BIODIVERSITY IN THE BAMBOO PLANTATION VIDIGUEIRA

- research report -

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for

BambooLogic

OUTLINE

Preliminary note

References

All subsequent images in the present report, which do not include numbering, are photographs taken by the author. Therefore, the source is not indicated in the list of figures.
Refering to the text, if no explicit source is mentioned, the statement can be attributed to the author.

1. Significance of biodiversity

In 2015, the United Nations, with all its 193 members, adopted „The 2030 Agenda for Sustainable Development." That marked a significant step towards a more sustainable future for nature and human beings. This agenda includes the 17 Sustainable Development Goals (SDGs), which unite all the necessary fields of action for a fairer future. It can be understood as a call for urgent action by all countries in a global partnership.

Goal number 15, „Life on Land," refers to the conservation of ecosystems and underscores the necessity of biodiversity: „Protect, restore, and promote the sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss" (United Nations, n.d.).

But what is the reason why the UN considers the protection of biodiversity as a global goal of great importance? Biodiversity plays a critical role in maintaining the balance and resilience of ecosystems. Firstly, diverse ecosystems ensure the availability of essential resources such as clean air, water, and fertile soil, which are vital for human well-being. Secondly, biodiversity fosters the stability of ecosystems, making them more resistant to disturbances like climate change and disease outbreaks. Finally, diverse species contribute to the functioning of ecosystems by performing various ecological roles such as pollination, nutrient cycling, and pest control (Bayerische Akademie für Naturschutz und Landschaftspflege, 2018; WWF, 2020).

Therefore, biodiversity is fundamental for a well-balanced ecosystem. The report at hand is an inventory of biodiversity in the bamboo plantation of Vidigueira/Portugal. Generally, biodiversity encompassess three levels: the variety of ecosystems, the diversity of species, and the genetic diversity within species. This report is focused on the diversity of species, since the investigation is focused in just one ecosystem and the genetic diversity is not studied (Bayerische Akademie für Naturschutz und Landschaftspflege, 2018).

The aim of this report, along with the previous investigations, is to determine and assess the status quo of the biodiversity on the bamboo site so then it can serve as a basis for future investigations. It facilitates the comparability of the present state with a more developed state, as well as comparisons between different seasons.

The report will be the foundation for analyzing in the future whether bamboo plantations like Vidigueira can be a possibility to protect or even improve biodiversity.

2. Bamboo plantation in Vidigueira and its abiotic factors

Vidigueira is a city in the South of Portgual in the region of Alentejo. The region is known for its desertic climate, meaning in summer time hot days and big variation in night temperature. In Winter temperatures fall down to minus degrees. The bamboo site has an area of around 10 ha and is parted in five sectors (Appendix 1). When the first inventory of biodiversity was taken in May 2023 the bambu plantation was established for already five years from 2018 (for all data see appendix 2). The investigation time in May was chosen because it is a lush vegetation period what makes it easier to perceive all the species visually.

ABIOTIC FACTORS in the air

All year there is an average rainfall of 571,8 mm, while the percipitation is concentrated in the period from October to March. The month with most rainfall is November and therefore Vidigueira belongs to the winter-wet subtropics.
In Vidigueira, the average summer humidity stands at 62%. In winter, the humidity rises significantly to an average of 89%, resulting in a noticeably more humid atmosphere.
When it comes to temperature, the summer season brings an average of 21°C. The hottest month is August with a temperature average of 24,3°C. Maximal tempertures of 45,2 °C were measured in July. In contrast, during winter, the average temperature drops to 9.6°C, signaling colder conditions. The region of Alentejo, where Vidigueira is located, is therefore part of the warmest region in Portugal, characterized by average temperatures above 21 degrees Celsius for six months. The months from May to September are extremely low in precipitation. These extreme weather conditions require a special adaptation of the flora and fauna (ICNF n.d., pp. 9-13; laenderdaten.info, n.d.).
For the composition of the air nitrogen and oxygen and carbon dioxde were measured. The numeric value of nitrogen is 1-1,3g/kg, and oxygen and carbon dioxide results in 430ppm (together 21% in air).
In summary, the given data indicates a normal composition of air, with nitrogen being the main component, followed by oxygen and a small amount of carbon dioxide. There are no unusual values that suggest significant air pollution or other deviations from the norm.

ABIOTIC FACTORS in the soil

The soil in this particular location exhibits a pH value of 6.3, indicating a slightly acidic to neutral condition. The presence of organic matter is measured at 1.10%, suggesting a moderate level of organic material within the soil. The composition of nutrients in the soil of Vidigueira results in the following numbers and appreciation (all values in mg/kg): Potassium 116 (high), Phosphorus 43 (low), Calcium 556 (low), Iron 117 (very high) and Magnesium 158 (very high). The cation exchange capacity (CEC), „(...) a measure of the ability of a soil to hold cations by electrostatic attraction“ (M.A.A. Wijayawardena, M. Megharaj, R. Naidu, 2016) results in 4,61 cmol/kg (low). And the soil texture is caused by 41% sand and 16% clay.
In conclusion, the soil in this location has favorable pH, moderate organic matter content, and high levels of potassium, iron, and magnesium. However, the low phosphorus and calcium levels, as well as the relatively low CEC, should be taken into account for optimal plant growth. Proper nutrient management and amendments are necessary to ensure the soil's fertility.

3. Bamboo plantation in Vidigueira and its biotic factors

3.1 Assessment of flora (Braun-Blanquet methodology)

In chapter 3.1.1 to 3.1.3 the observations are focused on floristic biodiversity inside the bamboo plantation. The assessment methodology of biodiversity in the area is refering to Braun-Blanquet.
The Braun-Blanquet vegetation assessment, also known as the Braun-Blanquet method or phyto-sociological approach, is a widely used technique for studying and classifying plant communities. It was developed by Josias Braun-Blanquet in the early 20th century and has since become a fundamental tool in vegetation ecology. It involves quantitative observations of plant species composition and their relative abundances within a given area (Appendix 3). To simplyify the assessment of the biodiversity the methodology is used as a guidline but not straight applied. Within on site an area of one to one hundred square meters is studied depending on the typ of land (Figure 1). When examining a rural field or fallow land, the inventory is conducted over an area ranging from 10 to 50 square meters. If the study area pertains to a field of ruderal vegetation, the typical range investigated is between 20 to 80 square meters. In the current study, the author has opted for a size falling between these two categories. Within the bamboo plantation, no tree layer is present, with the primary focus resting on herbaceous vegetation alongside minor shrubbery. Thus, an area measuring 5x5 meters has been selected as the sampling area, yielding a total of 25 square meters, which lends itself well to analysis.
The plant identification is done by the author and verified by Flora incognita (Brunzel, 2021; Gali-Izard Research Group, n.d. ; Spektrum der Wissenschaft, n.d.; Willig, 2023).

METHODOLOGY

1.	Selection of sample area	--> bamboo site Vidigueira (ca. 10 ha)
2.	Plot establishment	--> build a frame (here 5x5m = 25m²); applied on the first sector (Figure 1)
3.	Data collection	--> record of all species of the plot (inside the frame) --> remove frame and repeat 3. and 4. for at least five times per sector („data collection“ and „species abundance“)
4.	Species abundance	-->1. indication of coverage (Figure 1.1) (here simplified to a scale of 3 level: low/middle/high; see below) Assessment expand by following parameters (see 3.1.1 to 3.1.3) 2. location: distinction whether the species was found inside the bamboo field or in the edge areas 3. degree of extinction: distinction whether a low or middle degree of extinction 4. floristic state: distinction whether the species is native or non-native 5. sector: indication of specific sector where species were found
5.	Vegetation description	--> in chapter 3.1.5 information about dominant and characteristic species and overall structure of plant community
6.	Vegetation classification	--> in chapter 3.1.5 information about classifying plant communities into different vegetation types

PLOT ESTABLISHMENT

In Mitteleuropa können folgende Flächengrößen als Richtwerte gelten:

Vegetationsbestand	Aufnahmefläche
Trittrasen	0,5 bis 1 m²
Wiese und Weide	5 bis 25 m²
Ruderalflur und Brache	10 bis 50 m²
Ackerkrautschicht	20 bis 80 m²
Wald und Forst	100 bis 500 m²

Figure 1

SPECIES ABUNDANCE

Score	Modified Score	Description
N	0.1	Not many, 1-10 individuals
T	0.5	Sparsely or very sparsely present; cover very small (less than 5
1	1	Plentiful but of small cover (less than 5%)
2	2	Any number of individuals covering 5-25% of the area
3	3	Any number of individuals covering 25-50% of the area
4	4	Any number of individuals covering 50-75% of the area
5	5	Covering more than 75% of the area

Modified Braun-Blanquet (1932) scale estimating cover/abundance as per Heard and Channon (1997).

Figure 1.1

<u>Coverage simplified to</u>

low = N + T + 1 (< 5%)

middle = 2 + 3 (5 to 50%)

high = 4 + 5 (50 to >75%)

3.1.1 Plant list - bulb plants

<u>LEGENDE</u>

location: ◉ central area; ○ edge area

degree of extinction: □ low; ▭ middle

floristic state: native; non-native

coverage: I < 5%; II 5 to 50%; III 50 to >75%

sector: 1 2 3 4 5

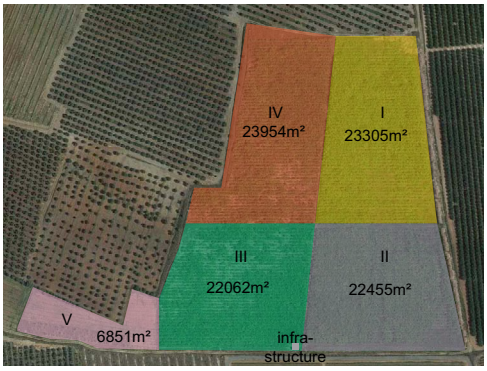


Figure 2

○ I 3 *Allium cepa*

◉ II 1-4 *Arisarum vulgare*

○ I 2 *Gladiolus italicus*

◉ III 1-4 *Oxalis pes-capra*

○ II 3-5 *Scirpoides holoschoenus*

3.1.2 Plant list - shrubs

LEGENDE

location — central area | edge area | both

degree of extinction — low | middle

floristic state — native | non-native

coverage — I < 5% | II 5 to 50% | III 50 to >75%

sector — 1 | 2 | 3 | 4 | 5

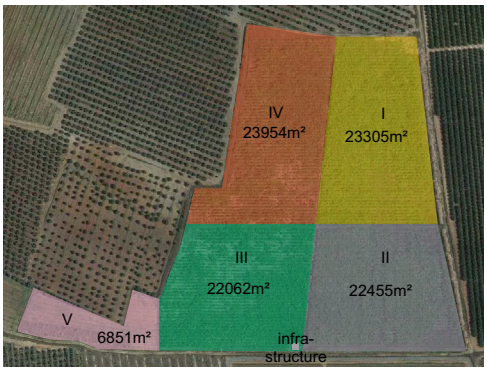


Figure 2


○ ● II 1-2
Anthemis arvensis


○ ● II 1-3
Anthriscus sylvestris


○ ● II 1-5
Avena fatua


○ ● II 1 2
Briza maxima


○ ● II 1-2
Calendular arvensis


○ ● I 2
Carduus pycnocephalus


◉ ● III 1-3
Chenopodium album


◉ ● III 1-4
Convolvulus arvensis


○ ● II 1-5
Daucus carota


○ ● III 1-4
Diplotaxis tenuifolia


○ ● III 2-5
Dittrichia viscosa


○ ● I 4
Echinops ritro

1-5
Echium plantagineum

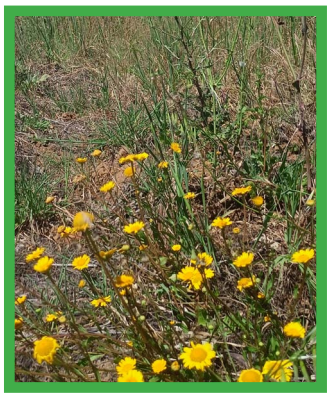
1-4
Epilodium hirsutum

2
Epilobium tetragonum

1-2
Erodium botrys

2-3
Foeniculum vulgare

1-4
Galium aparine



1-2
Glebionis segetum

1-4
Heliminthotheca echioides

1-5
Hordeum murinum

4-5
Hypericum perforatum

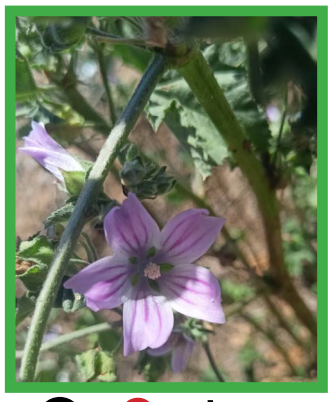
2-3
Hypochaeris glabra

2-5
Jacobaea vulgaris

1-2
Lathyrus annuus

1-4
Lolium perenne

1-4
Lysimachia arvensis



2-3
Malva sylvestris

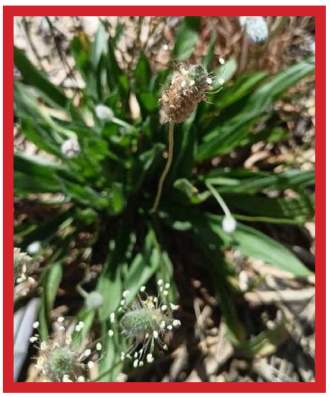
3
Medicago polymorpha

1-4
Misopates orontium

2
Ornithopus compressus

1-3
Paronychia argentea

1-2,5
Phleum pratensis



1-4
Plantago lagopus

2
Plantago lanceolata

1-4
Raphanus raphanistrum

3
Rubus rubus sect.

3-5
Rumex pulcher

4
Santolina rosmarinifolia

1-5
Sonchus asper

3
Stachys arvensis

1-4
Vicia villosa

2
Vitis vinifera

3.1.3 Plant list - grove

LEGENDE

location: central area; edge area

degree of extinction: low; middle

floristic state: native; non-native

coverage: I < 5%; II 5 to 50%; III 50 to >75%

sector: 1 2 3 4 5

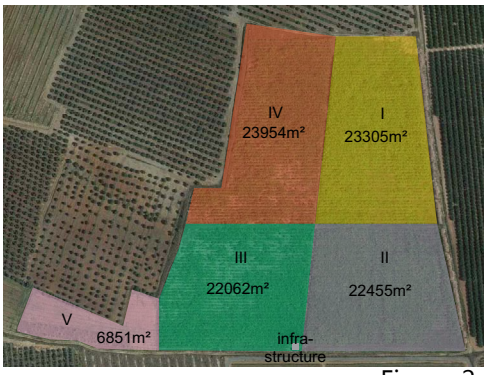


Figure 2


1-4 *Fraxinus angustifolia*


1,4,5 *Olea europaea*


2,5 *Populus alba agg.*


1 *Quercus coccifera*


1 *Quercus ilex*

3.1.4 Vegetation in the surroundings

The plantation is surrounded by intensively cultivated areas (see picture below). According to the author's assessment, these arable lands are considered extremely barren in terms of biodiversity. Apart from the desired crops, there are hardly any other plant species present. The main crops cultivated are grapes, almonds, olives, and grains. Only a small portion of the land is left uncultivated and can be considered grassland. Along a few pathways, there are rows of trees.
Individual plants, coming from these surrounding fields, can be found in the bamboo site (see plant list, chapter 3.1.1 to 3.1.3).
It should be noted that the comparison between the bamboo plantation and the surrounding areas reveals a significantly higher biodiversity in the bamboo plantation.

Figure 3

3.1.5 Flora discription and classification

The following text is a conclusion drawn by the writer based on the investigation (and the plant identification verified by Flora incognita n.d).

On the investigated area of all five sectors there were counted 52 different plant species (5 bulb plants, 43 shrubs and 4 trees). The author consolidate the five sectors into three different vegetation zones, indicated by different plant species (Figure 4).

Firstly, there is the central area where *Phyllostachys edulis* is cultivated and dominates. The central area corresponds to sectors 1-4 (Figure 2). 10 different plant species were assessed. The specific net of rhizomes of *Phyllostachys edulis* covers the entire area. Rhizomes are the formation of the underground shoot system, that is spread in the upper soil layer up to a depth of 30cm. *Phyllostachys edulis* forms leptomorph rhizomes with long and slender form. In this case, new shoots develop from the nodes, which are located along the rhizome. As a result, the rhizome network of *Phyllostachys edulis* spreads widely and effectifly. Special measures need to be taken to control the spread of the rhizomes. In Vidigueira drainage ditches are built a natural dispersal barrier. Despite these measures, regular checks should be carried out to assess the invasiveness of *Phyllostachys edulis*, ensuring that the planting does not spread uncontrollably (Crouzet et al. 2003; Eberts, 2008).

The foliage growth of *Phyllostachys edulis* forms a dense canopy, blocking direct sunlight from reaching the ground after five years of plantation. The bamboo poles can reach up to 4m in height, creating a sheltered environment from wind and heat. Since *Phyllostachys edulis* is an evergreen plant, this characteristic holds true throughout the year. Notably, there is a layer of leaves on the ground as *Phyllostachys edulis* consistently sheds its leaves. The biomass remains on the ground, decomposes slowly and generates soil.

Apart from the dominant bamboo species, there is a herbaceous layer covering approximately 20% of the ground and some trees like *Fraxinus angustifolia, Olea europaea* and *Quercus ilex* try to develope. The herbaceous species exhibit low growth and limited biodiversity. The most frequently observed species are *Arisarum vulgare, Convolvulus arvensis, Galium aparine*, and *Oxalis pes-capra*. It is noteworthy that two out of these four species are bulb plants, which have underground organs that allow them to survive in challenging conditions. In this case, the challenging condition could be the absence of direct sunlight due to the dominance of Phyllostachys edulis.

The central area can be classified as *Phyllostachys edulis*-dominated with a low-growing herb layer. It is a relatively non-biodiverse area as *Phyllostachys edulis* has an invasive tendency. At the same time it is shady, well-protected area from extreme weather influences such as strong winds and temperature variations.

The area with the clumping bamboos can be considered as a second vegetation zone, characterized by this growth habit (Figure 4). The distinctive feature of this area is the presence of tropical bamboo species, specifically *Bambusa*. Beside *Bambusa* 13 other species of plants were discovered in this zone. The genus *Bambusa* has a clumping growth habit, unlike *Phyllostachys edulis*, which spreads extensively. As a result, the clumping bamboo area is much brighter since the individual plants grow independently and do not form a dense arboreal layer. This condition allows other species to grow more easily, resulting in a higher biodiversity. Thus, the clumping bamboo area can be characterized as a biodiverse and well-illuminated area.

The third vegetation zone comprises the edge areas, including the belt around sectors 1 to 4 and the paths in between (Figure 4). Here 47 species of plants were assessed, thus it is the zone with the highest diversity of plant species. The area is almost entirely covered by plants, except where cars and machinery pass and the soil is too compressed. The high plant coverage protects the soil from erosion, enhances soil life, and prevents soil degradation. This area exhibits a high biodiversity, with a significant presence of insects. The vegetation consists mainly of shrubs and annual plants, with a layer of ground-cover plants as well as shrubs up to 2m in height.

The adjacent Phyllostachys edulis attains heights ranging from two to six meters. It casts shade over the areas of Zone 3, thereby mitigating heat stress. On more open expanses, such as the neighboring vineyards, shade is less prevalent, potentially leading to increased evaporation of wild herbs. Additionally, the bamboo's shading effect results in the accumulation of water within the surrounding trenches, diminishing the rate of evaporation. These water-filled trenches consequently establish a novel habitat (see chapter 3.2.2).

The trenches around the bamboo field are built to provide a natural barrier for the rhizoms of bamboo. A V-shaped trench is excavated around the planting area. When filled with water (from irrigation or rainfall in winter), the trench becomes even more effective, as the rhizomes exhibit an aversion to waterlogging. At the same time a new habitat is formed with the dammed water (Crouzet et al., 2003).

The characterization of vegetation zone 3 is highly biodiverse and structured by different levels of shrub vegetation.

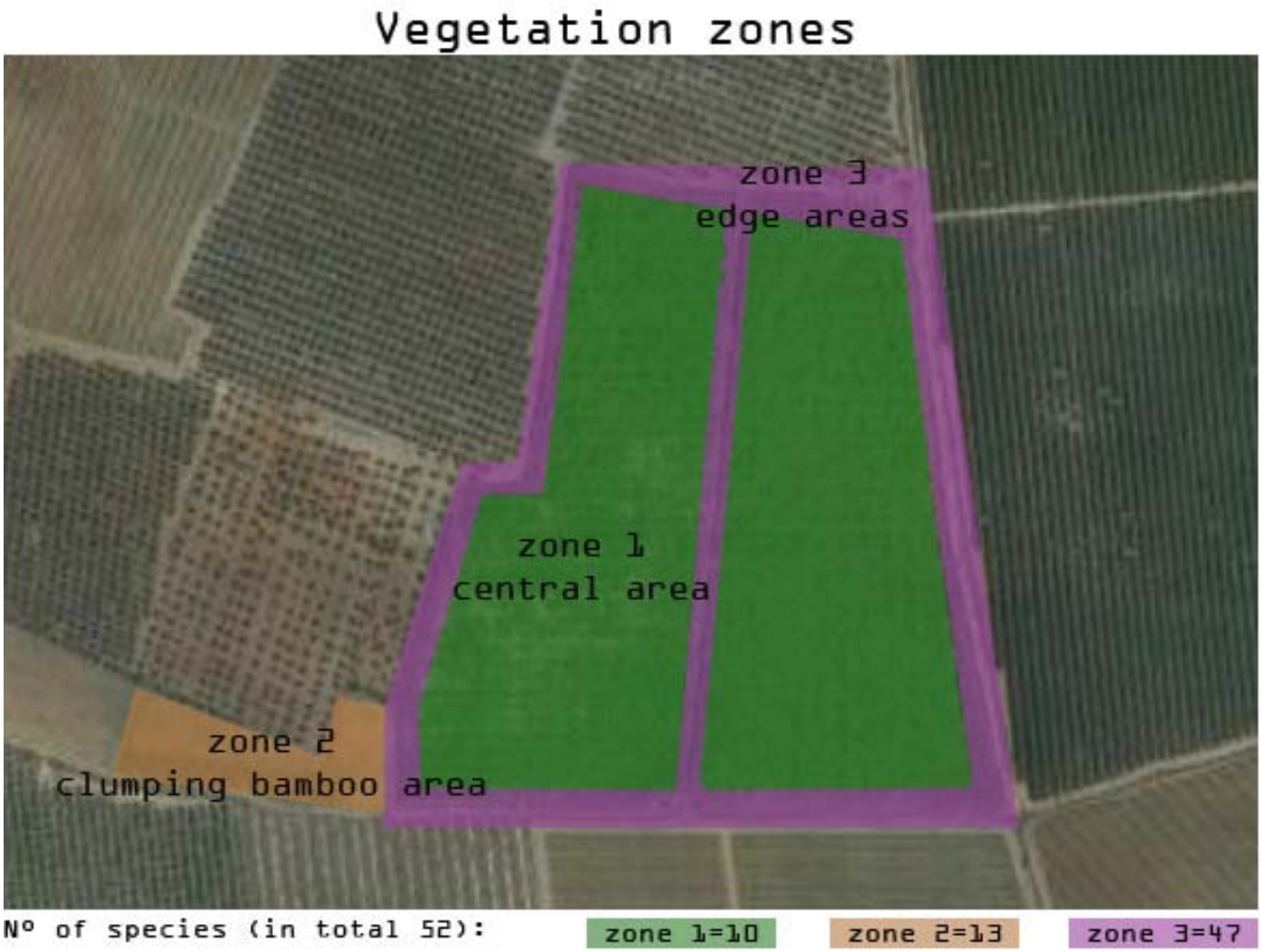
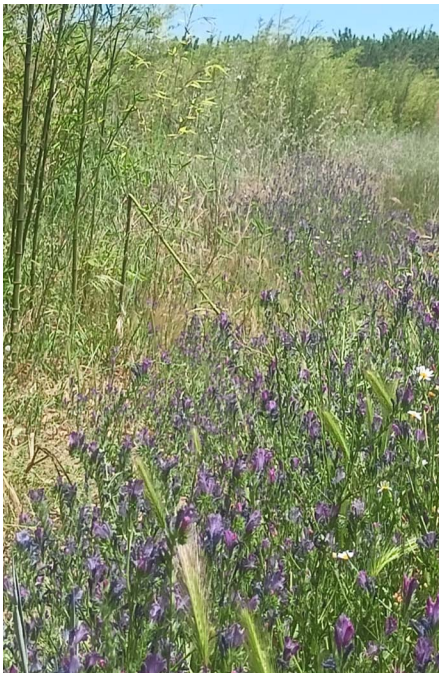


Figure 4

zone 1

zone 2



zone 3

3.2 Fauna

The survey method applied in section 3.1 specifically focuses on floristic species. For the fauna inventory, the common sighting method is employed and no specific survey methods for individual faunal groups were applied, such as territory mapping for birds, transect mapping for bats, or insect capturing with nets. The sighting method, also known as „visual survey method," is a commonly used approach to gather information on species composition and abundance in a particular area (Büro für Umweltplanung & Bildung, n.d.). However, it should be noted that it is a simple method and may not cover all aspects of fauna inventory. The requirement is to provide a general overview of the fauna. Also therefore, the animal species cannot be assigned to a specific sector or zone.
The simple sighting method was conducted through field surveys in which species were recorded based on acoustic and visual signals, such as calls, bird songs, insect buzzing, and direct visual observation.
In the following chapters 3.2.1 to 3.2.4 show the captured species that where perceived in May 2023. In 3.2.5 the faunal situation is described and can be seen as a resume of faunistic life in the site.

3.2.1 Mammals

The listed mammal species have all been sighted in the bamboo plantation by the author, except for the fox. The observer has spotted an entire family of wild boars. However, due to the animals' shyness and instinct to flee, the observer was unable to photograph them personally. The images were captured by a wildlife surveillance camera specifically installed for this purpose.
As the species of the deer is not identified, there is no further information about its state. The other three mammals are all native and non-threated of extinction (IUCN Red List, n.d.).

LEGENDE

degree of extinction

low

undefinite species

Sus scrofa
wild hog

Cervidae
deer

Lepus granatensis
iberian hare

Vulpes vulpes
red fox

3.2.2 Reptiles and amphibians

The assessment showns following species of reptiles and amphibien. Due to the green frame non of this animals are threated of extinction (IUCN Red List, n.d.). It is assumed that there are more species living in the bamboo plantation. Especially zone 3, the belt around sector 1 to 4, which is formed by trenches water-bearing, seems to be a vital habitat for amphibians.

Podarcis hispanica
iberian wall lizard
Figure 5

Psammodromus algirus
large psammodromus
Figure 6

Pelophylaxm perezi
iberian water frog
Figure 7

Bufo bufo
european toad
Figure 8

3.2.3 Birds

This report examines the bird diversity and habitat usage in a bamboo plantation. The author, although unable to capture ornithological pictures, provides subjective observations of bird activity at the plantation. Additionally, supporting figures indicate that the bamboo field serves as a habitat for various birds.

3.2.4 Insects

As described in Chapter 3.2, no specific trapping method was employed during the inventory of insects. The insects were merely observed and photographed whenever possible. Due to the complexity of the insect world, species identification could not be conducted. It is assumed that many more species inhabit the plantation. Representatives of various insect subgroups, such as beetles, butterflies, dragonflies, bees and wasps, and mosquitoes, were discovered. Microhabitats are formed around the drainage ditches surrounding the plantation (see picture on the following page), which appear to be particularly species-rich due to the accumulated water.
According to the author´s perception there were much more insects visible and hearable in the zone 2 and 3, where the vegetation is more divers.

3.2.5 Fauna discription

A limited number of four mammal species were observed. However, compared to the surrounding areas, the bamboo plantation provides habitat for a greater diversity of mammals. The conditions within and in the immediate vicinity of the plantation offer shade, visual concealment, and the area can serve as a food source. The plantation, in contrast to the surrounding monocultures, provides a habitat that is closer to natural conditions and offers shelter both in summer and winter.

The observed diversity of reptiles and amphibians is limited to four common species. Due to the high abundance of insects, which serve as a food source for amphibians and small reptiles, it can be assumed that additional species exist and further diversification is possible. Particularly for amphibians, the water ditches surrounding the bamboo plantations (see picture beside) are valuable habitats in this arid region. These water ditches are a contribute to their survival and population growth in an otherwise dry environment.

According to the observer, the bamboo forest represents a favorable and structurally rich habitat for birds. It provides a shaded environment with a dense, protective leaf canopy. The presence of abundant guano, observed on the bamboo culms and the ground, suggests a significant bird population within the plantation. The bamboo itself benefits from the guano, which serves as a natural fertilizer, enhancing its growth and vitality. Nevertheless, there is no number of bird species known.

Regarding insect life, zones 2 and 3 are particularly noteworthy. The presence of numerous flowering wild herbs in these areas attracts a diverse array of insect species, providing them food and habitat. Due to the bamboo not being harvested radically and the peripheral areas not being mowed, insects as well as other the other groups of animals find year-round habitat in these zones. This preservation of vegetation allows for sustained insect populations, contributing to the overall biodiversity and ecological balance within the bamboo plantation.

4. Threats to biodiversity in the bamboo plantation

Isolated habitat

In the bamboo plantation in Vidigueira isolated habitat can be one fact for a limited biodiversity. The plantation is surrounded by fragmented land that is intensivly used. The area is relativly limited to around 10ha and there is no connectivity to other biodivers habitat (see pictures below). Therefore, the movement of species is limited, what can lead to isolation and reduced genetic diversity.

Non-native species

The aspect of non-native species endangering the biodiversity itselfs in the bamboo plantation is assessed as low. According to the species list (Appendix 2), only two plant species are non-native, of which only *Oxalis pes-capra* is high in frequency. Since this species grows within the bamboo plants and does not appear to displace other species, its negative impact on biodiversity is considered to be low. However, it should be mentioned that the bamboo species *Phyllostachys edulis* has a strong tendency to spread due to its leptomorph rhizome network and fast growth (see chapter 3.1.5). According to Q.-F. Xu et al. (2020), the planting of *Phyllostachys edulis* bamboo itself leads to a reduction in biodiversity in tree and shrub layers. This is also the finding of the author of this study, that zone 1 is the least species-rich area with just 10 plant species despite a relativly big area.

Pesticides from surrounding

Another threat to biodiversity in Vidigueira is the use of pesticides. These chemicals may harm not only targeted pests on the surrounding fields but also non-target organisms, including beneficial insects, birds, and mammals. As evidenced by the images presented below, the adjacent agricultural soils exhibit signs of intensive cultivation. It is reasonable to assume that both herbicides and pesticides are being employed in these practices. In cases of suboptimal application, these chemical agents may inadvertently infiltrate the bamboo plantation, leading to unintended harm to individual organisms. The transmission of these chemicals via wind dispersal is particularly deemed to pose a substantial risk in this context (Isenring, 2010).

Climate change

A further risk for the suitability of the bamboo plantation as a habitat for certain species can be the changing climatic conditions, such as temperature and precipitation patterns. As indicated in Chapter 2, the climate of Vidigueira is classified as winter-wet subtropical. The ongoing climate change has brought forth a series of extreme weather events, which could potentially exert notable influences on the bamboo plantation. Specifically, the projected reduction in summer precipitation and the amplified intensity of summer temperatures may pose considerable challenges to the survival of specific species within the plantation (CBD, 2020; Europarl., 2020).

5. Strategies for biodiversity conservation in the bamboo plantation

Biodiversity conservation in bamboo plantations necessitates the implementation of various strategies to mitigate the threats (named in chapter 4) and ensure the preservation of a diverse ecosystem. Key strategies for the plantation in Vidigueira include enhancing habitat connectivity, monitoring non-native species, adopting sustainable harvesting practices, building protection against pesticide use in the surrounding, addressing climate change impacts, and conducting regular monitoring and evaluating (European Union, 2023).

Habitat connectivity

To promote habitat connectivity, it is advisable to create corridors that connect the bamboo plantation with adjacent fields exhibiting higher biodiversity, such as grasslands (Figure 3). These corridors facilitate species movement and genetic exchange, contributing to overall biodiversity conservation (Anderson, A. & Jenkins, C., 2006). The green corridors can be designed for native species, making a positive contribution to biodiversity.

Planting expansion

Similarly, native plants from Alentejo can be established at the edges of the bamboo plantation and along the property boundary. By selectively choosing, for example rare and protected species, the bamboo plantation becomes more biodiverse.

Supplement new species inbetween Phyllostachys edulis (agroforestry)

To enhance the vegetation structure, the author proposes the establishment of other plant species within the bamboo stands, thereby implementing the concept of agroforestry. By selecting native and competitively robust species, it is possible to create additional habitat for local fauna within the previously monotonous bamboo area. The specific plant species and the exact design of the area would need to be determined in a separate step of investigation and planning (DeFAF e.V., 2022). When applying this strategy, it must be borne in mind that Vidigueira is a working plantation. There will be intervention in form of harvesting, probably also with machines. Additional plantings must also not limit everyday management.

Monitoring non-native species

Non-native species like the *Oxalis pes-capra* should be monitored within the plantation. Furthermore, it is necessary to inhibit the spreading tendency of *Phyllostachys edulis* and regularly clean the trench specifically created for this purpose from new plant growth. The author recommends conducting an at least annual inspection and maintenance for this.

Sustainable harvesting practices

Sustainable harvesting practices are paramount in the bamboo plantation. The writer proposes to leave some vegetation structure intact and avoid radical harvesting. Overharvesting can deplete bamboo stands, disrupt the natural balance of the ecosystem, and directly impact species dependent on the bamboo as their habitat. In Vidigueira there are currently no regular and targeted harvests being carried out on the plantation. But in the future there are plans to make selective clear

harvests. Here, every third to fourth strip is harvested linearly and radically. On the one hand, this ensures a harvest and, on the other hand, not too much biomass is removed so that the plant can regenerate again. Strategies continue to be explored to achieve an optimal balance between harvest yield and a sustainable bamboo plantation.

Protection against pesticides

As in the planation as itself no pesticides and herbicides are applied the biodiversity is just threated by the fields around. Protective measures should be implemented to mitigate the effects of pesticide use in surrounding fields. Utilizing pesticide-resistant plants or constructing bamboo fences, whether living or dried poles, can serve as physical barriers to reduce pesticide drift and protect biodiversity within the bamboo plantation.

Collecting data of interchange between bamboo plants and climate

Bamboo plants offer a buffering effect against extreme temperatures and rainfall patterns, making them valuable for climate change adaptation. Bamboo's evaporative cooling properties and its ability to store water in rhizomes and poles contribute to climate regulation. Monitoring and documenting climate data, as well as testing different bamboo species, can enhance the resilience of the plantation. Diversifying bamboo species ensures that if one species is affected by climate change, the entire field will not be at risk (Minke et al., 2012). It should be kept open as an option to implement more different bamboo species within the *Phyllostachys edulis* field.

By employing the named strategies, biodiversity in Vidigueira can be more effectively conserved and according to expectation even enhanced.

6. Monitoring and evaluating

Regular monitoring and evaluating play a crucial role in biodiversity conservation. It is necessary in order to be able to implement or adapt protective measures. It is suggested to realize the monitoring and evaluation once a year always in the same period (LfU, 2015). As most of the plants bloom in spring it is recommended to do an annual monitoring at this period from March to May. The identification of plant species is the easiest in the blooming state, as well the faunistic life is more activ during this developing state like insects profit from the flowers, bird engage in their breeding songs, while amphibians undergo spawning activities. For the implementation of the monitoring, the list provided in Appendix 2 can serve as a guideline. Firstly, all parameters of the abiotic factors should be recorded, differentiating between air and soil values. As a second step, the vegetation composition should be surveyed. The Braun-Blanquet method, as described in Chapter 3.1, can be used for this purpose. After recording the species, classification should be conducted, taking into account the degree of coverage, the location within or outside the bamboo field, the level of endangerment, and the floristic state, if the species has not been previously recorded. Additionally, the sector in which the species occurs should be identified.

For the assessment of animal species, it is recommended to employ additional analysis methods alongside visual observation to obtain more detailed results. Conducting territory mapping is essen-

tial for accurate data collection of bird populations. Water traps can be used for amphibians, while insects can be captured using nets (Büro für Umweltplanung & Bildung, n.d.).
After data collection, the evaluation takes place. In this process, data from previous surveys is compared with the current data. To illustrate the data, the author suggests using different visualizations like bar chart and similar grafics (Figure 9). This allows for a quick visual representation of changes in biodiversity status refering to number of species (no ecosystem and genetic diversity is shown here). The graph can be elaborated in the following years with the data that will be collected to illustrate the evolution of biodiversity.
By regularly assessing the biodiversity status and identifying emerging threats, plantation management can implement timely and effective strategies. As well taken measures like supplement of edge areas, agroforestry or protection of pesticides can be evaluated after monitoring (CBD, 2014; Europarl., 2020).

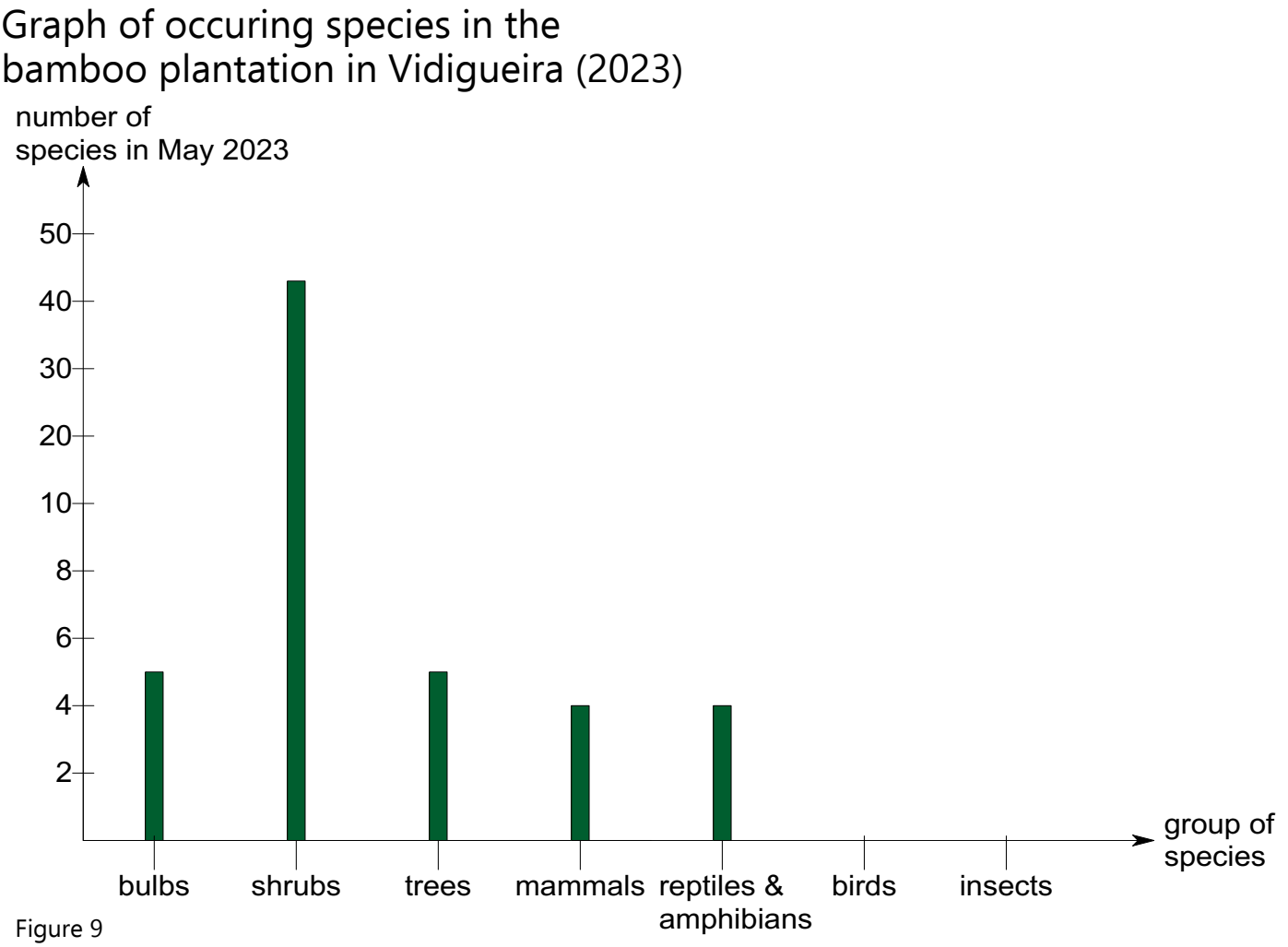


Figure 9

7. Summary of main findings

Limited validity due to limited data

As described in chapter 1, this report on the state of biodiversity in the bamboo plantation in Vidigueira specifically focuses on species diversity, while genetic diversity and diversity of communities remain unaddressed. Therefore, it is important to emphasize that the interpretive value of this report is limited. Additionally, as explained above, due to the simple means employed in the inventory, not all necessary data are available. Specifically, the information on animal species is incomplete.
Nevertheless, some findings have been gathered and will be summarized here. The inventory and data analysis have shown that, based on their biodiversity, the overall area, where all in all 52 plant species were found, can be divided into three zones.

***Phyllostachys edulis* controlles the field, provides protected area at the same time**

Starting with Zone 1, it exhibits the lowest species diversity. In this zone, the author has identified 10 plant species, excluding *Phyllostachys edulis*, within an area of approximately 9 ha. Animal species cannot be attributed to a specific sector or zone. The dominance of *Phyllostachys edulis* hinders the spread of other plant species. On the other hand, the dense growth of bamboo provides a protected and shaded area that can serve as a habitat, especially for larger animals (mammals). In comparison, the surrounding intensively managed areas offer minimal visual cover.

Clumping bamboo enables more biodiversity

Zone 2, in its appearance, is noticeably more open and brighter than Zone 1. 13 plant species have been counted in an area of approximately 0.7 ha. The clump-forming tropical bamboo genus *Bambusa*, does not cover the entire ground, allowing other plant species to establish themselves more prominently, ending in a higher biodiversity.

Egde zone has a comparatively high biodiversity

As the third zone, the peripheral areas have been defined. During the inventory, 47 plant species were recorded in this zone, representing the highest species diversity by far. However, it is also notable that, apart from the herbaceous layer, no shrub layer has developed, and there are no trees either. In this zone, new plantings could be integrated to increase species diversity and vegetation structure, thereby creating more habitat for animals. The selection of species should be based on native, protected and resistant species.

Bamboo plantation is biodiverser than monocultural crops around

Another noteworthy aspect is the contrast with the surrounding crop fields , which are significantly less diverse compared to the bamboo plantation.
During the survey of fauna, a total of four different mammal species and four reptile and amphibian species were identified. The number of bird and insect species is unknown.

In general, the author concludes that the bamboo plantation in Vidigueira does not exhibit a pronounced level of biodiversity but with a potencial of enhancement. Particularly, on the areas dominated by *Phyllostachys edulis*, the strong growth behavior of this species hinders the development of other plant species. However, these areas provide an important protected space for animals. On

the other hand, the other two zones demonstrate a higher level of biodiversity and can be expanded through minor interventions such as re-plantations of additional native species.
To achieve better biodiversity outcomes, the strategies outlined in chapter 5 should be implemented. The author sees particular potential in the further development of the peripheral strips. Through planting measures applied around and partially inside the field, more structure and habitat can be created without requiring intensive interventions within the plantation itself. Another potentially significant area for development, according to the author, is the transformation of specific sections of the plantation into agroforestry. However, since this would entail intensive intervention, the effects should be initially tested on a pilot field.
Annual monitoring should be conducted to assess and evaluate the results, thereby determining which strategies yield the most effective outcomes.
If the goal of good and stable biodiversity in Vidigueira is achieved, it can be assumed that the bamboo plantation contributes to the protection of vital resources such as clean air, water, and fertile soil while land is used agriculturally.
As described in the beginning, the biodiversity in the plantation is contribution against the climate change, and still has further potential.

8. References

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IMAGES

Figure 1: https://www.biologie-seite.de/Biologie/Vegetationsaufnahme

Figure 1.1: Heard, M. J. (n.d.). Modified Braun-Blanquet 1932 scale estimating cover abundance. Retrieved June 09th, 2023, from https://www.researchgate.net/figure/Modified-Braun-Blanquet-1932-scale-estimating-cover-abundance-as-per-Heard-and_tbl1_291086118

Figure 2: small site plan with sectors (Mona Stöhr)

Figure 3: Vegetation around the bamboo site (Mona Stöhr)

Figure 4: Vegetation zones (Mona Stöhr)

Figure 5: Iberian Wall LizardWildlife Macro Photography https://wildlifemacro.com/wp-content/uploads/2019/09/7-Iberian-Wall-Lizard.jpg

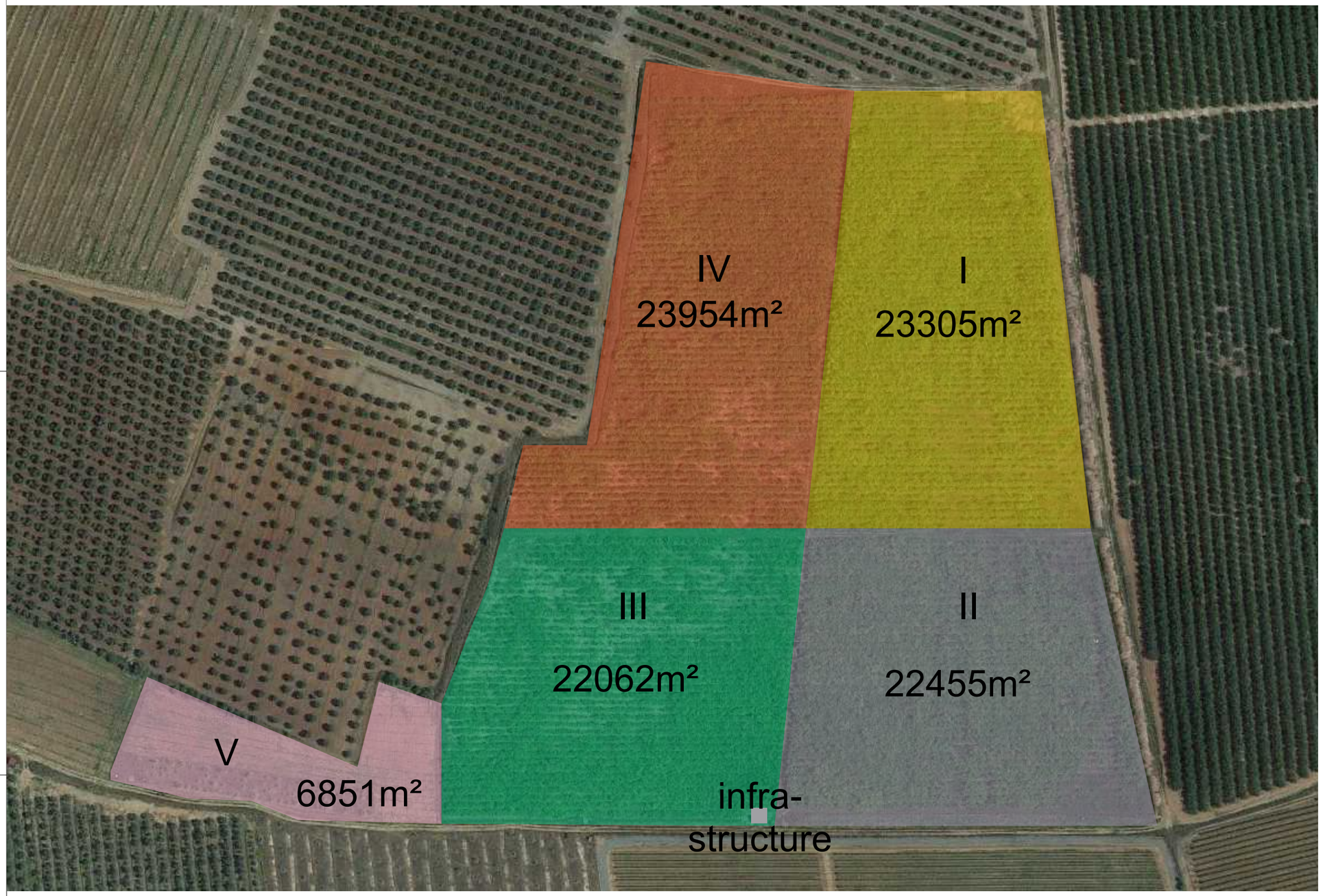
Figure 6: https://tse3.mm.bing.net/th?id=OIP.Ww00INXyq-cFVSWVmIZPtQHaIH&pid=Api

Figure 7: https://tse4.mm.bing.net/th?id=OIP.tvwT3XjKnUM0V16IGZUdVAHaE7&pid=Api

Figure 8: https://tse3.mm.bing.net/th?id=OIP.dix57WVZDHfZQngGTS7M2gHaJv&pid=Api

Figure 9: Graph of occuring species (2023) (Mona Stöhr)

Appendix 1



Allium cepa	Diplotaxis tenuifolia	Galium aparine agg.	Lathyrus annuus	Paronychia argentea	Scirpoides holoschoenus
Anthemis arvensis	Dittrichia viscosa	Gladiolus italicus	Lolium perenne	Phleum pratensis	Santolina rosmarinifolia
Anthriscus sylvestris agg.	Daucus carota	Glebionis segetum	Lysimachia arvensis	Plantago lagopus	Sonchus asper
Arisarum vulgare				Plantago lanceolata	Stachys arvensis
Avena fatua	Epilobium hirsutum	Heliminthotheca echioides	Malva sylvestris	Populus alba agg.	
	Epilobium tetragonum	Hordeum murinum	Medicago polymorpha		Vicia villosa
Briza maxima	Echinops ritro	Hypochaeris glabra	Mentha spicata agg.	Quercus coccifera	Vitis vinifera
	Echium plantagineum	Hypericum perforatum	Misopates orontium	Quercus ilex	
Calendula arvensis	Erodium botrys				
Carduus pycnocephalus		Jacobaea vulgaris	Olea europaea	Raphanus raphanistrum agg.	
Chenopodium album agg.	Foeniculum vulgare		Ornithopus compressus	Rubus rubus sect.	
Convolvulus arvensis	Fraxinus angustifolia		Oxalis pes-capra	Rumex pulcher	

plan VIDIGUEIRA - biodiversity list of existing plants -	plan n° 02
drawn Mona Stöhr	object bamboo plantation
date 31-05-2023	accomplishment BambooLogic European Bamboo Plantation Program
scale / format 1 : 2 000 / A3	

Appendix 2

Biodiversity Vidigueira

abiotic factors

category	subcategory	value	percentage	appreciation			
soil							
	pH	6,3					
	organic matter		1,1				
	nitrogen	1-1,3g/kg					
	oxigen &carbondioxgen	430ppm	21				
nutrients (soil)							
	Potassium (mg/kg)	116		high			
	Phosphorus (mg/kg)	43		low			
	Calcium (mg/kg)	556		low			
	Iron (mg/kg)	117		very high			
	Magnesium (mg/kg)	158		very high			
	CEC (cmol/kg)	4,61		low			
	Texture		41% sand 16% clay				
air							
	rainfall total	571,8mm					
	humidity summer avg.		62				
	humidity winter avg.		89				
	temperature summer avg.	21 °C					
	temperature winter avg.	9,6°C					

biotic factors

category	subcategory	species	frequency on the site	location (inside/outside the field)	sector	degree of extinction	floristic state
flora							
	bamboo						
		Phyllostachys edulis	high			low	non-native
		Bambusa (species unknown)	high		5	low	non-native
	bulbs (geophyt)						
		Allium cepa	low	outside	3	low	native
		Arisarum vulgare	middle	inside	1-4	low	native
		Gladiolus italicus	low	outside	2	low	non-native
		Oxalis pes-capra	high	inside	1-4	low	non-native
		Scirpoides holoschoenus	middle	outside	3-5	low	native
	number of species	7					
	shrubs (therophyt)						
		Anthemis arvensis	middle	outside	1-2	low	native
		Anthriscus sylvestris agg.	middle	outside	1-3	low	native
		Avena fatua	middle	outside	1-5	low	native
		Briza maxima	middle	outside	1-2	middle	native
		Calendular arvensis	middle	outside	1-2	low	native
		Carduus pycnocephalus	low	outside	2	low	native
		Chendopodium album	high	outside/inside	1-3	low	native
		Convolvulus arvensis	high	outside/inside	1-4	low	native
		Daucus carota	high	outside	1-5	low	native
		Diplotaxis tenuifolia	high	outside	1-4	low	native
		Dittrichia viscosa	high	outside	2-5	middle	native
		Echinops ritro	low	outside	4	middle	native
		Echium plantagineum	high	outside	1-5	low	native
		Epilodium hirsutum	middle	outside	1-4	low	native
		Epilobium tetragonum	low	outside	2	low	native
		Erodium botrys	middle	outside	1-2	middle	native
		Foeniculum vulgare	middle	outside	2-3	low	native
		Galium aparine	high	inside	1-4	low	native
		Glebionis segetum	middle	outside	1-2	low	native
		Heliminthotheca echioides	low	outside/inside	1-4	low	native
		Hordeum murinum	middle	outside	1-5	low	native
		Hypericum perforatum	low	outside	4-5	low	native
		Hypochaeris glabra	middle	outside	2-3	middle	native
		Jacobaea vulgaris	high	outside	2-5	low	native
		Lathyrus annuus	low	outside	1-2	low	native
		Lolium perenne	high	outside	1-4	low	native

		Lysimachia arvensis	high	inside	1-4	low	native
		Malva sylvestris	low	outside	2-3	low	native
		Medicago polymorpha	middle	outside	3	low	native
		Misopates orontium	low	outside	1-4	middle	native
		Ornithopus compressus	low	outside	2	middle	native
		Paronychia argentea	middle	outside	1-3	middle	native
		Phleum pratensis	middle	outside	1,2,5	low	native
		Plantago lagopus	low	outside	1-4	middle	native
		Plantago lanceolata	middle	outside	2	low	native
		Raphanus raphanistrum	middle	outside	1-4	low	native
		Rubus rubus sect.	low	outside	3	low	native
		Rumex pulcher	high	outside	3-5	low	native
		Santolina rosmarinifolia	low	outside	4	low	native
		Sonchus asper	high	outside	1-5	low	native
		Stachys arvensis	middle	outside	3	middle	native
		Vicia villosa	high	outside	1-4	low	native
		Vitis vinifera	low	inside	2	low	native
	number of species	43					
	trees	*Fraxinus angustifolia*	low	inside	1-4	low	native
		Olea europaea	low	outside/inside	1,4,5	low	native
		Populus alba agg.	low	inside	2,5	low	native
		Quercus coccifera	low	inside	1	low	native
		Quercus ilex	low	inside	1	low	native
	number of species	5					

category	subcategory	species	geographic habitat	location (inside/outside the field)		degree of extinction	floristic state
fauna							
	mammals						
		wild hog (*Sus scrofa*)	native				
		deer (no species known)					
		iberian hare (*Lepus granatensis)*	native				
		red fox	native				
	number of species	4					
	reptiles and amphibian						
		Iberian wall lizard (*Podarcis hispanica*)	native				
		large psammodromus (*Psammodromus algirus*)	non-native				

		Iberian water frog (*Pelophylaxm perezi*)	native				
		European toad (*Bufo bufo*)	native				
	number of species	4					
birds							
		-					
insects							
	bugs	-					
	butterflies	-					
	dragonfly	-					
	bees and wasps	-					
	gnats	-					

Appendix 3

Vegetationsgliederung nach soziolog. Artengruppen

FACHHOCHSCHULE ERFURT UNIVERSITY OF APPLIED SCIENCES Landschaftsarchitektur

Die Braun-Blanquet Methode wird häufig verwendet zur Vegetationsbeschreibung z. B. Erstellen von Vegetationskarten bei **Pflege- und Entwicklungsplänen**

Arbeitsschritte:

1. Schritt:

Anfertigung von Vegetationsaufnahmen - jeder Vegetationstyp sollte mit mindestens 5 Aufnahmen belegt sein

2. Schritt:

Verarbeitung der Aufnahmen ähnlicher Pflanzenbestände zu Tabellen
Erstellen einer Stetigkeitstabelle (ordnen der Arten nach Häufigkeit)

Artenaufnahme Nr.	**1**	**2**	**3**	**4**	**5**		
Artenzahl	**7**	**7**	**6**	**6**	**6**		
Carex acutiformis	4	5	3	4	4		
Cirsium oleraceum	1	2	+	+			
Scirpus sylvaticus	1	1		+	+		
Mentha longifolia	1	+	r		+		
Deschampsia cesp.	r		1	+			
Urtica dioica		1	+	+	r		
Ajuga reptans		+	+		1		
Galium apparine	+						
Lathyrus palustris	+						
Equisetum palustre				+			
Equisetum arvense		1					
Lysimachia numm.					r		

Beispiel: Stetigkeitstabelle Großseggenried (Biotop 144 in Kleinbreitenb.)

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3. Schritt:

Zuordnung der Arten zu ihren Rangstufen im soziologischen System der Pflanzensoziologie - bis zum Verband nach ELLENBERG et al. 1992 bzw. ROTHMALER

Das hierarchisch gegliederte System der Pflanzengesellschaften unterscheidet:
Klasse, Ordnung, Verband u. Assoziation (Gesellschaft)

1.	Vegetationseinheit	Süßwasser- und Moorvegetation
1.5	Klasse	*Phragmitetea australis* = Röhrichte und Großseggensümpfe
1.51	Ordnung	*Phragmitetalia australis* = Röhrichte und Großseggensümpfe
1.514	Verband	*Magnocaricion* = Großseggenried
1.514x	Assoziation (Gesellschaft)	*Caricetum acutiformis* Eggler 1933

Artenaufnahme Nr.	**1**	**2**	**3**	**4**	**5**	**Soziologisches Verhalten nach**	
Artenzahl	**7**	**7**	**6**	**6**	**6**	**ELLENBERG et al. 1992**	
Carex acutiformis	4	5	3	4	4	1.514	*Magnocaricion*
Cirsium oleraceum	1	2	+	+		5.415	*Calthion*
Scirpus sylvaticus	1	1		+	+	5.415	*Calthion*
Mentha longifolia	1	+	r		+	3.911	*Agropyro Rumicion*
Deschampsia cesp.	r		1	+		x	gesellschaftsvage
Urtica dioica		1	+	+	r	3.5	*Arthemisietea*
Ajuga reptans		+	+		1	x	gesellschaftsvage
Galium apparine	+					3.5	*Arthemisietea*
Lathyrus palustris	+					5.41	*Molinietalia*
Equisetum palustre				+		5.41	*Molinietalia*
Equisetum arvense		1				x	gesellschaftsvage
Lysimachia numm.					r	3.811	*Elymo-Rumicion*

Beispiel: Stetigkeitstabelle Großseggenried (Biotop 144 in Kleinbreitenb.)

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Vegetationsaufnahme

Vegetationsaufnahme Formblatt						
Gesellschaft:						Aufnahme Nr.:
Ort:					MTB Nr.:	Bearb.:
Schicht:					Aufnahmegröße:	Datum:
Höhe:					Aspekt:	Expos.:
Schluss:						
Bemerkung:						
Art:			Deckung:	Art:		Deckung:

Kombinierte Schätzskala nach Braun- Blanquet:

Schätzung der Dichte und Deckung (lebende Biomasse) für jede Art

r = sehr selten, sehr wenig deckend

\+ = spärlich, wenig deckend (< 1 %)

1 = zahlreich, aber weniger als 5 % deckend

2 = zahlreich, 5-25 % deckend

3 = zahlreich, 25-50%

4 = zahlreich, 50-75%

5 = zahlreich, 75-100 %