the fifth national report is also crucial for the United Nations Decade on Biodiversity.

Indonesia's fifth National Report can be downloaded from the CBD website. The website also provides guidance and suggestions how to report.

1.3 Data and information requirements for national reporting

1.3.1 Reporting requirements

As outlined in the CBD guidelines for the fifth national report[11], "[t]he fifth national report provides a key source of information for a mid–term review of the implementation of the Strategic Plan for Biodiversity 2011–2020". The report is structured as follows:

— PART I provides an update on the status of biodiversity in a country, reports on trends and threads and implications of r human well–being. The first part should answer questions on (i) why biodiversity is important for a country, (ii) what major changes have taken place in the status and trend of biodiversity, (iii) what are the main threads to biodiversity, (iv) what are the impacts of changes for ecosystem services and socio–economic and cultural implications, and (v) what are possible future changes for biodiversity and their impacts.

[10] Text source: `https://www.cbd.int/undb/media/factsheets/undb-factsheet-reports-en.pdf`
[11] See: `https://www.cbd.int/doc/nr/nr-05/NR5-guidelines-en.pdf`

— PART II provides information about the NBSAP and its implementation. The second part should answer questions such as (i) what are the biodiversity targets in the country, how has the NBSAP been implemented to serve as an effective instrument to mainstream biodiversity, (iii) what actions have been taken to implement the Convention, (iv) how effectively has the biodiversity been mainstreamed, and (v) how fully has the NBSAP been implemented.

— PART III reports on progress towards the 2020 Aichi Biodiversity Targets and contributions to the relevant 2015 Targets of the Millennium Development Goals. The third part should draw upon PART I and PART II to answer questions such as, (i) what progress has been made towards the implementation of the NBSAP and the Aichi Biodiversity Targets, (ii) what has been the contribution of actions to the implementation of the Convention towards achieving the 2015 targets of the Millennium Development Goals, and (iii) what lessons have been learned from the implementation of the Convention.

The above list clearly shows that those responsible for compiling the National Report (i.e., at the national level) need to have access to various sources of information, including information on the status and trends of biodiversity in a country. Article 7 of the Convention (Identification and Monitoring) states that all relevant components of biological diversity in a country need to monitored through sampling and other techniques, and that particular attention should be paid to those components that require urgent conservation measures.

At the national level data on biodiversity components are hardly collected in an organized manner. Far more often data on e.g., plant and animal species are gathered in large, medium or small scale surveys conducted by wide range of stakeholders, such as governmental agencies, research organizations, universities, the private sector, or NGOs. Hence, data relevant for reporting is scattered among many different organizations and institutions. In many cases the data collected is only accessible to those that did the assessment and are neither “visible” nor available to third parties. This creates a great challenge to those responsible for reporting on the status and trends of biodiversity at the national level. Moreover, data on some biodiversity components are scare or even absent. Reporting on these components, although required by the Convention, is difficult or sometimes impossible to accomplish.

Even if data or information are/is available, it is often not up–to–date, not properly managed and/or access and use are constrained by the absence of effective information and documentation systems [Indrarto *et al.*, 2012]. Regarding data collected by governmental agencies in Indonesia, Law No. 14/2008 on Public Access to Information, requires that these agencies make most of their data available to the public, i.e., there is a normative assurance of information access. Although the law came into effect in 2010, it has, however, not been functioning optimally thus far.

Access to data and information is not only a prerequisite for CBD reporting but also for wise decision making at the national and local level. This, however, does not always mean that more data result in better information and, hence, better decisions. Information and data need to be reliable and of reasonable quality. In computing science the concept of GIGO (“garbage in, garbage out”) is well known. Moreover, advances in computing technology have made data analysis easier than ever before. Nowadays, different desktop or server based computing software packages provide “one–click” solutions to complex problems, making data analysis an presumably easy task for almost anybody. The information that is provided by these tools need to be interpreted carefully before it is “translated” into decision making. Even if the information is carefully evaluated, different sources of information may lead to different conclusions, i.e., different information sources may contradict each other. In most cases this is an unpleasant situation. However, it may also help to identify those situations where more detailed, or better information is needed.

1.3.2 Biodiversity Information Systems and the Clearing–House Mechanism

In Indonesia several biodiversity information systems have been established that collect and distribute data. Most of these systems are websites that are accessible via the world wide web. They have many names, including biodiversity information platform, biodiversity information network, or biodiversity facility. Examples from Indonesia include:

— Indonesian National Biodiversity Information Network (NBIN)[12]

— Indonesian Biodiversity Information System (IBIS)[13]

— Indonesian Discovery and Information System (Indobiosys)[14]

— Indonesian Biodiversity Information Facility (InaBIF)[15]

— Indonesian–German Biodiversity Network[16]

Most of these systems facilitate the collection and distribution of biodiversity information and data in Indonesia. Many of them are limited in scope (e.g., bird, insects, or plant species only), some do not provide data at all and/or only link to other resources, some provide species list(s) “only”, others provide various kinds of datasets for download, and some are access restricted whilst other are open to the public. Other systems such as FORBIS[17], provide many features, including tools for data analysis.

Biodiversity information systems and knowledge sharing platforms are also an integral part of the CBD Parties that ratified the CBD are encouraged to establish knowledge sharing and information exchange services at the national level. The Clearing House Mechanism (CHM) of the Convention on Biological Diversity has been established further to Article 18.3 of the Convention. The mission of the CHM is “to contribute significantly to the implementation of the Convention on Biological Diversity and its Strategic Plan for Biodiversity 2011–2020, through effective information services and

[12]Web: `http://nbin.lipi.go.id/e_index.php?x=visimisi`
[13]Web: `http://ibis.biologi.lipi.go.id/`
[14]Web: `http://www.indobiosys.org/`
[15]Web: `http://inabif.lipi.go.id/`
[16]Web: `http://zsmblog.de/2012/towards-an-indonesian-german-biodiversity-network/`
[17]See: `http://jdsk-sumsel.net/`

other appropriate means in order to promote and facilitate scientific and technical cooperation, knowledge sharing and information exchange, and to establish a fully operational network of Parties and partners."[18]

Originally, the term "clearing–house" referred to a financial establishment where bills and checks are exchanged among member banks such that only net balances need to be settled in cash. Today, the meaning of clearing–house has been extended to include any platform that brings together those that seek goods, services or information and those that provide these goods, services or information.

The CHM has three major goals:

1. The **central CHM** provides effective global information services.

2. **National CHMs** provide effective information services to facilitate the implementation of the NBSAP.

3. **Partners** significantly expand the CHM network and services.

The second goal of the CHM mission are national CHMs. Their primary goal is to provide relevant information on the Convention on Biological Diversity in a particular country. National CHMs serve as a knowledge sharing and information exchange platform for biodiversity data and information. Thereby national CHMs may help to solve some of the problems that have been mentioned earlier (e.g., data "visibility" and access). They may also provide information on the NBSAP (visions, priorities, or targets), informations about actions that are taken to combat the loss of biodiversity (i.e., implementation of the NBSAP), or information about protected areas, threats to biodiversity, etc. An example of a CHM website menu structure is shown in Figure 1.1.

1.4 Towards a subnational CHM for South Sumatra

National CHMs are a valuable source of information for national CBD reporting. They also enable other interested parties to obtain information about national status and trends of biodiversity, as well as the country's biodiversity related strategies and actions. On the CBD website detailed guidelines on how a national CHM can be set up are provided[19]. The table of recommended CHM activities[20] states (2.2.6) that "whenever appropriate and feasible, further develop the national clearing–house mechanism at the sub-national or local level." Against the background that South Sumatra is currently developing a subnational Biodiversity Strategy and Action Plan, the development of a subnational CHM would be a logical consequence. Such a subnational CHM should provide access to information about biological diversity in South Sumatra. It may help to inform decision makers and other actors at the province level, and at the same time supports those responsible for CBD reporting at the national level.

[18]See: `https://www.cbd.int/chm`
[19]See: `https://www.cbd.int/chm/intro/default.shtml`
[20]See: `https://www.cbd.int/chm/work/default.shtml`

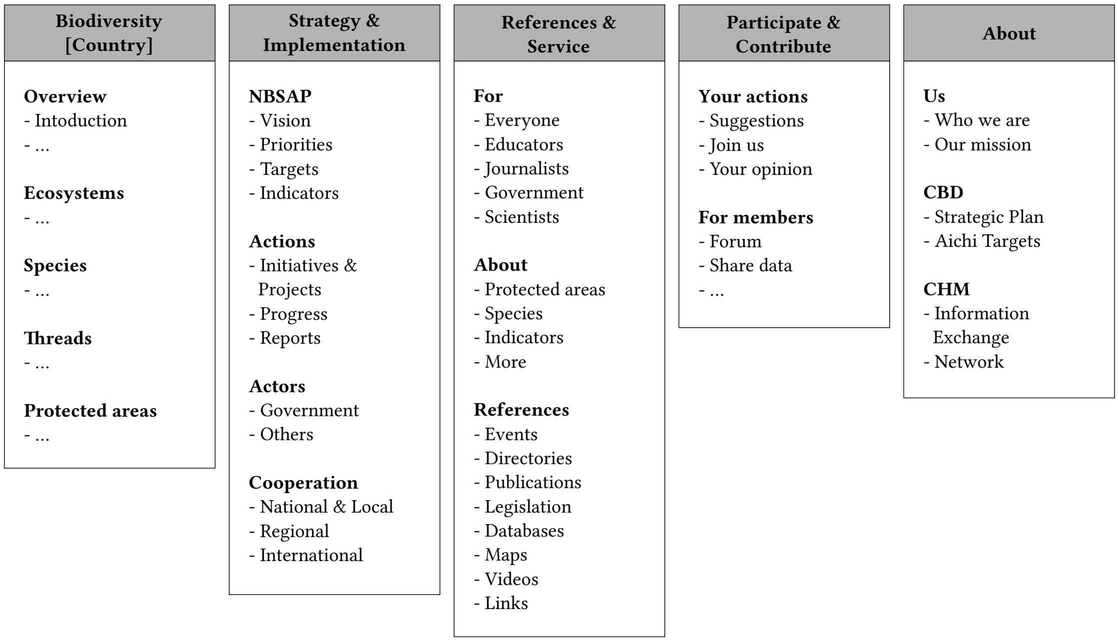

Figure 1.1: Example menu structure of a CHM website (adapted from de Munck [2014]).

In order to set up a sub-national CHM, not only technical aspects have to be considered, but also aspects about the information it should provide and the organization and maintenance of the content need to be considered. Relevant questions may include: what information should the sub-national CHM provide? What information is particularly important for South Sumatra? How can the information content be organized? Who is responsible for maintaining the CHM/system? In the following we will make several suggestions how such a system may be organized and what information and data it may provide.

2 The BIS and its components

2.1 General structure of the BIS

In this section the general structure of the Biodiversity Information System (BIS) is described. The focus will be on the conceptual framework of the BIS, rather than on technical aspects (see Section 2.3). At the core the BIS is a website; a platform that provides possibilities to share knowledge and exchange information and data. In order to set up such a website or platform, technical aspects have to be considered from the start. Whenever necessary we will make reference to these aspects, but they are not the focus of these guidelines.

The general framework of the BIS is shown in Figure 2.1. We will briefly describe the different components of the framework by looking at a potential use-case-scenario.

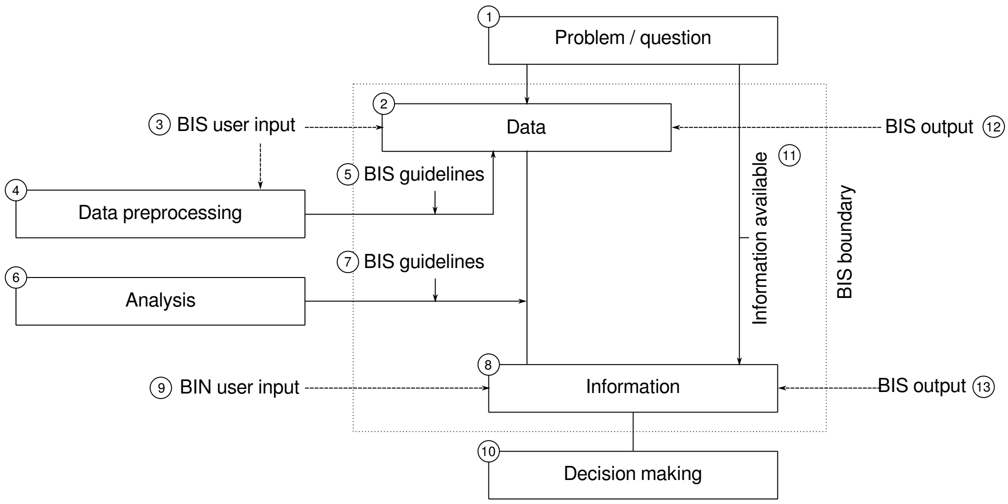

Figure 2.1: General structure of the proposed Biodiversity Information System (BIS; see text for more information).

Example: A donor agency is willing to provide financial funds for a rehabilitation project in which degraded forest lands are to be resaturated. A South Sumatran Forest Management Unit (FMU), a potential receipt of the funds, wants to identify those areas where rehabilitation measures are most promising. First, the FMU needs to identify degraded forest lands.

1. An FMU needs a map of degraded forest lands within the area of the FMU.

2. An FMU staff member enters the BIS and searches for data about degraded forests with the FMU. Unfortunately such a map does not exists (or is not available in the BIS). However, another map is available in the BIS that depicts the extent of forest land in South Sumatra (i.e., a forest cover map).

3. The forest cover map was added (uploaded) to the BIS by another users. In addition to the forest cover map, the FMU holds data of a forest inventory that was recently conducted within north-east South Sumatra (the study area also covers the FMU). This forest inventory dataset is stored on a hard-drive on one of the computers at the FMU office.

4. The forest inventory data is stored in several Microsoft Excel files (one sheet for each plot). Before the data can be used to map degraded forests it needs to be preprocessed.

5. Guidance on the different steps that are needed to preprocess the data can be found in a guideline that is available in the BIS. The preprocessing is done by a student from a South Sumatran university that is cooperating with the FMU for the rehabilitation project. Once the data is preprocessed, it is uploaded to the BIS data "warehouse" (3).

6. After the data are preprocessed, the FMU or a researcher from the university needs to analyze the data to produce the map. For data analysis the preprocessed forest inventory data, the forest cover map and, in addition, a recent satellite image of the area (e.g., a Landsat scene) is used. The final product is a map of degraded areas within north-east South Sumatra.

7. During the analysis all steps that were necessary to create the map (e.g., definitions, data needs, data preprocessing, modelling, etc.) were documented as described in the BIS data analysis guidelines (see Section 2.2.2.4).

8. The information (a map of degraded areas in the FMU) is now available and can be used for decision making (10).

9. The FMU uploads all the data that were used to create the map (3), as well as the map itself (9). Moreover, the documentation of how the map was created is uploaded (including definitions used). During the analysis, the researcher or FMU staff member used additional sources of information (e.g., books, scientific articles, etc.) to select the most appropriate methods to create the map of degraded forests. These sources are uploaded, too.

Suppose that a few months later, another South Sumatran FMU wants to map degraded areas, in e.g., in the south-west of South Sumatra. Staff members of the second FMU will be able to find all the relevant information (and most of the needed data) on how to create the map in the BIS. Maybe not all data needs are satisfied, but information about how to solve the problem is now available and easily accessible.

Taking a more general view on the BIS,

— it provides possibilities to down- and upload information and data,

— it provides guidance on how to handle and analyze data, and

— it assists in problem solving and decision making.

As mentioned earlier, the BIS is a website. The BIS website consists of four main components (see Figure 2.2). The components assist in accomplishing all the tasks that were described in the above example.. Each main component has several sub–components, which are again subdivided into lower level sub-components. The four main components are:

— Biodiversity

— Resources

— Indicators

— About us

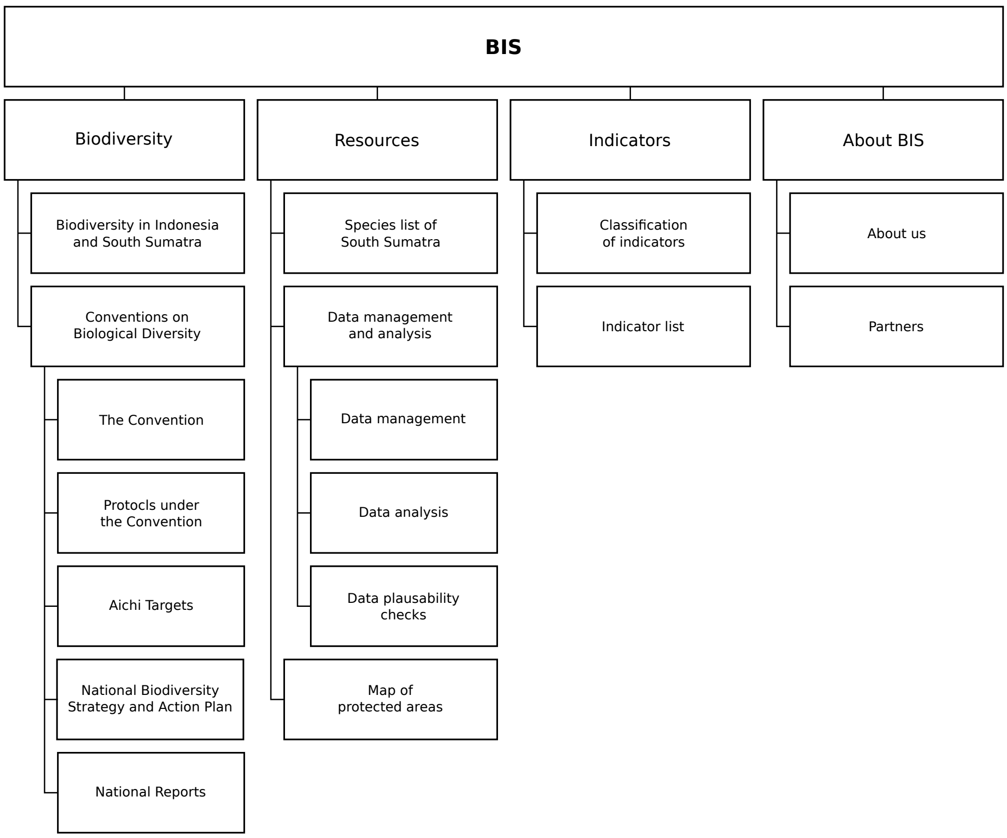

Figure 2.2: Potential menu structure of the Biodiversity Information System (BIS).

If one thinks about the BIN as a website, these four components represent the four top level menu items of the given website. The content that can be found under these menus (and its sub–components) is described in detail in subsequent sections. Please not that the menu structure is not "cast in stone"; one should view it as a suggestion that might be modified and altered. An example front–page of the BIS is given in Figure 2.3.

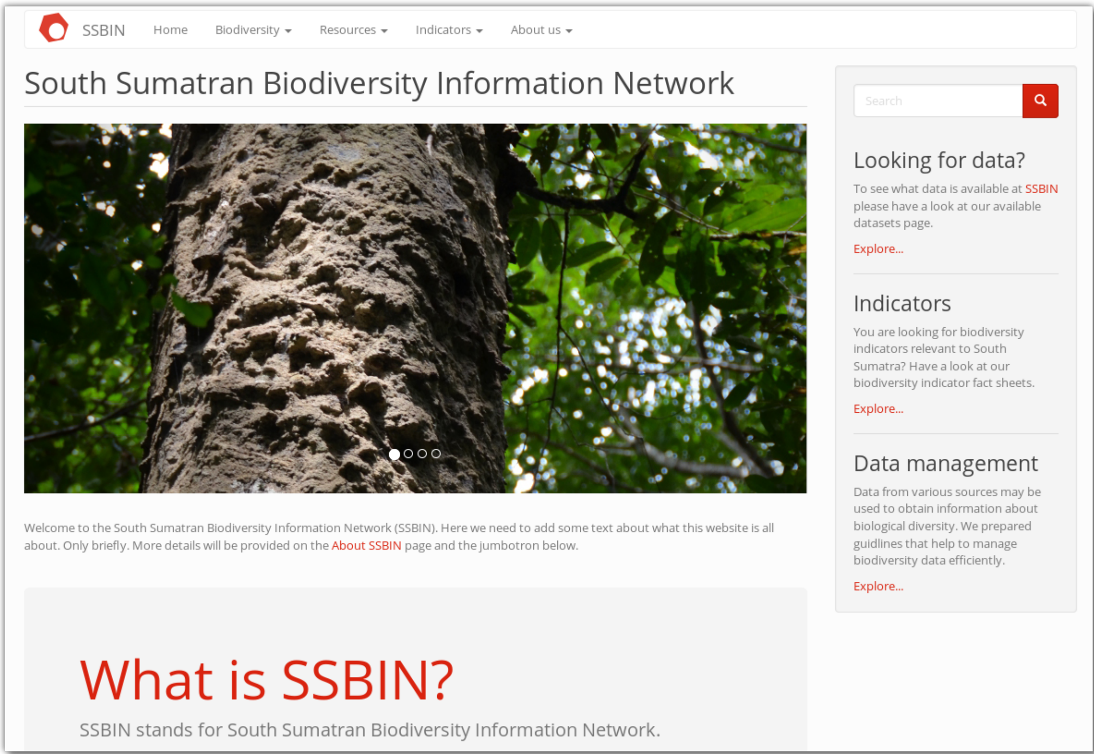

Figure 2.3: Example BIS website.

2.2 System components

2.2.1 Information about biodiversity

This component provides information about biodiversity in general and information about biodiversity in Indonesia and South Sumatra in particular. Under this menu item the following information should be provided:

— Information about Biodiversity in Indonesia and South Sumatra. The text from chapter 1 (Biodiversity in Indonesia and South Sumatra) may be used as content for this sub–component. The text can be extended if additional information is needed or available.

— Information about:

- The Convention on Biological Diversity (cbd). A general introduction to the CBD should be provided. See Section 1.2.1.
- Protocols under the CBD This sub–component provides information about the Cartagena and Nagoya protocol. Both protocols were ratified by Indonesia (the Cartagena Protocol came into force in 2005 and the Nagoya Protocol in 2014).
- Aichi Target. Under this sub–component information about the Aichi Targets should be provided. The Aichi Targets are closely linked to the National Biodiversity Strategy and Action Plan (NBSAP), which is again linked to national (and sub–national) reporting.
- National Biodiversity Strategy and Action Plan (NBSAP). This sub–component should, first, provide general information about NBSAP. Secondly, information about the Indonesian Biodiversity Strategy and Action Plan (IBSAP) should be made available. For both a link to the Aichi Targets should be established. If information is available for the proposed South Sumatran Biodiversity Strategy and Action Plan it should be provided under this sub–component.
- CBD National reports. For this sub–component the national reporting mechanisms of the Convention should be described in detail. It may prove useful to display the structure of the last (fifth) national report of Indonesia (e.g., the table of contents). If information about sub–national reporting is available (i.e., reporting for the South Sumatran Biodiversity Strategy and Action Plan) this information should be made available under this sub–component.

Input for the first three sub–components listed above are available on the CBD website (see the fact sheets under Programmes on the CBD landing page). Most of the text in Section 1.2.1 to Section 1.2.5 have been extracted from these fact sheets.

Whenever possible hyperlinks to relevant web resources should be provided for the different sub–components. In addition the most recent IBSAP and, once available, the South Sumatran Biodiversity Strategy and Action Plan, should be made available for download (in a PDF file format).

The main goal of the component "Biodiversity" is to inform the potential BIS user about status, trends, strategies and actions related to biodiversity in Indonesia in general and biodiversity in South Sumatra in particular.

2.2.2 Resources

2.2.2.1 Overview of sub–components

The Resources component consist of a number of sub–components. This includes: (i) a fauna and flora species list for South Sumatra, (ii) a sub–component "Available datasets", that lists all available datasets that are available on BIS, (iii) guidelines on how to handle and analyze (biodiversity) data, (iv) an interactive map of protected areas in South Sumatra, and (v) a list of documents and links.

2.2.2.2 A species list for South Sumatra

The Species list is a list of animal species that have been detected in South Sumatra. For each species several attributes are provided. These attributes include:

— A unique ID (one ID for each species).

— The taxonomic class, family, genus and species name (four columns in a database table). Higher classes may be included (e.g., order, phylum, kingdom).

— The local (also vernacular or common) name. Sometimes more than one common name is used for a species. This issue has to be considered when planning the database table design.

— Date detected (the date when the species have been detected): month and year (two columns). The separation into year and month would allow to filter by year (or month). Alternatively standard data formats may be used such as YYYY-MM(-DD), from which the year and month (and day) can easily be extracted.

— IUCN, CITES, and Indonesian status (three columns). These values may change over time for a given species.

— Date entered (when was the species entered into the database?). As e.g., the status of a species may change over time the date when the species was entered into the database (list) is important. If a user sees that the species was entered a long time ago, he or she might be able to check him- or herself if the status have changed since the date the species was entered into the database.

— Data source (who detected the species?). Whenever possible, a reference to a reliable data source (e.g., scientific article) should be provided.

— Optional:

  - Location (coordinates, or name of a district, regency, and alike). If coordinates are provided they should be given in decimal degrees (and not in latitude/longitude). Information about the coordinate reference system (CRS) needs to be provided.
  - Additional information: in this column additional information about the species can be added.
  - Images. Images of the species may be provided. These image files need to be stored in the remote file system of the BIS. The database table needs to link to these files.

BIS users should be able to add detections to the species list. However, entries should only made visible to all users if the detection has been verified by an expert.
The content of the species list, i.e., the different variables and their values, should be separated from its appearance on the website. Not all of the species attributes have to be

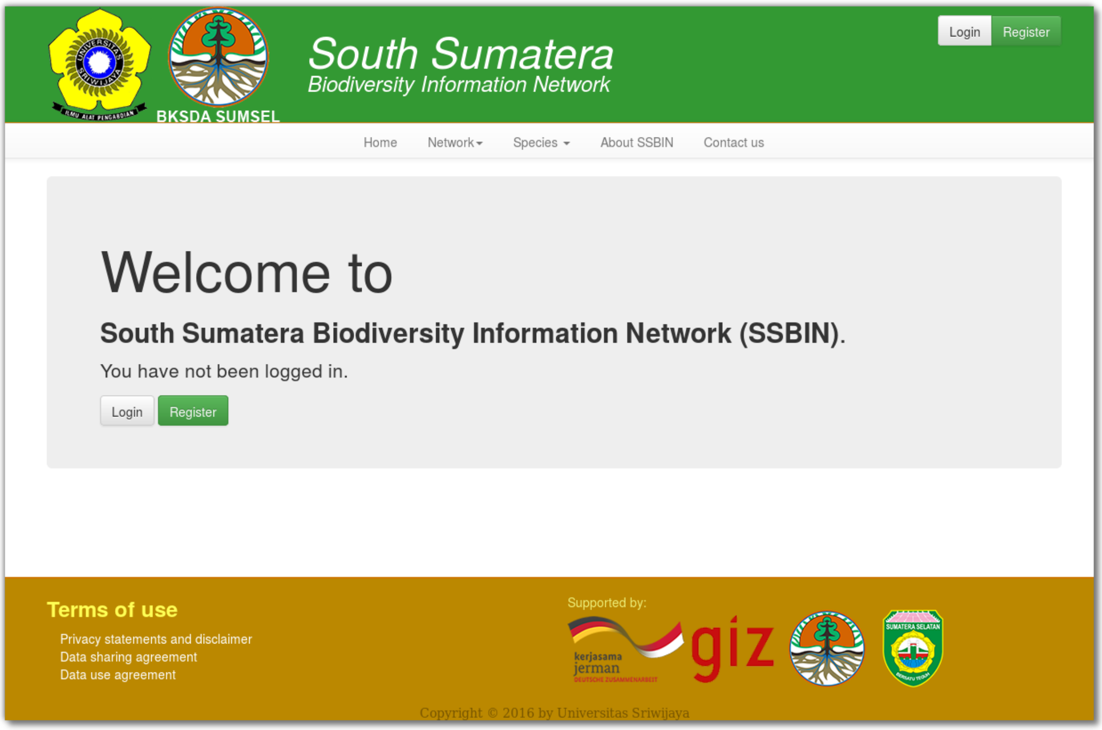

Figure 2.4: South Sumatera example website `http://ssbin.unsri.ac.id`.

displayed in the list (or table) view. Modern websites (and most Content Management System (CMS)) provide the probability to extract only a subset of attributes for display. What and how a species is displayed can easily be changed if content and display are separated. Access to all attribute values should be made available when a user "clicks" on a single species.

The SBBIN website[1] already provides a species list that holds information on all the attributes listed above (see Figure 2.4). So far the list includes animal species only (i.e., fauna list). A second list may be created that contains all plant (flora) species that have been detected in South Sumatra. Alternatively, both lists (i.e., fauna and flora) may be combined into a single list by adding another column that indicates whether the species belongs to the fauna or flora realm.

2.2.2.3 Available datasets

In Indonesia and South Sumatra various institutions, agencies, and organizations hold data on biological diversity (see Figure 2.5). The aim of this sub–component is to make these datasets visible (and accessible) to others. Users of the BIN will be able to either upload or download data of different type. Here, the term "data type" refers to different

[1]See: `http://ssbin.unsri.ac.id/`

kinds of data such as data collected during a forest field inventory, remotely sensed data, or presence–absence data for a certain endangered bird species. This definition of the term "data type" is different from the definition used by, e.g., professional database managers. There, "data type" usually refers to a classification of data into: integers, booleans, floating–point numbers and alike.

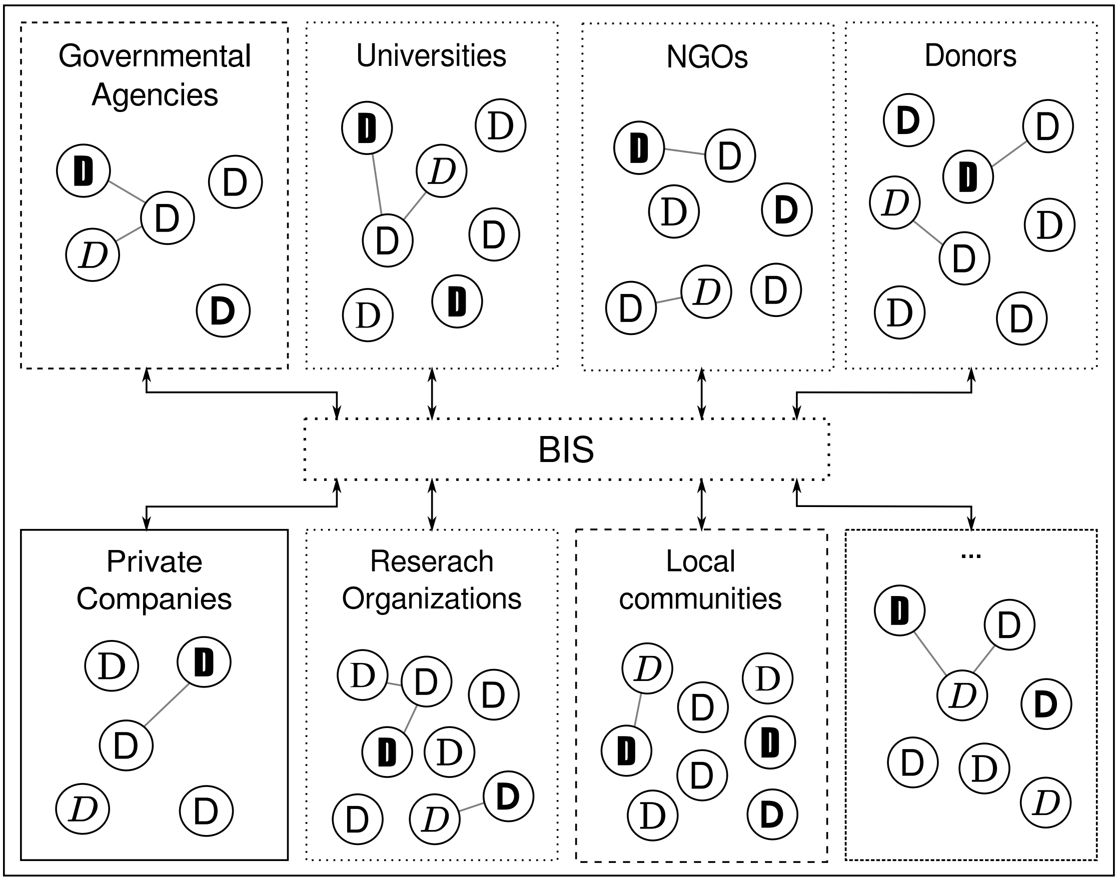

Figure 2.5: In South Sumatra various stakeholders (e.g., governmental agencies, private companies, local communities, etc.) hold very different types of data. The Biodiversity Information System (BIS) can make these datasets visible and accessible.

Data also comes in various file formats, such as plain text file formats (.txt), comma–separated–value (.cvs), Microsoft Excel (.xls[x]), ESRI shapefile (.shp), or in a tagged image file formats (TIFF). The BIN will enable users to upload (and download) datasets irrespective of what file format is used for a particular dataset.

Before data is entered into BIN, the data contributor needs to pre–process the data. Here, we refer to "preprocessing" as the procedures that are needed to make the data usable, storable and sharable. Guidance on best–practice for data preprocessing is available in Section 2.2.2.4.

Once the data are preprocessed they can be uploaded to the BIS. However, before a potential user can make use of the data he or she needs more than just the file that holds the data; the user also needs information *about* the data. Suppose, as an example, a comma–separated–value (CSV) file that contains data collected during a forest field inventory was uploaded to the BIS. The potential user who downloads the data may ask the following questions:

— Where have the data been collected?

— What is the extend of the forest where the inventory was conducted (sampling population)?

— Have tree attributes been collected on fixed area sample plots? How have the sample plots been selected (arrangement of plots; sample design)?

— Have cluster plots been used? How are they arranged in space?

— Where attributes measured on all trees that were found on the plots (including saplings) or was a nested plot design used?

— What attributes have been measured on each tree? And how are these attributes linked to the variables (columns) in the CSV file?

— Can the data be send to a colleague by email?

The itemized list above lists only a small subset of questions that might be asked. If these questions can not be answered by the user, the data may be of little use to him or her. Therefore, it is important that supplementary information is provided in addition to the data file itself. Such supplementary information is often called meta–data, i.e., data about data. Meta–data may not only include data about the content of the file, but also about the file owner, terms of use, date of collection, etc. For the example forest inventory data file, the following data and documents may be provided by the data contributor:

— Subject: the type of data that is provided (e.g., forest inventory data)

— Creator: the person or organization that “created” (e.g., collected) the data.

— Publisher: the person or organization that uploaded the dataset

— Rights holder: the person or organization that legally owns the data

— Contact email: the email address of the person the data owner

— Terms of use: information about how the data can be used

— Coverage (temporal): the date when the data were collected

— Coverage (spatial): information about where the data were collected

— Language: the language used (e.g., Bahasa Indonesia or English)

— File format: the file format of the data file (e.g., xlsx, shp, csv, etc.)

— File size: the size of the file in kilo–, mega–, or giga–bites

— Supplementary documents: field manuals or measurement protocols that contain information about plot sizes and shapes, height of DBH measurements, etc.) and documentation of the sample design used should be provided.

More on the different meta–data elements is provided in later sections. Once the information listed above is provided, a potential user can put the data file into context. The meta–data should provide sufficient information about what type of questions can be investigated with the available data and how.

In some cases it might not be possible to upload a given dataset directly to the BIS, because of e.g., privacy issues or data volume. This does not mean that the data can not be made visible in the BIS. If a data upload is not possible the data provider can, nonetheless, provide information about the data file(s). Additionally, a hyperlink to an external source (where the data can be downloaded), or an email address can link to the source where access to the data file can be provided or granted.

If several datasets have been uploaded to the BIS, users should be able to easily find them. The display of available datasets can be organized in many different ways, e.g., table or list view. Users should also be able to search, reorder and filter these views. For the "subject" item (see the last list above), for example, data contributors may be required to select values, e.g., forest inventory data, satellite imagery, etc., from a predefined list when they enter data into the BIS. User can then filter the view according to these values, e.g., only forest inventory data is displayed in the list or table.

2.2.2.4 Data management and analysis

Data management Data about biological diversity derive from various sources and is stored in various file formats. Traditionally, ecological data is collected in the field using pen and paper. Other data may be available only in digital form, e.g., satellite imagery. This component of the BIS provides guidance on how raw data (available on paper or digital) can be preprocessed in order to make it sharable in the BIS. The recommendations found in this section are based on those provided in Borer *et al.* [2009], Costello & Wieczorek [2014] and Wieczorek *et al.* [2012].

Throughout this section we will use an example forest inventory dataset which is depicted in Figure 2.6. The figure shows a tally sheet that lists 12 trees that have been found on a fixed area cluster sample plot (i.e., a plot consists of four subplots). On each tree several attributes have been recorded, i.e., the ID of a tree, the subplot ID, the diameter at breast height (in cm), the tree height (m), the crown diameter (m), the species (vernacular name), the azimuth (gon) and the distance of the plot center to the respective tree (m). The first four lines of the sheet provide information about the plot (e.g., field team ID, date of the assessment, slope, etc.). The last 12 lines provide the tree data. The data from the (paper) tally sheet need to be transferred to digital format.

Inventory Palembang (plot 103)								
Field team ID:	12	Date:	Oct 23, 2016	Time:	Start	07:01		
					End	07:54		
Plot information								
Plot number:	103	Coordinates:	East	38996	Slope:	12		
			North	966738	Elevation:	212		
Tree information								
Tree ID	Subplot 1	Subplot 2	Subplot 3	Subplot 4	DBH [cm]	Height [m]	Species name	Stem Quality
1	x				31	26	Waru	1
2					41	31	Rubber	3
3		x			30	brocken	Rubber	3
4		x			21	17	Waru	2
5		x			34	25	Waru	4
6			x		42	32	Waru	1
7			x		21	16	-	1
8				x	32	28	Rubber	2
9				x	38	37	Rubber	3
10				x	10	123	Rubber	4
11				x	38	33	Wari	2
12				x	32	30	Balibago	3
13				x	42	38	Rupper	5
14				x	11	36	Waru	8

Inventory Palembang (plot 104)								
Field team ID:	13	Date:	Oct 24, 2016	Time:	Start	01:42		
					End	02:38		
Plot information								
Plot number:	104	Coordinates:	East	38896	Slope:	5		
			North	966638	Elevation:	155		
Tree information								
Tree ID	Subplot 1	Subplot 2	Subplot 3	Subplot 4	DBH [cm]	Height [m]	Species name	Stem Quality
1	x				31	27	Rubber	4
2	x				20	14	Rubber	5
3	x				33	26	Waru	5
4		x			33	25	Rubber	5
5		x			2	-3	Waru	3
6		x			38	32	Rubber	1
7			x		31	28	Waru	2
8			x		33	27	Waru	2
9				x	31	25	Rubber	1
10				x	39	26	Waru	2

Figure 2.6: Example dataset from a hypothetical forest inventory conducted in Palembang, Indonesia in October, 2016. The figure shows the data from two inventory plots, plot number 103 and 104.

Using paper to store data has some advantages, but many disadvantages: because of the non-digital format, the data are not readable by data analysis software packages and are not sharable via the world wide web, USB devices, or DVD.

Most commonly the data from the tally sheet will be entered into a spreadsheet software package such as Microsoft Excel and is saved as e.g., “tally sheet 1.xlsx”. The result may look as shown in Figure 2.6.

In the following we will provide recommendations how to further pre–process the data before it is uploaded to the BIS. The goal is to make the data readable by both, humans and and computers.

a)

plotid	treeid	subplotid	dbh	height	vername	sciename	stemquality
103	1	1	31	26	Waru	Hibiscus tiliaceus L.	1
103	2		41	31	Rubber	Hevea brasiliensis Mull.Arg.	3
103	3	2	30	brocken	Rubber	Hevea brasiliensis Mull.Arg.	3
103	4	2	21	17	Waru	Hibiscus tiliaceus L.	2
103	5	2	34	25	Waru	Hibiscus tiliaceus L.	4
103	6	3	42	32	Waru	Hibiscus tiliaceus L.	1
103	7	3	21	16	-		1
103	8	4	32	28	Rubber	Hevea brasiliensis Mull.Arg.	2
103	9	4	38	37	Rubber	Hevea brasiliensis Mull.Arg.	3
103	10	4	10	123	Rubber	Hevea brasiliensis Mull.Arg.	4
103	11	4	38	33	Wari	Hibiscus tiliaceus L.	2
103	12	4	32	30	Balibago	Hibiscus tiliaceus L.	3
103	13	4	42	38	Rupper	Hevea brasiliensis Mull.Arg.	5
103	14	4	11	36	Waru	Hibiscus tiliaceus L.	8
104	1	1	31	27	Rubber	Hevea brasiliensis Mull.Arg.	4
104	2	1	20	14	Rubber	Hevea brasiliensis Mull.Arg.	5
104	3	1	33	26	Waru	Hibiscus tiliaceus L.	5
104	4	2	33	25	Rubber	Hevea brasiliensis Mull.Arg.	5
104	5	2	2	-3	Waru	Hibiscus tiliaceus L.	3
104	6	2	38	32	Rubber	Hevea brasiliensis Mull.Arg.	1
104	7	3	31	28	Waru	Hibiscus tiliaceus L.	2
104	8	3	33	27	Waru	Hibiscus tiliaceus L.	2
104	9	4	31	25	Rubber	Hevea brasiliensis Mull.Arg.	1
104	10	4	39	26	Waru	Hibiscus tiliaceus L.	2

b)

plotid	fieldteam	date	start	end	xutm	yutm	slope	elevation
103	12	2016-10-23	07:01	07:54	38996	966738	12	212
104	13	2016-10-24	13:42	14:38	38896	966638	5	155

Figure 2.7: Tree (a) and plot data (b) in two separate tables.

1. **Record unique measurements only once**
   The example sheet in Figure 2.6 contains data about plots and trees at the same time. It is often useful to separate different types of information into different data files. For the example sheet above, it might be useful to separate the plot information from the tree data. For the trees in the sheet the plot information does not change from one tree to another. We recommend to create two separate

files: one file that holds the plot data and one file that holds the tree data. An additional column containing the plot number can be added to the tree data file. In that way each tree can be linked to a plot in the plot data file. Moreover, forest inventory datasets usually hold data on many plots (and many trees). The plot data file should have one row for each plot. The tree data file should, on the other hand, contain all the trees that have been recorded during the field inventory. See Figure 2.7 for an example how plot and tree data can be separated.

2. **Include header lines**
   Most software applications assume that the first line in a data file is the "header line". The "header line" lists the names of the different variables in the dataset. Variable names should be as short as possible and as long as necessary. Some software packages or file formats are not able to cope with long variable names such as "diameter at breast height measured in centimeters". We recommend to never user blank spaces in variable names, e.g., "DBH in cm", or "Species name". Instead use either underscores, i.e., "DBH_cm" or hyphen, i.e., "species–name". For the latter example, the variable name "species" might even be better. The header line is usually not more than a single line; everything that follows is interpreted as data. The example tally sheet in Figure 2.6 has more than one line before the tree data starts. The tally sheet is easy to read and understand by humans. However, additional work is required if the data is to be used for data analysis using software packages different from Microsoft Excel. Almost all software packages (except Excel) would have difficulties to read and understand the data.

3. **Use descriptive file names**
   Descriptive file names provide an easy way to indicate the content of a given file. We recommend to use file names that capture hints of the place, time and theme of the data file. Similar to the recommendations given in 2., do not use blank spaces in file names. For file names we also recommend stringing words together, e.g.,
   palembang_trees_biomassInventory_2016.csv and
   palembang_plots_biomassInventory_2016.csv
   Files names such as plots.xlsx, or trees..xlsx, or even worse data1.xlsx and data2.xlsx are not recommended.

4. **Keep original and uncorrected data files**
   If the data has been entered into a spreadsheet (as shown in Figure 2.6) these files should be save on a hardware device even if the data is not stored in the format we recommended above (step 1 to 3). While modifying data mistakes might happen. It will not be possible (or often require a lot of work) to return to the original version of the digitized data. This holds also true when data is modified during data analysis. As a guiding principle: always make copies of the original data files when it is expected that the original data is modified.

5. **Use non–proprietary file formats**

Today, software packages such as Microsoft Access and Excel are used widely. This has not always been the case and it may again change in the future. If certain software packages become unavailable, the data simply disappear. This may, to a lesser extent, also be the case if the software packages become uncommon. Others may then not be able to use your data. We highly recommend to store tabular data in (plain) text files including comma–separated–value (CSV) files. These formats can be read–in by almost any software package including Excel, SPSS, R, SAS, MATLAB, and many more. Excel is also able to save sheets in the CSV file format.

6. **Use non–proprietary hardware formats for data storage**
What holds true for file formats also holds to for hardware formats. Not long ago data has been stored on 8–track tapes or floppy disks. Data stored in these formats are inaccessible to most computer users, today. This may also be the case for CDs, DVDs, or even devices that are connected via USB. We recommend to upload the data to remote devices (e.g., ftp servers) whenever possible.

7. **Use ASCII or Unicode character encoding**
Since many software applications do not support diacritical marks, accents and other characteristics of written language, it is important to avoid those language specific characteristics in file names, variable names and data values. ASCII (American Standard Code for Information Interchange) and Unicode (e,g., UTF–8) are text formats that are supported by most software applications. It is not important whether ASCII or UTF–8 is used, it is more important that country specific language as well as their specific written letters, such as umlauts, should be avoided in order to ensure the interoperability.

8. **Use standard formats for date and time**
In order to avoid misunderstandings in reading dates and time, we recommend to use standardized date and time formats such as the ISO 8601 of the International Organization for Standardization (ISO). For ISO 8601 dates are given as YYYY–MM–DD and time as hh:mm:ss+00:00. The last term +00:00 indicates the offset from UTC (Coordinated Universal Time, or Greenwich Mean Time [GMT]).

9. **For species data use full taxonomic names**
Plant and animal species are often recorded in the field using vernacular names of the species. When the data is entered in a database or spreadsheet, full scientific names should be added, e.g., *Tectona grandis* L.f. The name of the author, here L.f. (Carl Linnaeus the Younger), and if possible the date it was first described should be included. Species names sometimes change over time, or the same species name is used for different species and can only be distinguished by the author's name, e.g., *Viola montana* L. and *Viola montana* Juzepzuk.

10. **Use meta–data to describe and organize datasets**
As has been mentioned above, meta–data (i.e., data about data) is important to be able to put data into context. Moreover, meta–data is essential for effective data management. This holds particularly true if a wide range of data types and

(file) formats are used, as it is the case for data related to biodiversity in South Sumatra and elsewhere. Meta–data can be added to a dataset in many different ways. The simplest way to create meta–data for a data file is to create another file that holds the meta–data. A number of organizations developed meta–data standards for a wide variety of applications.

A relatively simple and widely applicable meta–data standard is the Dublin Core Metadata Initiative (DCMI). The Dublin Core is a set of terms which can be used to describe datasets. Originally, the Dublin Core comprises 15 terms, which are known as the Dublin Core Metadata Element set. Those elements can and have been refined in the past. Out of the core elements and their refinements one can choose those terms which are useful or relevant for a given datasets. A possible DCMI code example[2] for the forest inventory dataset is shown in Figure 2.8. As shown, relevant terms were chosen from the core elements (title, creator, subject, description, publisher, contributor, date, type, format, language, coverage, rights). Of course, different elements and refinements may be chosen according to what is needed.

In addition to the DCMI — a very versatile and widely applicable meta–data standard — many other standards have been proposed. For the BIS, metadata standards for datasets containing information about biodiversity or other ecological data seem to be most useful. One example for a widely used standard for biodiversity data is the so-0called “Darwin Core”[3] which is a continuation of the DCMI. Wieczorek *et al.* [2012] give an overview of the development and the application of Darwin Core. They note that information on biodiversity has to be “in digital form, accessible, discoverable, and integrated” [Wieczorek *et al.*, 2012]. The Darwin Core was developed in order to create a standard which is complementary to general meta–data standards and makes biodiversity data sharable. Therefore, the Darwin Core, like the Dublin Core on which it is based on, also consist of a defined set of terms. In contrast to the Dublin Core, the terms of the Darwin Core are grouped into nine categories. Six of those nine categories (event, location geological context, occurrence, taxon and identification) are related to the biodiversity field.

Table 2.1 shows the nine categories of Darwin Core. Those categories can be divided in “Simple Darwin Core” and “Generic Darwin Core”. The Simple Darwin Core represents descriptive data which may be available in one file consisting of one row per record and one column per term. The Generic Darwin Core consists of two additional variables for data which cannot appropriately be represented in the Simple Darwin Core Wieczorek *et al.* [2012].

Since many biodiversity datasets have a spatial component, it is important to handle this spatial information appropriately, too. Similar to biodiversity data, meta–data standards exist for spatial data. For Indonesia, standards for spatial data

[2]See: `http://wiki.dublincore.org/index.php/User_Guide.`
[3]See: `http://rs.tdwg.org/dwc/terms/`

Table 2.1: Darwin Core Categories divided in Simple and Generic Darwin Core (taken from Wieczorek *et al.* [2012]).

Record–level Terms	Dublin Core terms, institutions, collections, nature of data record	Simple Darwin Core
Occurrence	Evidence of species in nature, observers, behavior, associated media, references	Simple Darwin Core
Event	Sampling protocols and methods, date, time, field notes	Simple Darwin Core
Location	Geography, locality descriptions, spatial data	Simple Darwin Core
Identification	Linkage between Taxon and Occurrence	Simple Darwin Core
Taxon	Scientific names, vernacular names, names usages, taxon concepts, and the relationships between them	Simple Darwin Core
GeologicalContext	Geologic time, chrono-stratigraphy, biostratigraphy, lithostratigraphy	Simple Darwin Core
ResourceRelationship	Explicit relationships between identified resources (e.g., one organism to another, taxon to location, etc.)	Generic Darwin Core
MeasurementOrFact	Measurements, facts, characteristics, assertions, references	Generic Darwin Core

management can be found in the Dictionary of Spatial Data for Forestry (Kamus Data Spasial Kehutanan) by the Ministry of Forestry (Kementerian Kehutanan).

Integrating meta–data into the BIS should be kept as simple as possible. When a dataset is to be uploaded to the BIS, the contributor should fill in the meta–data in text field that have been defined during the planning and implementation of the BIS. A good starting point would be to use the minimum standards of the Dublin Core. Please note that once data is entered into the BIS, it will be almost impossible to add new meta–data terms.

Data analysis We mentioned several times before that biodiversity data derive from various sources. The information that might be extracted from these datasets is also extremely diverse. The BIS will not be able to cover all the possible data analysis tasks that are possible. Here, we will present a number of general hints on what one should consider during data analysis. Most of the aspects we mentioned in the last subsection also hold for data analysis (and they often overlap).

1. Start with a clear objective (what question will be answered)?

2. Think about data requirements and analytical methods (which data do I need? Which methods are available to answer the question? Usually, the latter two two questions are interconnected).

SUBJECT	CORE ELEMENTS	ELEMENT REFINEMENTS	DESCRIPTION
ID			
	identifier		Unique identification of the document
TECHNICAL DATA			
	format		
		extent	
		medium	
	type		Type of the document (e.g., URI of “DCMI Type Vocabulary”)
		collection	
		event	
		sound	
		image	
		text	
		physical object	
		interactive resource	
		software	
		dataset	
		service	
	language		Content language (ISO 639 country codes are recommended)
CONTENT			
	title		Title of the document
		alternative	
	subject		Subject of content as keywords (useful for search engines)
		keyword	
	coverage		Coverage of content (spatial or temporal)
		spatial	
		temporal	
	description		abstract of content, and/or table of contents
		abstract	
		tableOfContents	
AUTHORS AND RIGHTS			
	creator		Name of a person or organization
	publisher		
	contributor		
	rights		Information about rights
		license	
		accessRights	
NETWORKING			
	source		Resources used
	relation		Refers to other documents that are related to the given document
		references	
		isReferencedBy	
		hasFormat	
		isFormatOf	
		hasVersion	
		hasPart	
		isVersionOf	
		isPartOf	
		replaces	
		isReplacedBy	
		conFormsTo	
TIMEPOINT			
	date		
		dateCopyrighted	
		created	
		dateSubmitted	
		modified	
		dateAccepted	
		issued	
		available	
		valid	

Figure 2.8: Dublin Core Element Set and element refinements.

3. Consult with experts on the subject matter, as well as on the methods and data if these are unfamiliar to you. In the BIS, look for documentation and other information about similar studies.

4. If data is already available (either in the BIS or elsewhere), carefully check if the data can be used to answer the question under study. This is why proper documentation and the availability of meta–data for datasets uploaded to the BIS is so important.

5. Often data from different sources are used for the analysis. Carefully investigate whether the sources are consistent and if and how they can be integrated.

6. Always (always) document your work!

7. Use, whenever possible, scripted languages and/or software packages for the data analysis such as R [R Core Team, 2016]. Scripts with informative comments are extremely useful for documentation.

Data plausibility checks Before data is uploaded to the BIS it should be carefully checked for errors and inconsistencies. What constitutes an error or inconsistency is highly context dependent. Whereas a data point may be likely in one instance, the same value might be highly unlikely or even impossible in another.

Data is recorded on different measurement scales, e.g., nominal, ordinal, or metric scales. The nominal scale refers to qualitative data. Each data point belongs uniquely to a specific category. Sex (male or female) or profession are examples of variables recorded at the nominal scale. In forestry, the tree species is an example of a nominally scaled variable. There is no natural ordering of categories. In contrast, ordinal scaled variables contain more information; they can be ordered. School grades are a classical example of an ordinal scaled variable. Note however, that differences between data points may not be interpreted. For example, an A+ is not as twice as good as a B+. To reliably interpret differences, variables measured at a metric scale are needed. Temperature in degree Celsius is an example of a interval scaled variable. The origin, i.e., zero degree, is a defined origin (the temperature at which water starts to freeze). In contrast to interval scaled variables, ratio scaled variables have a natural origin. Length, width, time or weight are examples of ratio scaled variables.

When data is checked for errors and inconsistencies plotting the data is is usually a good starting point. Plots may look very different depending on whether nominal, ordinal are metric scaled variables are displayed. Figure 2.9 Shows a frequency plot of the different tree species from the example forest inventory dataset (Figure 2.6). The first "species" in the figure is not actually a species but a hyphen that indicates that the species was not recorded for the given tree (or was unknown to the tree spotter). This error was introduced during data editing. If a value for a variable is not available, the cell should be left empty. Do not use a hyphen or "unknown" to fill empty cells. The error can easily be removed by removing all hyphen from the dataset. However, before you remove all hyphen carefully check if there is a variable that holds data like

"–" and "+" (minus and plus). Such a values may indicate a binary variable: negative and positive. If this is the case, use 0 for minus and 1 for plus instead.

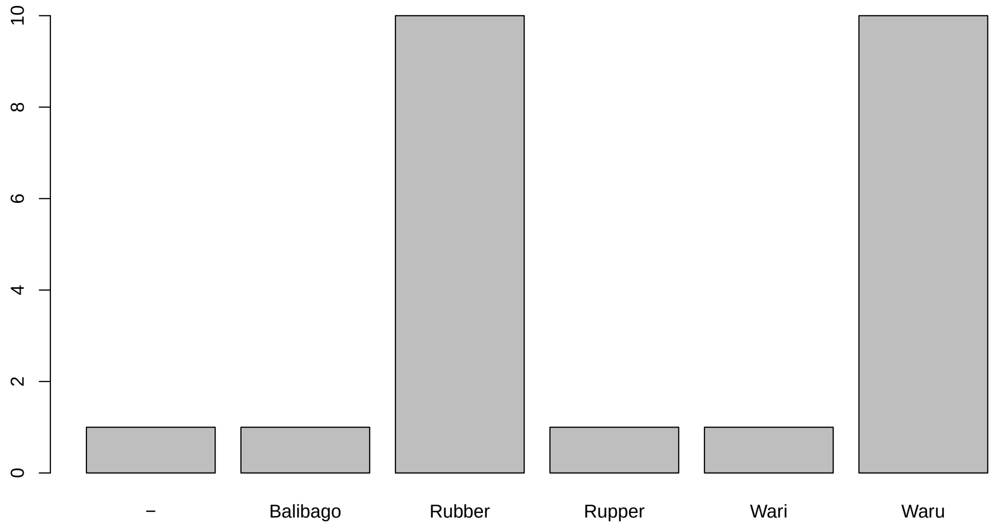

Figure 2.9: Frequency plot (barplot) of the different tree species from Figure 2.6. The plot was created using the statistical language and software R [R Core Team, 2016].

The second species is "Balibago". The Waru tree (*Hibiscus tiliaceus* L.) is called Balibago in Tagalog, a language that is spoken by about one quarter of the population of the Philippines. "Errors" like this are particularly hard to detect, but not uncommon. For a single species there are often different vernacular (or common) names. Carefully check if different vernacular names have been used for the same species. To prevent errors of this kind use scientific names instead. However, even if you use scientific names the problem may not be solved. For the Waru tree there are at least two scientific names *Hibiscus tiliaceus* L.and *Talipariti tiliaceum* (L.) Fryxell known in the literature.

The forth and fifth species in Figure 2.9 are "Rupper" and "Wari". Its very likely that these are simply typographical errors (or "typos"). Check carefully if these two species exist. Typos may increase species richness in a given area unintentionally.

The variable stem quality (stemquality; see Figure 2.7) indicates the quality of a stem — from a commercial perspective. Suppose that in a field manual five classes are given for stem quality. The field team has to classify each tree into one of these five classes. Figure 2.10 Shows a frequency plot of the different stem quality classes. The figure shows six classes; class 8 is impossible and therefore an error. In order to detect such an error it is important that the data analyst has access to the field protocol that describes how attributes are recorded. Plots are most useful to detect errors for ordinal scaled variables.

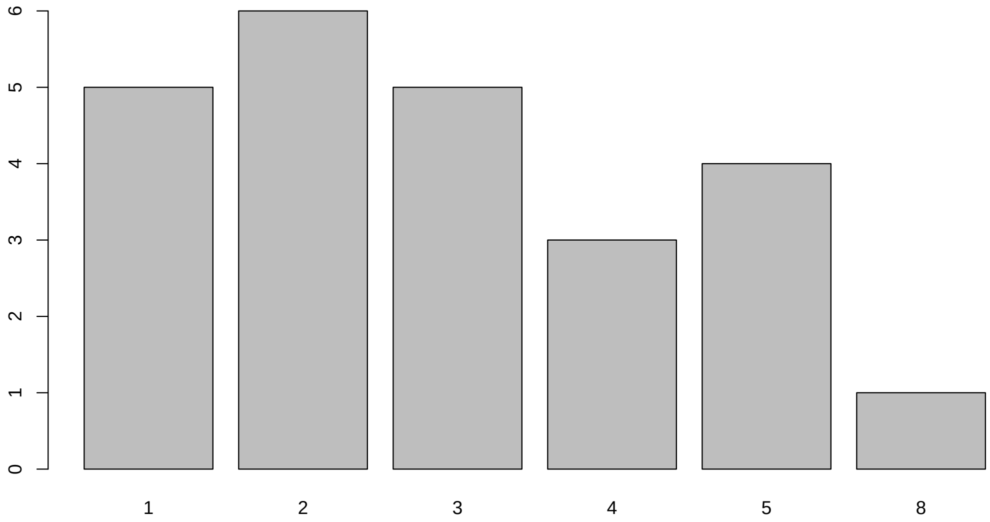

Figure 2.10: Frequency plot (barplot) of the different stem quality classes from Figure 2.6.

The variable “height” gives the height of a tree in meters. Theoretically, height values can be in the interval zero to infinity, or [0, ∞]. Of course there is an upper limit of how large a tree can grow. However, from a data analyst (statistical) point of view, trees can grow infinitely large.; but a negative value of for tree height is not possible. The height measurement of the fifth tree on plot 104 is therefore incorrect, or was wrongly edited. One should either recheck the tree in the field or field form, or, when this is not possible, remove the value. To detect errors of these kind, plotting the values is often useful. Figure 2.11 shows a boxplot of height values. The negative height value can easily be spotted.

The value for tree height of tree number three on plot 103 is “broken”. Tree height is a ratio scaled variable, again [0,∞], and should, therefore, only contain numerical values and no character strings such as “broken”. If you add the string to one of the cells of the variable, most software packages will recognize all values in the entire column as a “character string”. This means that numbers, e.g., 32, will also be treated as characters and not as a numbers (you can not do calculations with them anymore). If you want to add the information that the tree was broken, add another variable, named e.g., “remarks”, to the data table and enter “broken”.

As mentioned above, trees do not growth endlessly in height; there is a physical limit of tree height growth. As can be seen in Figure 2.11 The height of tree 10 on plot 103 is 123 m. This may be an error that may have entered the data table already in the field

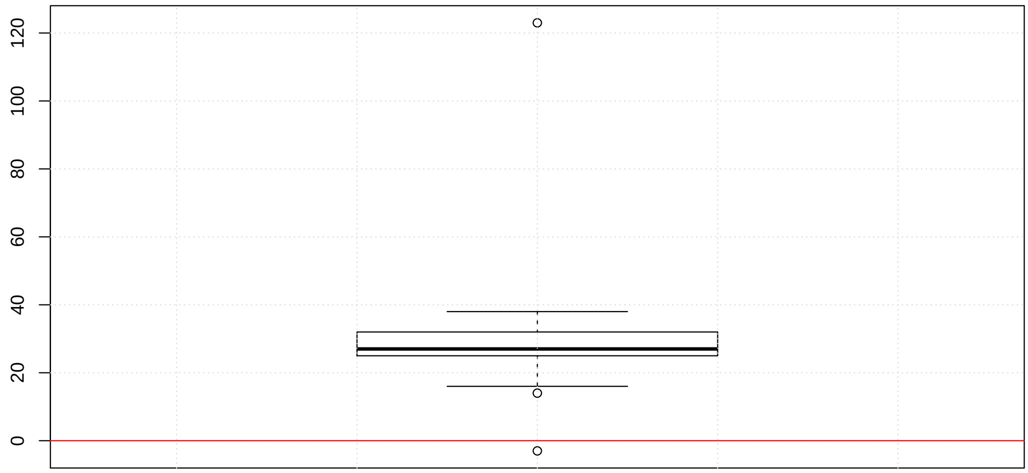

Figure 2.11: Boxplot of height values (data from Figure 2.6).

or later during editing. A boxplot of the variable height will enable you to detect and correct this error.

It might well happen that all values seem plausible for a set of variables, e.g., height and dbh measurements. Even if all values are supposedly correct, there might still be errors. Figure 2.12 shows a plot of dbh against height. The height of the tree that has a dbh of 11 cm (the first from left) looks spurious because the tree is more than 35 m tall. This might be an error. The tally sheet of plot 103 should be checked if the error was introduced during data editing. If the same values can be found in the tally sheet, one has to check whether the height value or the dbh value is incorrect. This may require to revisit the tree in the field. Just removing the tree from the data table is risky. If one is interested in e.g., biomass, and the tree is indeed 38 m high, it contributes a lot to total or plot level biomass. Removing the tree from the data table may significantly change the results and, thus, the interpretation of the results.

In the above example, we plotted two variables against each other. If there are many metric variables you should plot them all against each other. At least those variables for which the relationship can be interpreted. In this way errors or suspicious values may be easily spotted.

Above we showed different techniques how errors or inconsistencies can be checked for a forest inventory dataset. However, the methods described may be used for almost any dataset. We mentioned several times that plotting the data is often a useful first step for plausibility checks. For nominally and ordinal scaled variables we recommend to

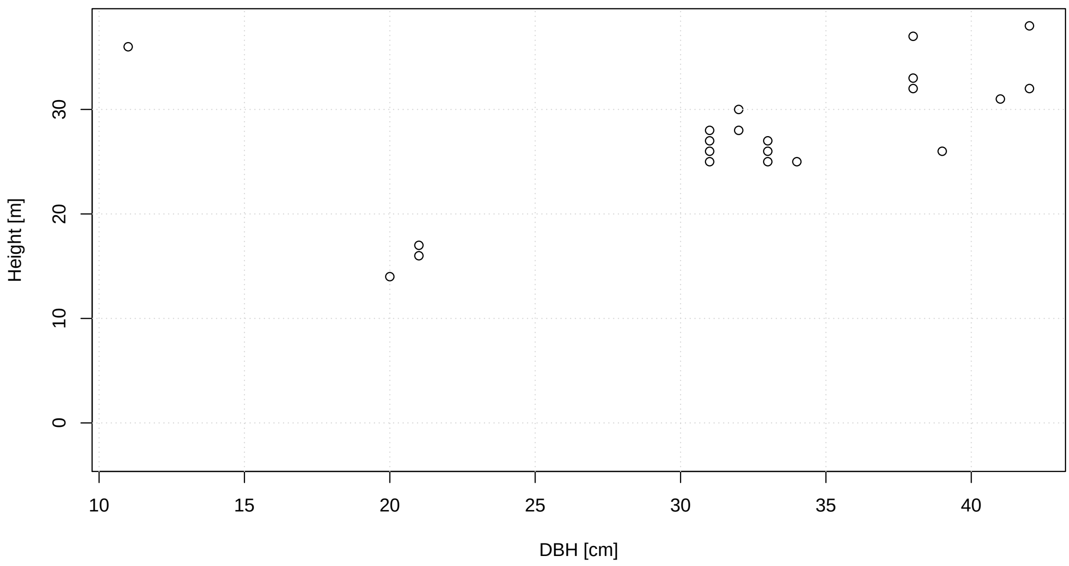

Figure 2.12: Scatterplot of dbh vs height of trees (data from Figure 2.6).

use barplots or pie charts. For metric scaled plots, cleveland plots or scatterplots (and scatterplots matrices) are useful. To combine metric and ordinal or nominally scaled variables boxplots are usually a good choice.

Once all errors and inconsistencies have been removed from the tree data, the tree data table may look like in Figure 2.13. The data table can now, together with the supplementary information, be uploaded to the BIS.

2.2.3 Map of protected areas

The sub-component "Map of protected areas" provides a map of protected areas in South Sumatra. An example map is shown in Figure 2.14. The map can be found on the following website: `http://webgis.dephut.go.id/ditplanjs/index.html`. Such a map can be integrated into the BIS in may different ways, e.g., using OpenLayers, or GoogleMaps.

2.2.4 Documents and links

The number of biodiversity related (scientific) articles is enormous. A search for "biodiversity" on Google Scholar will give more than 1.7 million results (October 12, 2016). Obviously, not all of these works can be integrated into the BIS. However, some of the key works should be made accessible via the BIS. In addition, articles that have been

plotid	treeid	subplotid	dbh	height	vername	sciename	stemquality
103	1	1	31	26	Waru	Hibiscus tiliaceus L.	1
103	2		41	31	Rubber	Hevea brasiliensis Mull.Arg.	3
103	3	2	30		Rubber	Hevea brasiliensis Mull.Arg.	3
103	4	2	21	17	Waru	Hibiscus tiliaceus L.	2
103	5	2	34	25	Waru	Hibiscus tiliaceus L.	4
103	6	3	42	32	Waru	Hibiscus tiliaceus L.	1
103	7	3	21	16			1
103	8	4	32	28	Rubber	Hevea brasiliensis Mull.Arg.	2
103	9	4	38	37	Rubber	Hevea brasiliensis Mull.Arg.	3
103	10	4	10		Rubber	Hevea brasiliensis Mull.Arg.	4
103	11	4	38	33	Wari	Hibiscus tiliaceus L.	2
103	12	4	32	30	Balibago	Hibiscus tiliaceus L.	3
103	13	4	42	38	Rupper	Hevea brasiliensis Mull.Arg.	5
103	14	4	11	36	Waru	Hibiscus tiliaceus L.	8
104	1	1	31	27	Rubber	Hevea brasiliensis Mull.Arg.	4
104	2	1	20	14	Rubber	Hevea brasiliensis Mull.Arg.	5
104	3	1	33	26	Waru	Hibiscus tiliaceus L.	5
104	4	2	33	25	Rubber	Hevea brasiliensis Mull.Arg.	5
104	5	2			Waru	Hibiscus tiliaceus L.	3
104	6	2	38	32	Rubber	Hevea brasiliensis Mull.Arg.	1
104	7	3	31	28	Waru	Hibiscus tiliaceus L.	2
104	8	3	33	27	Waru	Hibiscus tiliaceus L.	2
104	9	4	31	25	Rubber	Hevea brasiliensis Mull.Arg.	1
104	10	4	39	26	Waru	Hibiscus tiliaceus L.	2

Figure 2.13: Tree data table after the data have been carefully checked (data from Figure 2.6).

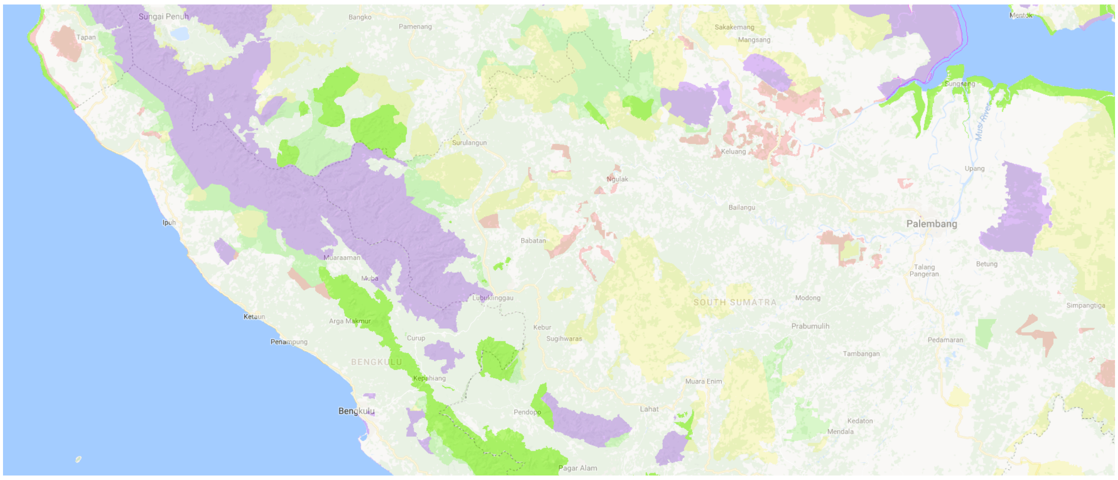

Figure 2.14: Map of protected areas in South Sumatra (The web–GIS can be found on the following website: `http://webgis.dephut.go.id/ditplanjs/index.html`).

consulted during the analysis of biodiversity data from South Sumatra should be made visible in the BIS.

Documents may either be uploaded as PDF or links may be provided. As most publishers of scientific journals request money for individual articles, one must consider copyright issues. Uploading an article to the BIS that is access restricted may cause trouble to those responsible for maintaining the BIS. It is, however, still possible to link to the article's webpage.

In addition to scientific articles, official documents such as the Indonesian Biodiversity Strategy and Action Plan (IBSAP) or the South Sumatran Biodiversity and Action Plan, as well as national and sub-national reports should be available on the BIS. Links to the CBD country profile can be provided, as well as to the Bioclime website which provides various documents for download that are relevant to the BIS

2.2.5 Indicators for biodiversity and forest degradation

2.2.5.1 Classification of biodiversity indicators

In most forests there are thousands of flora and fauna species and countless possible species interactions. In order to monitor or measure them, need arises to redefine biodiversity in terms of measurable attributes relevant to the scale and purpose for which it is to be assessed [Sarkar & Margules, 2002; Williams, 2004; McElhinny *et al.*, 2005]. Indicators are usually a measurable surrogates that allow isolation of the key aspects of a system from an overwhelming array of signals, to describe and monitor biodiversity. To be able to evaluate management performance against conservation goal, indicators need to reflect changes taking place at various levels in the ecological hierarchy from gene, to species, to complete ecosystem, including all processes of the ecosystem that maintain these various level [Noss & Cooperrider, 1994; Hunter, 1996; Lin *et al.*, 2009]. A hierarchical characterization approach of biodiversity (see Figure 2.15) includes all three major attributes of the ecosystem i.e the function, composition and structure at four levels of organization: regional-landscape, community-ecosystem, population-species, and genetic [Noss, 1990].

For the BIS, an extensive literature survey was conducted to create a list of biodiversity indicators that might be relevant for South Sumatra. A hierarchical characterization approach of biodiversity was used as a conceptual framework for identifying specific, measurable indicators to monitor change and assess the overall status of biodiversity. On the basis of the attribute they measure, indicators are defined as a structural, functional and compositional indicator.

Structure attributes of the biodiversity involve physical organization or pattern of a system, from habitat complexity as measured within stand communities to the pattern and other elements at the landscape level. Heterogeneity (variation due to relative abundance of different structural components whether in vertical or horizontal plane), complexity (variation due to absolute abundance of individual structural), and scale (variation due to size of the area or the volume used to measure heterogeneity and complexity), are the major component of the structural element.

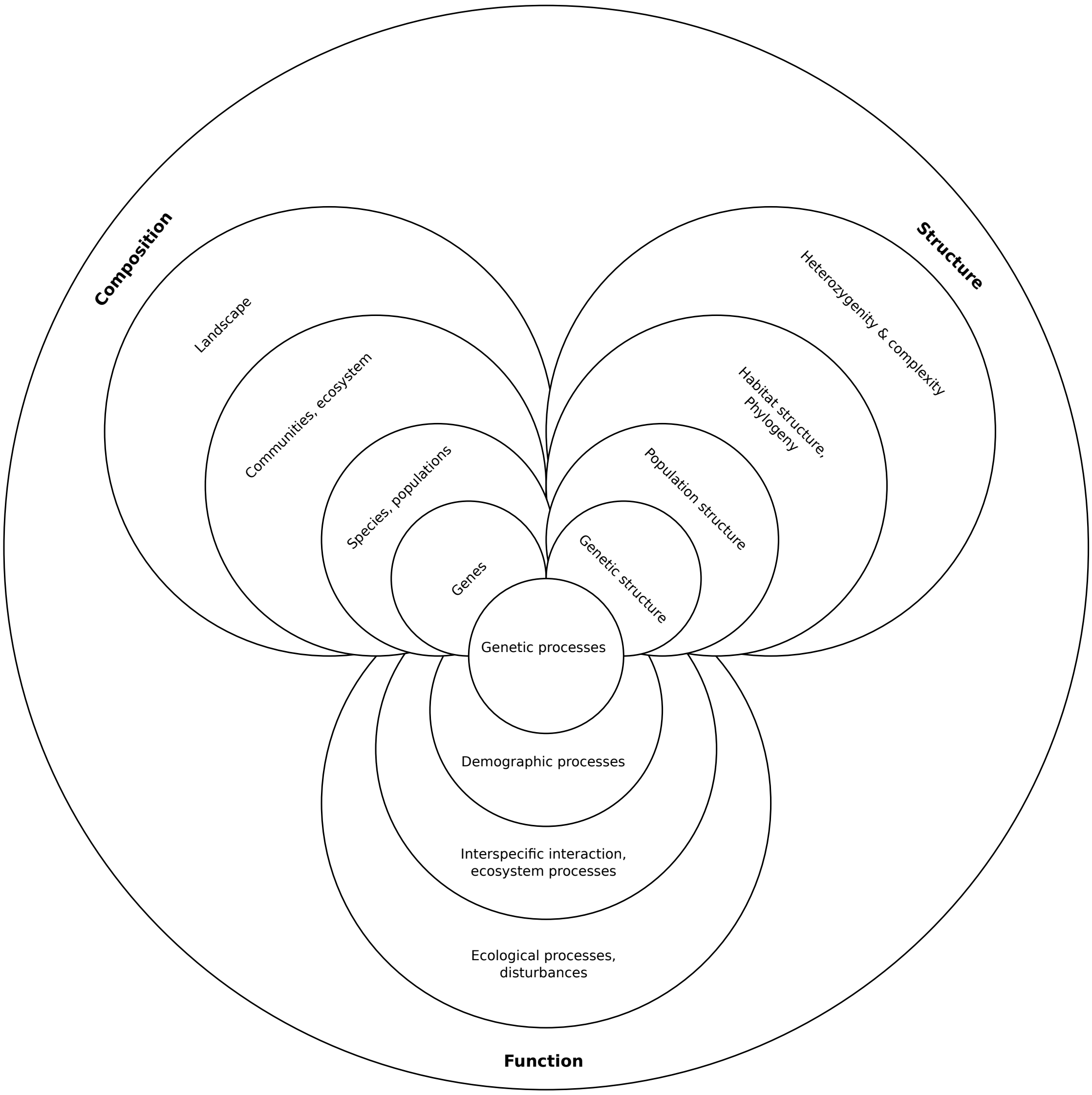

Figure 2.15: The hierarchical definition of biodiversity. Biodiversity defined as a multidimensional 'meta-concept' encompassing genes, populations, species, habitat and ecosystem. Source: redrawn from Noss [1990].

Function involves ecological and evolutionary processes including gene flow, disturbances and nutrient cycling. Many approaches of biodiversity monitoring often ignores ecological processes eg natural disturbance, the decomposition of woody debris, the cycling of nutrients, etc.), which are critical for the maintenance of biodiversity [Noss, 1990]. However, this ignorance will fail to provide complete definition of biodiversity.

Composition refers to the identity and variety of element in a collection that includes richness and abundance. The compositional indicator approach is the most commonly used measure in biodiversity monitoring.

The structural, functional, and compositional attributes of a forest stand are often interdependent and interconnected, so that attributes from one group may also be surrogates for attributes from another group [Noss, 1990; Ferris & Humphrey, 1999; Franklin *et al.*, 2002; McElhinny *et al.*, 2005]. For example, a structural attribute such as dead wood can also be a good indicator of functional attributes such as decomposition and nutrient cycling processes McElhinny *et al.* [2005]. Similarly, compositional attributes, such as species composition and abundance can be indicators of structural attributes such as canopy layering [Franklin *et al.*, 2002; Gardner, 2012]. Furthermore, measures from one scale can provide information relevant to another [Olsen *et al.*, 2007; Lin *et al.*, 2009].

2.2.5.2 Methods used to create the biodiversity indicator list

For the BIS an indicator matrix was created by researchers employed at the University of Hamburg. To ensure transparency and, to a lesser extent, reproducibility, the methods used to create the list of indicators is described in the following.

The indicator selection matrix was built up in order to organize the different levels of biodiversity, namely landscape level, habitat/ecosystem level, population /species level and genetic level. Each organizational level was further arranged into three categories: composition, structure and function.

Once the base matrix was developed, we used the ISI Web of Knowledge to review literatures. Combination of different keywords ("Biodiversity monitoring", "Indicator selection", "indicator", "Biodiversity" and "Forests") were used. During the search, we applied restriction to search only peer reviewed literature resources. Studies, publication and reports at the regional and at larger scales (e.g International Tropical Timber Organization (ITTO), Center for International Forestry Research (CIFOR), CBD) were also included in the study.

We conducted a quick review of the abstracts of the retrieved 562 articles and screened 52 articles that were relevant to our study. Out of 52 articles, we selected 17 most relevant papers that dealt with biodiversity indicators. Since many studies were based on the one or few attributes (e.g., structural indicators only), and at limited spatial scale (e.g., literatures involved with population level studies only), we considered four criteria to characterize and assign each indicator described in the literature to particular category: purpose of indicator (e.g., habitat quality assessment, ecological status assessment), indicator type, spatial scale, biodiversity attributes addressed. Each selected indicator was added as an entry to our pool of indicators. Altogether 62 indicators and 164 parameters/ variables were generated from the study. The set of keywords used for the literature survey might have influenced our indicator list. The final indicator matrix can be found in an accompanying document that was created for the GIZ BioClime Project by the University of Hamburg.

2.2.6 About BIS

2.2.6.1 About us

Under this sub-component the BIS should be briefly described. Users of the BIS website need information about the purpose of the BIS, why it was put in place, for what and how it can be used and how the site visitor can contribute. It should also be mentioned who is responsible for the content of the website (i.e., imprint) and who is the maintainer.

2.2.6.2 Partners

This sub-component lists all partners of the BIS. For each partner the following information should be provided:

1. The logo of the partner (in sufficient quality)
2. A brief description of the partner
3. A hyperlink to the partner's website (if available)

2.3 Technical aspects

The recommendations given in the preceding sections should be viewed as a set of suggestions how a Biodiversity Information System for South Sumatra may be structured and build up. We noted that the focus of this guideline is on the general concept and structure of the BIS. However, below we provide some hints on (technical) aspects that one should consider when the BIS is implemented as a website.

— **CMS**
It is highly recommended to use one of of the existing Content Management Systems (CMS) that have been developed to create interactive and easy to maintain websites. Examples of CMSs include WordPress[4], Drupal[5], Joomla[6], or Typo3[7]. These CMSs include features to publish, edit, index, search and retrieve content. Modern CMS clearly separate content from appearance., which is a very useful feature for future maintenance. Moreover, if the maintenance of the website is handed over to another person, he or she does not have to study all the code to understand how the systems works (and does not need to be a skilled programmer).

[4]See: `https://wordpress.org/`
[5]See: `https://www.drupal.org/`
[6]See: `https://www.joomla.org/`
[7]See: `https://typo3.org/`

- **Available datasets**
  If data is to be uploaded to the BIS, it is important to take into account the limited space that is available at the webhost hard drives or server where the data is to be stored. In particular remotely sensed data (e.g., satellite imagery) often requires lost of disk space; often several hundreds of mega–bytes or more. One should either be prepared for these amounts of data or limit the size of data files that can be uploaded to the BIS (e.g., 32 Mb). Moreover, still a few webhosts limit the amount of traffic and it is, therefore, recommended that a host is selected that does not limit traffic. This is particularly important against the background that until now, it is difficult to estimate how much data will be up- and downloaded to and from the BIS.

- **Stability and speed**
  For website users it is extremely inconvenient if the connection to a server is unstable, e.g., during data download. This holds particularly true if the speed with which data is retrieved is low.

- **Comments by users**
  Most web blogs enable users to post comments on content. If this feature is to be implemented in the BIS one have to consider the burden that comes with it (e.g., detecting and removing inappropriate comments). One needs also to clarify which BIS users are allowed to post comments.

- **User roles**
  Most CMS provide features to grant different permissions to different users. An website administrator, for example, has full access to add, remove and modify content. One should carefully think about the permissions of other users.

- **Copyright**
  Some content may be added by users that do not have the permission to do so. This can cause great trouble to those responsible for the content of the BIS. One should provide a fair warning, that users are only allowed to upload content that was created under an appropriate license. Susceptible content should be immediately removed.

- **Security**
  Everyday thousands of websites are being attacked. Security issues need to be considered when setting up the BIS. Security updates should be made frequently. User roles play an important role in this respect.

- **Language**
  The BIS is about data and information related to biological diversity in South Sumatra. Using Bahasa Indonesia as the prime language for the BIS would, therefore, make the most sense. However, users from other countries may visit the BIS. Translating the BIS content to English would broaden the potential audience.

— **Responsibilities**
Planning and implementing a website is a demanding task, often involving many different people with different expectations and expertise. It is important to as early as possible reach clarification about who is responsible for which task This does not only encompass the planning and implementation phase, but also future maintenance of the website. Many websites are badly maintained because responsibilities are not clearly defined. This may cause that, for example, hyperlinks are not updated, content is outdated, or security issues arise because the application is out of date. This holds true also for the BIS. We recommend that a single individual is identified that is responsible for overall site maintenance. It does not mean, that this individual has to be a skilled website administrator or programmer. It is, however, important, that a person with decent insights into the BIS and can be contacted if problems occur.

— **Displaying the most recently added content on the landing page**
The landing (or front) page is the webpage a user will be directed to if he or she visits a web-address such as https://www.cbd.int/. The front page is usually the page a user will see first when he or she is visiting a website. It is important that the menus of the site are clearly structure, such that the user easily finds what he or she is looking for. Users that frequently visit a website are often interested what changed since he or she visited the site for the last time. In a CMS it is relatively easy to display a disclaimer of the most recent added content. Such a feature could also be made available in the BIS.

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