



## Planning and design principles of Artvin Çoruh University Ali Nihat Gökyiğit Botanical Garden in a sustainable approach

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### Abstract

Botanic gardens are institutions holding documented collections of living plants for the purpose of scientific research, conservation, display, and education. Gardens and the cultivation of plants have been around for thousands of years with the first examples dating to around 3,000 years ago in ancient Egypt and Mesopotamia. In the last 50 years botanic gardens are increasingly recognised as being extremely important to conservation due to their existing collections and the scientific knowledge they possess in the propagation of plant species. There are 3765 botanical institutions, 1775 botanic gardens and arboreta in 148 countries around the world with many more under construction or being planned. 628 of them are being members of the Botanic Gardens Conservation International (BGCI) platform. The Artvin Çoruh University Ali Nihat Gökyiğit Botanical Garden (ANGBB) was established in 2018 and opened to the public in 2022. ANGBB is one of the 13 botanical gardens from Turkey that are members of this platform. There are around 30,000 plants belonging to approximately 2000 different species, including 400 rare, 200 medicinal-aromatic, and about 1400 decorative species, cultivated in the garden. A total of 594 seeds belonging to specialized species such as Medicinal Aromatic and endemic plants are preserved in the seed house of the botanical garden. Within the scope of this research, the purpose, functions, planning, and design of botanic gardens have been evaluated according to the economic, ecological, and social components of sustainability, and sustainable planning and design criteria have been established for the ANGBB. These criteria address structural landscape design, plant landscape design, administrative planning, spatial planning, educational, social, and cultural planning, as well as management and maintenance. The ANGBB has been evaluated in terms of sustainable planning and design criteria, and recommendations for enhancing the sustainability of the ANGBB have been provided based on the data obtained.

**Keywords:** ANGBB, Artvin, conservation, planning, sustainability.

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### Sürdürülebilir bir yaklaşımda Artvin Çoruh Üniversitesi Ali Nihat Gökyiğit Botanik Bahçesi planlama ve tasarım ilkeleri

#### Özet

Botanik bahçeleri, bilimsel araştırma, koruma, sergileme ve eğitim amacıyla belgelenmiş canlı bitki koleksiyonlarını barındıran kurumlardır. Bahçeler ve bitki yetiştirme binlerce yıldır var olmuş olup, ilk örnekler Mısır ve Mezopotamya'da yaklaşık 3.000 yıl öncesine dayanmaktadır. Son yıllarda botanik bahçeleri, mevcut koleksiyonları ve bitki türlerinin üretiminde sahip oldukları bilimsel bilgi nedeniyle koruma açısından son derece önemli olarak kabul edilmektedir. Şu anda dünya çapında 148 ülkede 3765 botanik enstitüsü, 1775 botanik bahçesi ve arboretum bulunmakta olup, birçoğu inşa edilmekte veya planlanmaktadır. Artvin Çoruh Üniversitesi Ali Nihat Gökyiğit Botanik Bahçesi (ANGBB), 2018 yılında kurulmuş ve 2022 yılında ise halkın ziyaretine açılmıştır. ANGBB, bu platforma üye olan Türkiye'deki 13 botanik bahçesinden biridir. Bahçede, 400'ü nadir, 200'ü tıbbi-aromatik ve 1400'e yakın dekoratif tür olmak üzere 2000'e yakın farklı türe ait 30.000 civarında bitki yetiştirilmektedir. Botanik bahçesinin tohum evinde Tıbbi Aromatik ve endemik bitkiler gibi özel türlere ait toplam 594 tohum muhafaza edilmektedir. Bu araştırma kapsamında

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botanik bahçelerinin amacı, işlevleri, planlanması ve tasarlanması sürdürülebilirliğin ekonomik, ekolojik ve sosyal bileşenlerine göre değerlendirilmiş ve ANGBB için sürdürülebilir planlama ve tasarım kriterleri oluşturulmuştur. Bu kriterler yapısal peyzaj tasarımı, bitkisel peyzaj tasarımı, idari planlama, mekânsal planlama, eğitsel, sosyal ve kültürel planlama ile yönetim ve bakım ele alınmıştır. ANGBB sürdürülebilir planlama ve tasarım kriterleri açısından değerlendirilmiş, elde edilen veriler doğrultusunda ANGBB'nin sürdürülebilirliğinin geliştirilmesine yönelik önerilere yer verilmiştir.

**Anahtar kelimeler:** ANGBB, Artvin, koruma, planlama, sürdürülebilirlik

## 1. Introduction

People need to get away from their environment for a short or long period to regain their life integrity, which has been disrupted due to both the fast pace of life and the intensive working order, and for this purpose, they turn to natural or near-natural rural areas. However, the lack of conditions and opportunities often prevents the realization of this desire. In this case, urban outdoor spaces with sufficient opportunities to meet the recreation needs come to the fore. Botanical gardens, the first examples of which were found around 350 BC, although different from today's ones, have important scientific (research and conservation), educational (teaching, culture) and recreational functions [1, 2]. Botanical gardens constitute the center of the studies carried out in the world to identify plant species in danger of extinction, to protect plant species diversity, to ensure the continuity of living environments and biological diversity in the world, and to conduct research in the field of botany [2]. Botanical gardens, which have the mission of introducing their visitors to the natural vegetation of their regions as well as the plants growing in different parts of the world, contribute to the formation of environmental awareness and conservation awareness by providing information about plants to people of all age groups and introducing plant life. At the same time, it is noteworthy that many of the botanical gardens, which also serve purposes such as organizing various educational meetings, and creating institutional publications and documents, have recently included uses and organizations that will meet the active recreation needs of society in addition to their passive recreation opportunities [3].

British botanist Heywood defined botanical gardens as organizations that grow the world's natural and cultivated plants in a certain order under the purposes of the garden, educate children, students and the public by introducing them to them, and conduct scientific research on plants for various purposes [4]. Yaltrık defined botanical gardens as living plant museums where trees, shrubs and other herbaceous plants, each carefully labeled, are exhibited in a systematic arrangement and combined for scientific research [5]. According to Hohn [6], botanical gardens are open-air museums of living and non-living plants that provide plant material for branches of science such as medicine, chemistry, agriculture, forestry and botany, offer education, research and application opportunities, support them with units such as herbarium and museum, and help educate the public outside the school. In the horticultural dictionary of the Royal Historical Society, botanical gardens are referred to as gardens that form study and teach plant diversity, aim to cultivate plants, and organize them according to the classification system, not only for ornamental and utility purposes, but also for research and teaching about botanical science or both in an organized manner [7]. The definition of Botanical Garden accepted by the British Royal Horticultural Society in 1969 is as follows; It is a garden that includes plants separated according to botanical classification, arranged only for ornamentation and use, by a certain classification for research and cultivation. Today's botanical gardens, which have developed in the direction of raising public awareness, not only conduct horticultural research such as botany, pharmacology, selection and hybridization but also organize courses, seminars and exhibitions on a wide range of subjects that endear the plant world to people from all segments and age groups of the society [8]. Botanical gardens have a wide variety of functions together. They have recreational functions as well as being green areas for urban life. The most important functions are to identify, protect and contribute to the reproduction of various plants, especially those in danger of extinction. Botanical gardens also have functions as an institution. These include providing training, organizing meetings, creating documents, and organizing exhibitions [9, 10]. In addition to enabling various researches to be carried out, botanical gardens play an important role in providing information about plants to people of all ages and giving the love of nature to the society.

Ali Nihat Gökyiğit Botanical Garden, which was established in Artvin Province with the concern of keeping alive the plant species that disappeared especially with the construction of dams, is a life museum, an important educational institution, a scientific plant research facility and a conservation organization. The number of botanical gardens, which are very common and important abroad, is quite small in our country. ANGBB was established as the 13<sup>th</sup> Botanical Garden with international qualifications in Turkey. The establishment, design, renovation, transformation or

expansion of a botanical garden is a unique and invaluable activity with ecological, cultural, educational and economic benefits that will last for generations. Managing and guiding the development of botanical gardens presents challenges in terms of both economic and human resources.

### *1.1. Planning and design principles of botanical gardens*

Considering the scientific functions of botanical gardens on the one hand and their educational and recreational functions on the other, it is seen that botanical gardens require a different planning and organization than parks and gardens. To create a sustainable botanical garden, first of all, the land must be suitable for the goals and objectives [11]. When the idea of developing a new botanical garden is put forward, the most suitable land is selected. A list of possible sites is considered. These lands are evaluated for their suitability to the vision and mission. Botanical gardens differ from other parks in terms of their size because they contain plant collections, greenhouses, administrative buildings, laboratories, technical equipment areas, and also because of their educational and research aspects. For this reason, the place to be allocated to the botanical garden should be carefully selected. For this, factors such as ecological conditions, transportation, irrigation facilities gain importance [10, 12].

It is also desirable to choose a moving terrain when selecting a location. Areas such as lakes, rivers, slopes and hills create enjoyable and non-monotonous areas for visitors as they move around the area. Slope is a desired principle in site selection. Sloping areas provide different perspectives. Location selection should be made in suitable areas outside the city center that can stay away from the physical pressure and development of the city with a long development projection [13].

In addition to the green building system that reveals the main space-defining structure of a botanical garden, its use for research, education, collection and other functions is based on scientific basic data. For scientific purposes, plants are organized in botanical gardens according to systematic classification, geographical regions, ecological requirements, dendrological characteristics, uses and flora regions. The first unit that requires the scientific use of plants in botanical gardens is the systematic section. A botanical garden usually includes an ecological section as well as a systematic section. Ecological grouping is the cultivation of plant species that show similar living environment in terms of soil and climate requirements of plants as well as their relations with each other. In order to carry out these studies, the desired ecological conditions must be provided in the garden in advance [6].

The planning and design principles of botanical gardens discussed in different sources can be listed as follows [1, 8, 14, 15, 16, 17]:

- Botanical gardens range in size from 5 hectares to 5,000 hectares.
- Since botanical gardens need to be in communication with universities or similar scientific institutions, it is appropriate to plan them close to these institutions.
- In terms of conservation, emphasis is placed on protecting species and gene resources used in agriculture.
- In the planning and materials of the units in the gardens, the local climate and materials are taken into account and care is taken to ensure harmony with the physiognomy of the environment.
- The educational role of botanical gardens should be taken into account. The use and design of space can be not only for scientific purposes, but also for practical knowledge and aesthetics-based activities and year-round interest.
- Research policies are established. Development areas are found for future needs.
- All parts of the botanical gardens that can be visited should be accessible for people with disabilities.
- Attention is paid to a multifunctional structure in functioning. It is necessary to divide the use of the area into basic sections such as management, education and research, production and recreation. Policies on Plant Collections are also established.
- An operating directive or management plan for the establishment and operation is prepared.
- Maintenance and protection operations must be continuous and regular,
- Botanical gardens include a planning that will realize environmental silence and an internal circulation texture that does not require auto traffic.
- Botanical gardens have cafe restaurants and seating areas for visitors to relax and meet their needs.
- Botanical gardens are usually open from 9:00 to 18:00 or 19:00. For this reason, lighting is not available in some botanical gardens. However, there is partial lighting for security purposes.
- Generally, the materials used for walkways in botanical gardens should be safe and in harmony with the environment (usually gravel, stabilized soil or grass). Benches and trash bins are provided on the walkways.

In its planning decisions, the Royal Botanic Garden at Kew has determined principles that emphasize the educational aspect of the garden. The planning criteria in a publication prepared by the Education Department are given below [7, 8]:

- Organizing the garden in line with the information it wants to give, especially determining what topics it wants to address and exhibit (permaculture practice, plant taxonomy, etc.),
- Identifying and promoting the resource values of the garden,
- Emphasizing some of the properties of plants that can be useful to society,
- Preparation of promotional signs about some plants in places,
- Creating special performance areas or surprise areas for small groups, learning spaces (surprise encounter spaces where walking paths intersect, small squares, etc.)
- Systematic arrangement of plants according to their root and leaf characters, or according to the purpose for which the plants are used, and also according to families,
- Exhibiting and explaining plants according to their local, cultural characteristics and history,
- Creating spaces for children to explore and investigate by playing in the garden.
- Arrangement of plants according to a theme or storytelling,
- First of all, the display of plants that visitors know a lot about,
- The garden interacts with adults, children and students,
- Providing practical work environments, especially for school groups, such as growing plants, harvesting crops and gardening,
- Displaying a product made from the plant source right next to the exhibited plant, thus satisfying visitors' desire to touch it.

### 1.2. Purpose and scope of the study

The aim of this study is to explain the design process and stages of the botanical garden that will ensure the sustainability of the plant wealth of Arvin Province, which is located in the east of the Eastern Black Sea, which has been destroyed by the dam constructions, as well as the protection and exhibition of the existing plant wealth, and at the same time to provide the city with a scientific recreation area. With the implementation of the botanical garden, it is aimed to reach a holistic structure that will serve users as a recreation, education, scientific study and research area with its structures such as greenhouse, education and management, cafe and restaurant, in addition to the important contributions to the urban landscape. This study aims to outline the proposed steps and strategic thinking for the planning, design and implementation of the ANGBB botanical garden project. It also evaluates the sustainable approach strategies adopted and implemented in the botanical garden.

## 2. Materials and methods

Artvin has an important position in terms of its geography. While the region has a mountainous topography and a continental climate, the valley of the Çoruh River, in which there are many dams, harbors Mediterranean climate characteristics. This increases the biodiversity of the region and allows plant species with different tolerances to grow in the region. The study area, which is the main material of the study, is administratively located within Artvin Çoruh University. It is located at the 13<sup>th</sup> km of the Şavşat-Artvin highway. The Botanical Garden is located within the borders of Salkımlı Village, Artvin province. It is on the Artvin-Ardahan road, an average of 525 m in elevation and is in the south slope. The area is situated between lat 41°11'12'' – 41°11'21'' N and long 41°51'13''- 41°51'24'' E and is approximately 140.000 m<sup>2</sup> in area (Figure 1).

The method of the study consisted of data collection, on-site identification, synthesis and evaluation stages. To determine the existing structure, natural and sociocultural characteristics of the study area, plans, maps, reports, analyzes and data were collected, sources were scanned, and determinations were made regarding the vegetative and structural assets of the Botanical Garden. In the synthesis and evaluation phase, the information obtained, the characteristics of the area and the factors that reveal the need for botanical gardens were evaluated together and long-term planning and design principles were put forward.

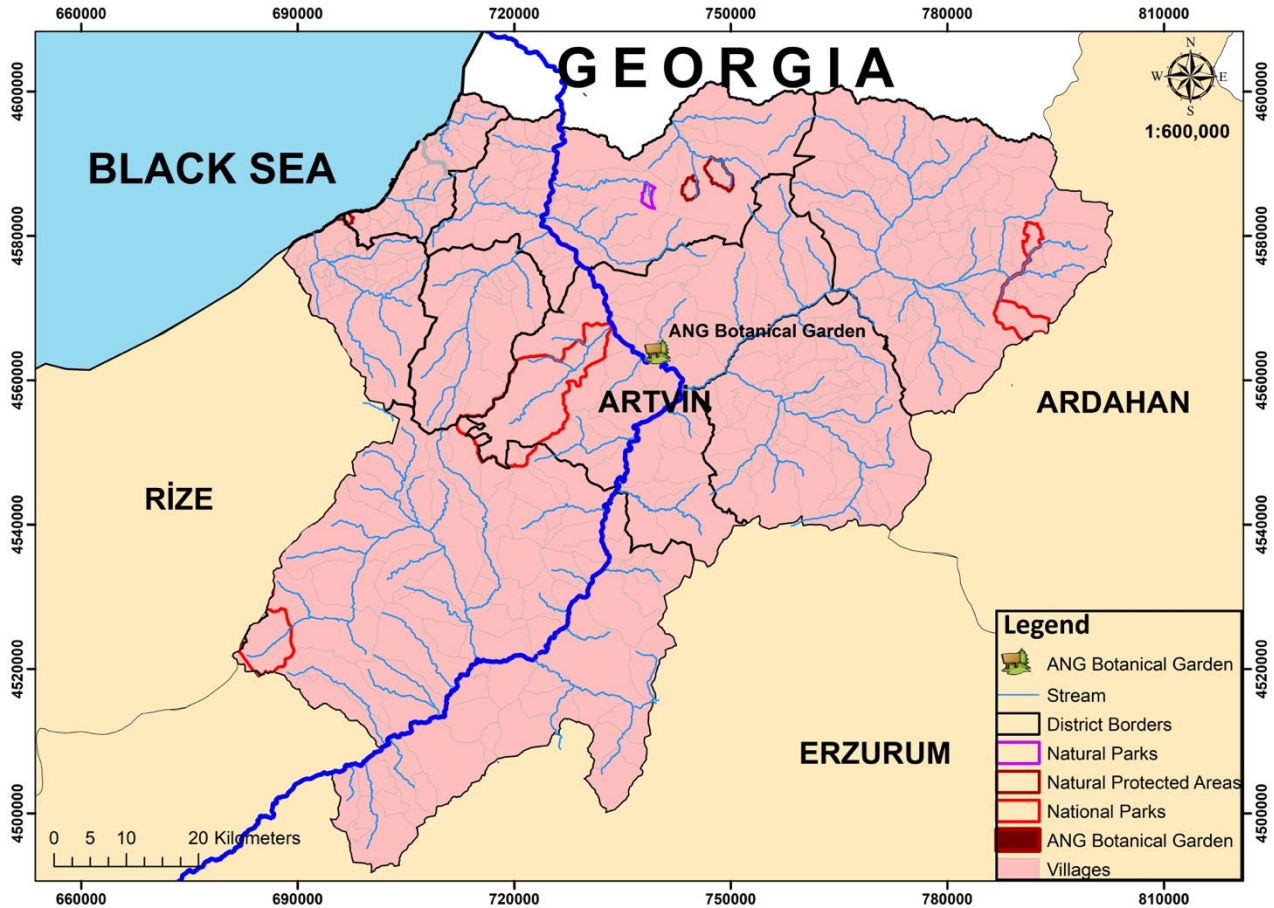


Figure 1. Location of the research area

### 3. Results

#### 3.1. Establishment of the Artvin Çoruh University Ali Nihat Gökyiğit Botanical Garden

The Botanical Garden area was used as a prefabricated housing area for the employees of the Deriner Dam construction company, and at the end of the construction, the prefabricated houses were dismantled and the area remained idle as a pile of concrete (Figure 2). In 2015, with the initiatives of Prof. Dr. Özgür Eminağaoğlu, a faculty member at Artvin Çoruh University, work was started to establish a botanical garden in the area in question.

Feasibility studies were carried out for the area with the support of the Eastern Black Sea Development Agency (DOKA) and a Feasibility Final Report was prepared in 2017 [18]. In addition, with the support of TÜBİTAK in 2018, an international workshop was held with the participation of scientists from Turkey and abroad, and the workshop final declaration was published [19]. When the suitability of the area was revealed as a result of all these researches, the search for resources began. As a result of the meetings held within the framework of the Botanical Garden Project prepared under the coordination of Prof. Dr. Özgür Eminağaoğlu, Ali Nihat Gökyiğit, an investor from Artvin, the chairman of the board of ANG Foundation, supported the project and the process started. In this process, legal procedures were initiated for the transfer of the lands within the scope of treasury land to Artvin Çoruh University. As a result of the application for the allocation of the area to the University for the Establishment of the Botanical Garden, the General Directorate of National Real Estate allocated approximately 170 decares of land consisting of 11 parcels. Ali Nihat Gökyiğit Botanical Garden Directorate was established within Artvin Çoruh University and working groups were formed.



2. The construction site of the area before the botanical garden (May 2005- June 2018)

First of all, the borders of the area were enclosed with a fence in order to protect and reveal the existing plant presence in the botanical garden. Then, within the scope of the project, the infrastructure projects, structural landscaping and vegetative landscaping projects of the area were commissioned to an architectural office under the control of consultants appointed from the university. In 2019, the implementation of the infrastructure and structural landscaping projects of the Botanical Garden was awarded to a private company through a tender method. In 2019, the negativities experienced during the pandemic (covid-19), which was an unforeseen process, were overcome and the planned part of the construction stages was partially completed in 2021. However, it seems that construction activities in the area will continue for a while. 60% of the planned vegetative landscaping works have been completed. Planting activities are going and will continue at all times.

Since the garden has a sloping terrain, terracing was used. The planning of the botanical garden was organized on these pre-existing terraces. There are 16 terraces at different levels and of different sizes, 9 of which are open to visitors and 7 of which are closed to visitors. For these terraces, the term "Palya" was used within the scope of the garden. The names of the palyas are given according to their use and the presence of plants. There are various structures, plant arrangements and collections within the palyas. The collections and the Palyas in which they are located are listed as follows from the top level downwards: Entrance, administrative- educational-research units, greenhouse and nursery, rose garden, medicinal-aromatic plants, local houses and plants, honey and fodder plants, labyrinth and playground, theme area, production facilities, fruit species gene garden palyas (Figure 3).

*Entrance Palya:* The main entrance of the garden is at the top level. There is also an entrance at the lowest level. The palya at the top level, which is used as the main entrance, has a carriageway, security and a guesthouse. The carriageway is on this pavilion and ends at the parking lot. After this point, there is no vehicular circulation in the area. There are only pedestrian circulation areas and vehicles for the elderly and disabled. Only circulation areas suitable for the circulation of service vehicles and emergency vehicles have been organized within the area. There is also a section with the bust of Mr. Ali Nihat Gökyiğit at the entrance of the area. (Figure 3, 4).

*Administrative - Education-Research Units Palya:* It is the 2<sup>nd</sup> palya from the top of the garden. The management and administrative units of the garden are located here. It is an area where multifaceted and intensive activities such as education and research are carried out. In addition, the parking lot, observation terrace and pedestrian circulation area reaching the café are located in this pallet. There are also various plant collections in this area (Figure 3).

*Greenhouse Palya:* This palya houses the R&D and Exhibition Greenhouse. There are also shaded hard floors around the greenhouse where plants are exhibited and events are organized. It is one of the most important structural areas of a botanical garden. Their purpose is to expand the range of plants in the botanical garden. Not only cultivated plants but also natural plant species can be propagated with all kinds of production techniques. The greenhouse needed for the production of plants to be used in ANGBB and for the display of visual plants was established in 2019 as 460 m<sup>2</sup>. Later, a section of 200 m<sup>2</sup> was added to be used for production purposes (Figure 3).

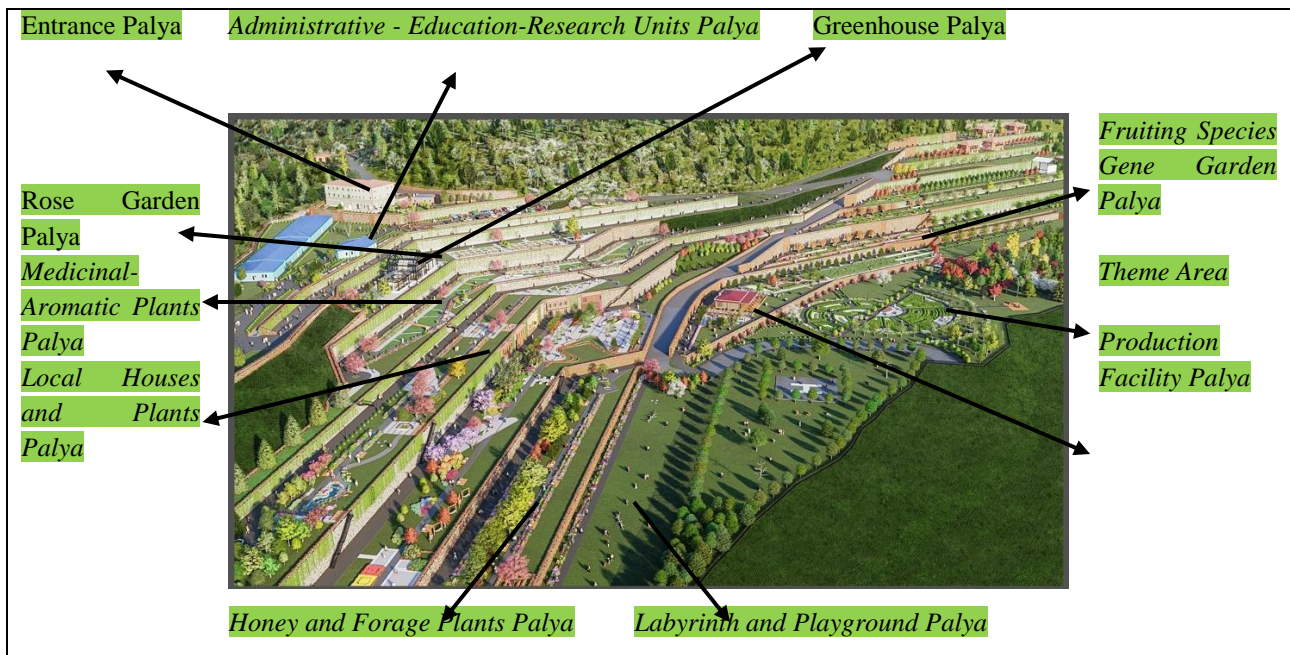


Figure 3. Botanical Garden renderings (Collections and Palya)

*Rose Garden Palya*: A garden of dwarf and tall roses (*Rosa* spp.) with different characteristics. There are many varieties of roses in winding and dwarf forms. There are also examples of rose species (7 taxa) that grow naturally in Turkey (Figure 3).

*Medicinal-Aromatic Plants Palya*: The vascular plant flora of Artvin is represented by 2727 taxa, 2616 species, 397 subspecies, and 144 varieties belonging to 761 genera and 137 families [17, 20, 21]. The number of medicinal-aromatic plants with natural distribution in Turkey is around 1400 and 850 of these species are also found in Artvin [20]. There are nearly 1000 plants in the collection in this palya. There are 50 raised plant pads made for the cultivation of special medicinal-aromatic plants in this palya. There is an organic pond at the end of this palya. In addition, water surfaces were created on the ground. On the stagnant water surfaces, collections of local rare aquatic plants as well as aesthetic plants have been created (Figure 3).



Figure 4. General view of the entrance gate and its surroundings

*Local Houses and Plants Palya*: In this palya, there are rural architectural housing examples of Artvin, which are applied to the retaining wall surface. It is aimed to create a traditional street with the road passing in front of the houses and reaching the garden. In addition to the woody plant species of the region, there are many herbaceous plant species in the palya. The species are arranged alphabetically by genus and family. In addition, the garden has become an outdoor studio for photographers since its establishment. In order to increase the use of the garden by the public, heart-shaped iron profiles were created in certain areas to be wrapped with winding plants (Figure 3).

*Honey and Forage Plants Palya*: Approximately 800 honey plants and 250 forage plants are naturally distributed in Artvin province [20, 21]. In this palya, forage plants are included in addition to honey plants. The number of plant species is being increased day by day by transferring the plants removed from nature to the area; and it is also planned to build a honey house in this palya in the future. (Figure 3).

*Labyrinth and Playground Palya:* A playground for children arranged with thuja and viburnum plants. In the area organized as a labyrinth, children try to find their way out by wandering among the thuja. In addition, playgrounds are planned to be designed in natural environments where children will discover and experience adventure (Figure 3).

*Production Facility Palya:* The previously mentioned greenhouse and nursery palya is an important production center for the garden. It is also the palya where a production facility is planned to process the fruits produced in the garden and serve the local people (Figure 3).

*Fruiting Species Gene Garden Palya:* Turkey is an important country in terms of fruit diversity, where nearly 300 species have evolved and diversified. The number of protected fruits has reached 1534 grapes, 704 apple, 651 pear, and 627 citrus fruits [22]. ANGBB's fruit collection includes 21 different types of grape varieties. At the same time, a collection of other fruit varieties has also been created. This collection covers a total of five differently sized pallets. This palya, which is not open to visitors, is organized to increase interest in nature and botanical science as well as to exhibit the biodiversity of our country. In the following stages, it will be opened to visitors when suitable conditions arise (Figure 3).

*Theme Area:* It is organized as a reception and viewing area to present the developments in the field of floriculture. It is at the lowest level, visible from all parts of the botanical garden. Here, it is planned to exhibit new varieties obtained as a result of studies on periodically changing species. Experimental gardens have been created for annual and perennial and aesthetic natural plant species. Natural stones and gravel are used for the borders of the walking area, which is bordered by plants with high visual and aesthetic value (Figure 3).

### 3.2. Structural planning and design principles

When the land for the establishment of ANGBB was received, there were concrete floors of prefabricated structures that had been dismantled and taken away by the company that built the Deriner Dam. The general appearance of the site was that of a construction site with concrete floors in places (Figure 2). The company in question left its prefabricated administrative building, prefabricated meeting building and guesthouse building for the use of the botanical garden, while its villa at a point overlooking the landscape was demolished due to procedural reasons. In the structural planning of the site, the principle of preserving all existing buildings by functionalizing them, taking into account their economic value and needs, was adopted. Structures and structural sections within the Botanical Garden:

*Guesthouse:* The guesthouse building is located at the entrance of the site in its original form and is not yet in use. It is a three-storey reinforced concrete building with 10 rooms. Façade improvement and interior renovation are planned according to budget conditions.



Figure 5. Administrative - Education and Research Buildings

*Administrative - Education and Research Buildings:* The largest of the preserved prefabricated buildings. It is approximately one thousand square meters. It contains administration, offices, classrooms for training and courses, library, meeting room, laboratories, herbarium, sales office, exhibition hall, prayer room, kitchen and restroom. In order to make the external appearance of this building more harmonious with the natural environment, window openings and entrances were left empty and the facades were surrounded by a wire cage on all sides. This wire cage was wrapped with suitable vines to give it a green and flowery surface and a wooden surface in the form of veins in winter (Figure 5).

*Meeting Building:* It is a prefabricated building used in its original form without any renovation or modification. The structure has an amphitheater-type seating arrangement and seats one hundred people.



*Cafe-Restaurant:* This building was constructed on the site of the previously demolished villa. While the villa was located in the middle of the area dominating the view, the new building was set back and the front area, which has a panoramic view, was utilized as a large garden area. The facade of the building is clad in brick, a material in harmony with nature and used in the architectural tradition of the region. The façade also features large window surfaces for easy viewing of the view from all directions. The Café and Restaurant building consists of a food and beverage area, kitchen, administrative office, restroom and balcony units. In order not to interrupt the view and not to dominate the nature, care was taken not to exaggerate the scale of the building and to harmonize with the natural environment (Figure 6).



Figure 6. Botanical Garden cafe and view of the city

*Greenhouse:* The greenhouse is one of the largest structures built within the site, depending on the targeted production and exhibition capacity. Especially with its location that does not block the view, its transparent structure and its height that does not exceed the retaining wall, the scale concern was tried to be eliminated. Not only cultivated plants but also natural plant species can be propagated with all kinds of production techniques. The greenhouse needed for the production of plants to be used in ANGBB was established for the first time in 2019 at 460 m<sup>2</sup>. The greenhouse, planned for R&D and Exhibition purposes, was built as polycarbonate on steel construction. The greenhouse consists of 3 sections with 3 different climates and 5 different irrigation and fertilization functions. A 200 m<sup>2</sup> production section was added to the greenhouse. The central part of the greenhouse has a gallery and the other sections are single storey. In the greenhouse; offices, department, main production section, Black Sea Plants section, tropical plants section, desert plants section, machine room, warehouse, germination room, and restrooms. Plants in different habitats that can live at different temperatures can be exhibited in the greenhouse (Figure 7).

*Restrooms and Water Tank:* There are three prefabricated restroom structures at different locations in the area. There is also a water tank with a capacity of 450 tons.

*Parking Lot:* There is a parking lot at the entrance of the Administrative-Education-Research Units Palya, where employees and visitors can park. This parking lot has a capacity of approximately 50 vehicles. It is also used as a proposed gathering area for botanical gardens.

*Pathways and Stairs:* Vertical circulation in the area is provided by stairs that follow each other vertically on the surface of the walls. Horizontally, a main road divides the area vertically in the middle and reaches from the top level to the bottom level of the area. This road is also used as a vehicular road, but vehicles are allowed to enter the parking lot. The section of the carriageway after the parking lot is planned to be used for service and emergencies, as well as for transfer vehicles provided by the garden. In principle, the garden is designed for pedestrian access. All palyas are connected horizontally and vertically by pedestrian circulation. The design of the pedestrian paths, is aimed to ensure that the plants in all palyas are easily seen from all directions and to ensure their continuity. Colored and uncolored concrete, keystones and natural stones are used on the ground of the paths.



Figure 7. General view of the R&D and Exhibition Greenhouse

**Retaining Walls:** ANGBB has a sloping terrain. For this reason, the land was used to form terraces. Depending on the terrace formations, there are high retaining walls on the land. One of the most important issues in the planning and design process of the site was to harmonize these retaining walls with the natural environment and to use the wall surfaces. For this purpose, pots were built at certain intervals at the bottom of the walls and covered with wire mesh in strips perpendicular to the wall surface. It is aimed that the vines in the pots will wrap these wires and create aesthetic vertical garden images on the surface (Figure 8).

**Local Houses:** Based on the idea of utilizing retaining walls as exhibition surfaces, a street of local houses was created. Portable applications were made on the retaining wall surface by selecting from the traditional-rural housing examples seen in the center and different districts of Artvin Province. These structures were scaled to the surface based on the height of the retaining wall. Five rural architectural housing examples are exhibited on the street. These Applications made with traditional materials such as wood, stone and brick were built as curtain walls on the steel skeleton built on the wall surface (Figure 8).



Figure 8. General view of local houses, organic pond and plant-covered walls

**Biological Pond:** Another structural element in the garden is the biological pond. It is located in the Medicinal-Aromatic Plants Palya. The pond is surrounded by a wooden railing and there are fixed metal frames in which interchangeable pots can be placed. The pond creates a surprising space with its location and its surroundings that provide a panoramic view.

As a structural element, there are fixed seating elements in different positions in the garden that follow the view. On these seating elements, there is a metal lattice-shaped cover that will be wrapped with plants to protect from the sun. There are also some decorative wooden elements in the area. There is an exhibition section where the products obtained from plants are exhibited in a glass case in the Medicinal-Aromatic Plants Palya. Here, plants and products can be viewed together.

### 3.3. Vegetation planning and design principles

Living materials used in landscape design are trees, shrubs and herbaceous plants that grow in different conditions. As with other living things, plants grow and spread in an ecology characterized by basic conditions such as soil, water, temperature and light. Differences in the structural structure of the elements that make up the ecology lead to the emergence of different ecological environments. The vegetation between the ANGBB buildings, the plants covering the high retaining walls, the fruit trees that refresh the memory of the past, the natural plant environments, the areas formed by the protected plants, and the structural differences of the plants exhibited create different ecological conditions.

One of the basic principles of plant design in the botanical garden is to support biodiversity and provide habitat for endangered species. First of all, the transportation and cultivation of plants that were under the waters of the Deriner dam has been one of the priority issues. In this context, locally distributed endemic species such as *Acer cappadocicum* subsp. *divergens*, *Alyssum artvinense*, *Alkanna cordifolia*, *Campanula troegerae*, *Centaurea pecho*, *Centaurea woronowii*, *Clypeola raddenea*, *Convolvulus pseudoscammonia*, *Micromeria elliptica*, *Lathyrus woronowii* were taken under protection in the botanical garden. In addition, the conservation and reproductive biology of endangered species, especially endemic plant species within the rich biodiversity of our country, are studied; ecological environments as suitable as possible for their habitats are created.

While designing the botanical garden, first of all, a scientific classification was made for the plants to be used in the garden. The "geographical distribution, ecological requirements, usage areas, habitats and dendrological characteristics" of the plants were investigated in detail. In addition to scientific classification, it also includes vegetation science (plant sociology). Therefore, plant species growing in similar habitats are exhibited together in terms of their ecological requirements and their relationships with each other. In plant design, emphasis is placed on the use of low maintenance plants, plant species compatible with the ecological structure of the region and natural plants.

Living plant collections in botanical gardens are living plant communities cultivated for specific purposes. Such collections can be considered on their own or as part of a more general garden collection. Botanic gardens also have a duty to preserve plant collections [11]. Plant collections in ANGBB are organized and arranged in a certain order and arrangement, and plant species with similar habitat characteristics are grown and exhibited together with the "ecological grouping" method. In this context, well-documented collections are kept and some plant species are also taken under protection. The existing plant collections are classified as bulbous plants collection, hedge plants collection, cactus and succulent plants collection, fern collection, climbing and climbing plants collection, medicinal-aromatic plants collection, local (Artvin) plants collection, honey and fodder plants collection, rock plants collection, woody plants collection, aquatic plants collection, fruiting species gene collection.

The Botanical Garden area was previously used as a construction site and lodging area for the construction of the Deriner Dam. The plants planted during this period and the woody plants living naturally on the site were preserved during the planning process of ANGBB and after its establishment. It is one of the first collections started to be created in the garden. During the establishment process, approximately 15.000 trees and shrubs were planted in the area between 2018 and 2023 [23]. There are many different genera of woody plants throughout the garden. The woody plant collection is one of the largest collections scattered throughout the garden. Broad-leaved and coniferous trees, shrubs and perennials with attractive flowers are native to the region. In the garden, there are woody plant species such as *Osmanthus decorus*, *Alnus glutinosa* subsp. *barbata*, *Castanea sativa*, *Fagus orientalis*, *Quercus petraea* subsp. *polycarpa*, *Quercus pontica*, *Quercus hartwissiana*, *Ostrya carpinifolia*, *Tilia dasystyla* subsp. *caucasica*, *Betula medwediewii*, *Pinus sylvestris*, *Abies nordmanniana*, *Picea orientalis*, *Vaccinium myrtillus*, *Epigaea gaultherioides*, *Cistus creticus*, *Cistus salvifolius*, *Acer trautwetterii*, *Acer campestre*, *Acer cappadocicum*, *Euonymus europaeus*, *Euonymus leiphloeus*, *Hypericum androsaemum*, *Hypericum xylosteifolium*, *Prunus laurocerasus*, *Rosa pimpinellifolia*, *Mespilus germanica*, *Jasminium fruticans*, *Carpinus orientalis*, *Crataegus monogyna*, *Sorbus aucuparia*, *Cotinus cogyria*, *Sambucus nigra*, *Buxus sempervirens*, *Juglans regia*, *Rhododendron ponticum*, *Rhododendron luteum*, *Punica granatum*. In addition, there are winding plants such as *Hedera colchica*, *Periploca gracea*, *Clematis vitalba*. There are many herbaceous plant species such as *Achillea millefolium*, *Galanthus krasnovii*, *Hypericum perforatum*, *Lilium kesselringianum*, *Primula vulgaris*, *Primula elatior*, *Sedum album*, *Saponaria prostrata*, *Salvia sclarea*, *Salvia verticillata*, *Origanum rotundifolium*, *Teucrium polium*, *Satureja hortensis*, *Trifolium pratense*, *Plantago major*, *Tussilago farfara* and *Cichorium intybus*.

Fruit trees were uprooted from different areas in Artvin and transferred to the fruiting species gene collection area. The planted fruit trees were mainly Walnut (*Juglans regia*), Mulberry (*Morus alba*), Apple (*Malus domestica*), Cherry (*Prunus avium*), Mandarin (*Citrus reticulata*), Pomegranate (*Punica granatum*), Persimmon (*Diospyros kaki*), Loquat (*Eriobotrya japonica*), Linden (*Tilia dasystyla* subsp. *caucasica*) and olive (*Olea europaea*) trees, as well as apple (*Malus* spp.) and pear (*Pyrus* spp.) rootstocks obtained from nurseries.

In the collection of honey and forage plants; there are a lot of honey plants such as *Acer campestre*, *Arbutus andrachne*, *Castanea sativa*, *Cistus salvifolius*, *Cornus sanguinea*, *Diospyros lotus*, *Diospyros kaki*, *Centaurea macrocephala*, *Echium vulgare*, *Echium italicum*, *Crataegus microphylla*, *Crataegus orientalis*, *Prunus laurocerasus*, *Laurus nobilis*, *Lythrum salicaria*, *Cotoneaster nummularia*, *Origanum vulgare*, *Paliurus spina-christi*, *Satureja hortensis*, *Teucrium polium* as well as fodder plants such as *Onobrychis sativa*, *Medicago sativa*, *Vicia cracca*, *Lathyrus laxiflorus*. The collection is planned to be developed.

In the immediate surroundings of the buildings, grasses, ground covers and hugging plants that contribute to lowering the temperature felt in and around the building and on the retaining wall surfaces, creating microclimate environments were used. In addition to the aesthetic features of hedgerow plants, functional features such as wind and sound blocking, noise and image blocking were utilized in landscape planning. There are 15 different species of hedge plants in this collection. Hedge plants that can fulfill these functions are exhibited in front of the wire fence that defines the outer boundaries of ANGBB, in the labyrinth garden and many other areas. The hedge plants used include *Pyracantha coccinea*, *Platycladus orientalis*, *Viburnum tinus* and *Carpinus betulus*. ANGBB's "Fern Collection" was prepared to showcase Artvin's fern diversity. One of the remarkable plants of the collection is the King's Fern (*Osmunda regalis*).

Rock gardens are generally found in most botanical gardens around the world and their design is inspired by nature. The plants selected in this collection are generally selected from plants that can grow in very little soil and at high altitudes. In addition to rock gardens, there are also rock crack gardens in the garden, which contain plants that grow between rock cracks and contain less soil area. The collection of plants such as *Sedum album*, *Sedum gracile*, *Valeriana rubra*, *Valeriana erotica*, *Potentilla divina*, *Veronica liwanensis*, *Campanula betulifolia*, *Scrophularia chrysantha*, *Asphodeline lutea*, *Asplenium ceterach*, which are found in natural rocky areas in the province of Artvin, are transferred to different areas of the garden.

For the cactus and succulent plants collection, a special section has been created in the R&D and Exhibition greenhouse. For the bulbous plants collection, plants belonging to genera such as *Muscari*, *Galanthus*, *Fritillaria*, *Tulipa* transferred from nature are currently grown in the greenhouse.

In order to create vertical gardens on the retaining walls, a collection of climbing plants consisting of species such as *Wisteria floribunda*, *Wisteria sinensis*, *Campsis radicans*, *Clematis spp*, *Passiflora incarnata*, *Rhynchospermum jasmynoides*, *Bougainvillea spectabilis*, *Bougainvillea glabra*, *Hedera helix*, *Parthenocissus tricuspidata*, *Parthenocissus quinquefolia* was created.

Aquatic plant collections were created with aesthetic plants such as *Lythrum salicaria*, *Juncus effusus*, *Nuphar lutea*, *Nymphaea alba*, *Typha latifolia*, *Epilobium hirsutum*, *Nasturtium officinale*, *Primula auriculata*, *Drosera rotundifolia*, *Nelumbo nucifera* in the biological pond and on the water surfaces created on the ground.

There are around 850 medicinal-aromatic plants with natural distribution in Artvin province [20]. 250 of these species are grown in the medicinal-aromatic plants collection area. In addition, while selecting the plant groups in the botanical garden, studies are carried out on the plants of the world in order to gain an international identity, as well as the plants in the local and Turkish flora, and it aims to show some special plants to its visitors. In this context, we cooperate with international botanical gardens and receive seed support. Thus, in the near future, it will become a garden with many international plants [24].

#### 3.4. Strategies for sustainable approach in the botanical garden

The botanical garden differs from other parks because it contains plant collections, greenhouses, administrative structure, laboratories, technical equipment area and also because of its educational and researcher aspect. Ecological conditions, transportation and irrigation facilities are important for the sustainability of the garden. When the idea of developing a new botanical garden emerged, a feasibility study was conducted to assess the suitability and sustainable qualities of ANGBB's site [18], and an international workshop was organized with the participation of foreign scientists [19].

The main sustainable approach of ANGBB is to create a center where biological diversity is protected, preserved and recorded. Within the rich biological diversity of our country, it is to carry out studies for the protection and production of endangered species, especially endemic plant species, to study their biology, and to create suitable living environments as much as possible. For this purpose; water surfaces and water lines were created in the area.

Developing effective methods and techniques to ensure the continuity of plant collections in the botanical garden is important for sustainability. In addition to the ANGBB Herbarium, the DNA of plants is studied and recorded in the national gene bank. Scientific research activities are carried out to create and develop living plant and seed collections. In order to ensure the continuity of plant collections, plant materials are collected from nature, identified and systematically recorded by adding them to all collections. Research is carried out in the fields of taxonomy, phylogeny, biodiversity, ethnobotany and conservation biology to improve the collections.

In order to ensure the protection of entomological elements without harming the plant diversity in the botanical garden, biological control methods are used throughout the area instead of chemical spraying. In addition, there is a compost area in a section of the garden that is not open to visitors, which is created with green waste from the garden.

Animal manure purchased from livestock farmers in the region is stored in the storage area and is mixed with soil and sand when needed.

Low maintenance plants and plant species compatible with the ecological structure of the region are used in plant design. There is a goal of preserving and collecting plants belonging to the geography of Turkey and all geographies of the world in indoor or outdoor areas. In the parceling works carried out in line with this goal, it is aimed to carry out low-cost planting works in both maintenance and operation and installation of the remaining areas as well as areas where plants suitable for the ecological structure of the region can be modeled. For this purpose, natural plants of the region were used and their natural distribution was supported.

It is important to produce and cultivate plant species that are valuable in terms of economic sustainability and contribute to the national economy. In this direction, ANGBB provides the detection, identification, production, reproductive biology, chemical contents and ethnobotanical characteristics of plant species that can contribute to the national economy. It is thought that the research information obtained and the results of phytochemical analyzes will help the relevant parties and other researchers to work in this direction, not to cultivate plant species that can contribute to the national economy.

Recycling and renewable resources are also given importance in the garden. Solar panels are planned to be installed on the roofs to utilize solar energy and a storage area where rainwater is used for garden irrigation. One of the main factors in the sustainability of Botanical Gardens is that they appeal to all segments of society. In the design of the garden, the principle that solutions for disabled individuals are a part of the design has been adopted. In addition, accessibility has been ensured by considering that not only disabled individuals but also all disadvantaged groups can visit the area.

For the sustainability of botanical gardens, it is important to ensure their legibility and to take place in the memory of the society. For this, it is important to have informative signs and labels in addition to plant designs. In ANGBB, directional signs have been arranged to facilitate circulation within the area, but they have not yet been completed. Likewise, the labeling of plants in the area is currently done in the form of temporary labels. Design work is ongoing to design permanent plant labels so that the text on the signs and labels can be read and understood by everyone. In addition, it is planned to include barcode and QR code applications that will be associated with the ANGBB database and embossed text so that visually impaired individuals can recognize the plants.

A management scheme has been created for a sustainable administrative planning. This scheme consists of a directorate, central units and departments. The units reporting to the center are accounting, purchasing, business and marketing, administrative affairs, archives, library, security, internal and external relations, human resources and legal affairs. The departments under the center consist of seven divisions: administrative and institutional services division, plant sciences division, visitor services-education and courses division, property and facilities management division, plant health division, scientific agriculture division, seed bank and gene center division. While creating ANGBB, planning decisions were taken according to BGCI's accreditation checklist, especially to include structural and spatial units in the area. ANGBB received BGCI membership certificate in 2023. With this membership, it has gained international recognition by joining the largest global network of botanical gardens and conservation institutions worldwide. In addition, it is important in terms of sustainability that it provides advantages such as access to grants from the Global Botanic Garden Fund, training courses, and discounted participation in congresses.

Educational units such as the library and herbarium are planned to be easily accessible to researchers and students. Education is important for sustainability and ANGBB plans courses, trainings and events for this purpose. For example, courses such as medical aromatic plant cultivation and cosmetic product production training are offered; seed planting and sapling planting activities are organized for students in cooperation with the Directorate of National Education.

The number of people working in scientific, educational and horticultural activities should be in direct proportion to the size of the garden. In this context, the number of people working in ANGBB is quite insufficient. This naturally increases the number of responsibilities per person and causes some of the work in the garden to be unable to be done. The activities carried out in the garden are carried out with the support of the university, the ANG Foundation, donations and collaborations with other institutions. Although there is not yet a fee at the entrance to the garden, an entrance fee will soon be charged, creating an important source of income that will contribute to the sustainability of the garden.

#### 4. Conclusions and discussion

ANGBB will fulfill its nature conservation mission with its 12 different collections. However, the small number of employees allows for the execution of mandatory works. However, there are volunteers working continuously in different parts of the garden. They help with events and general garden work. This also helps to spread the aims and objectives of the garden more quickly. Due to the large size of the area and its continuous development, more staff is needed and this need is met with the support of the staff working within the university.

In line with the planning and design principles of the Botanical Garden, it is important to define general and long-term goals in terms of sustainability. In this context, a sustainable strategic plan is needed. As part of creating a strategic plan, it is necessary to identify the major threats, opportunities, strengths and weaknesses that the garden may face while trying to achieve its goals. One of the best opportunities of ANGBB is that it is located within a university and is in constant collaboration with university academic staff for various scientific research. ANGBB actively cooperates with domestic and international organizations.

Despite the small number of personnel working in the botanical garden, the enthusiastic- excited working understanding and motivation should be maintained, trained and experienced gardeners should be included in the garden, and continuous professional training of garden staff should be provided. In addition, the diversity of activities in the botanical garden should be increased and improved. The development of infrastructure in education should continue. Scientific studies should be increased in the garden within the university. ANGBB should be promoted more in the media and digital platforms, and the contributions of the garden to the region should be explained and the public should be made aware of this issue.

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