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ÉGHAJLATVÁLTOZÁS-MÉRSÉKLÉSI ÉS -ALKALMAZKODÁSI STRATÉGIÁK TÖRTÉNELMI BOTANIKUS KERTEKBEN

CLIMATE CHANGE MITIGATION AND ADAPTATION STRATEGIES IN HISTORIC BOTANIC GARDENS

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ABSZTRAKT

Az éghajlatváltozás témája előtérbe kerül, és a biológiai sokféleség (biodiverzitás) válságára adott válaszként a botanikus kertek megmutatták alapvető szerepüket a biológiai sokféleség aktív megőrzésében. Mivel a botanikus kertek őshonos és egzotikus növényfajok élő gyűjteményei, ki vannak téve az éghajlatváltozás potenciális veszélyeinek. Ez a tanulmány megvizsgálja és elemzi az éghajlatváltozás mérséklésére és az ahhoz való alkalmazkodásra szolgáló megoldásokat, amelyeket két vezető botanikus kert valósított meg: a Kew Gardens (Kewi Királyi Botanikus Kert) és a Royal Botanic Gardens Victoria (Királyi Botanikus Kertek Victoria, Melbourne). A tanulmány először azonosítja azokat a fő kihívásokat és potenciális kockázatokat, amelyekkel a botanikus kertek szembesülnek az éghajlatváltozás árnyékában. Másodszor, feltárja és kiemeli a két esettanulmányban alkalmazott fenntartható megoldásokat, amelyek célja az ökoszisztéma ellenálló képességének növelése és a biológiai sokféleség előmozdítása. Végül a kutatás bemutatja az alkalmazott stratégiák lehetséges eredményeit a kertek ökológiai és menedzsment szempontjaira nézve. Ezen túlmenően, a tanulmány megállapításai hangsúlyozzák e konzervációs stratégiák relevanciáját a jövőbeni természetvédelmi kezdeményezések kialakításában is, a botanikus kertek keretein túl.

Kulcsszavak: Botanikusk kertek, Klímaváltozás (or: Éghajlatváltozás), Növényvédelem (or: Növényi konzerváció), Fenntarthatóság, Klímaalkalmazkodás ⦿

ABSTRACT

As discussions around climate change intensify and as a response to the biodiversity crisis, botanic gardens have shown their fundamental role in the active conservation of biodiversity. Being a living collection of native and exotic plant species, botanic gardens are subject to potential threats from climate change. This paper investigates and analyses the climate change mitigation and adaptation solutions implemented by two leading botanic gardens: Kew Gardens and the Royal Botanic Gardens Victoria in Melbourne. The study first identifies the major challenges that botanic gardens face in the shadow of climate change and its potential risks. Second, it explores and highlights the applied sustainable solutions in the two case studies, aiming to enhance the ecosystem's resilience and foster biodiversity. Lastly, the research presents the potential results of the applied strategies on the ecological and managemental aspects of the gardens. Furthermore, the findings of this study emphasise the relevance of these conservation strategies in shaping future conservation initiatives extending beyond botanic gardens.

Keywords: botanic gardens, climate change, plant conservation, sustainability, climate adaptation.

INTRODUCTION

Climate change is the most pressing challenge for the 21st century, with impacts on ecosystems, biodiversity and human societies. According to the Intergovernmental Panel on Climate Change (IPCC), significant damage has already been caused by climate change in addition to irreversible losses (Calvin et al, 2023: 15). According to the 2023 IPCC report, global greenhouse gas emissions have continued to increase, contributing to global warming. As a result, since 1970, the global surface temperature has risen rapidly, more than in any 50-year period in the last two millennia (Calvin et al, 2023: 17), and several changes and impacts have been documented globally in terms of environmental issues and biodiversity loss.

Botanic gardens are at particular risk from climate impacts due to their live collections of plants, which have highly diverse eco-physiological needs, many of which do not fall within their natural climate ranges. In addition, botanic gardens serve as centres for seed banking, scientific research, education and the conservation of plant species. They are important institutions in the global adaptation effort, so it is imperative to understand how they are affected by climate change. Botanic gardens' ex-situ collections can be threatened by extreme hot weather events, shifts in patterns of seasonal rainfall, the expansion of pests and diseases, and the alteration of microclimates at local level. Thus, understanding how these organisations will react to climate-related stressors is critical to both site-level management and the formulation of effective conservation policies.

This paper explores the adaptive strategies used by botanic gardens as a potential climate change mitigation solution. The study is based on reviewing the case studies of Royal Botanic Garden Melbourne and Royal Botanic Gardens, Kew, and synthesising their expert insights on climate change adaptation. The aim is to identify the best practices adopted by these gardens and their innovative approaches that can enhance the resilience of their ecosystems. This work is significant, because it not only addresses the immediate needs of botanic gardens, but also contributes to broader efforts in biodiversity conservation and climate change adaptation.

The two case studies examined in this paper were chosen based on their status as globally respected institutions, and they also exist within two different climatic environments. Because of this difference in climates, each garden provides an opportunity to see how differing climatic environments have created differing adaptations by means of the garden's plants.

MATERIALS AND METHODS

The paper employs a qualitative case study approach to explore how historic botanic gardens are responding to climate change challenges. The study focuses on two cases: Royal Botanic Gardens, Kew and Royal Botanic Gardens Victoria in Melbourne. The gardens were chosen due to their significant history of biodiversity

Figure 1: Five-step plan to become climate-positive.
SOURCE: ROYAL BOTANIC GARDENS, KEW, 2021:18

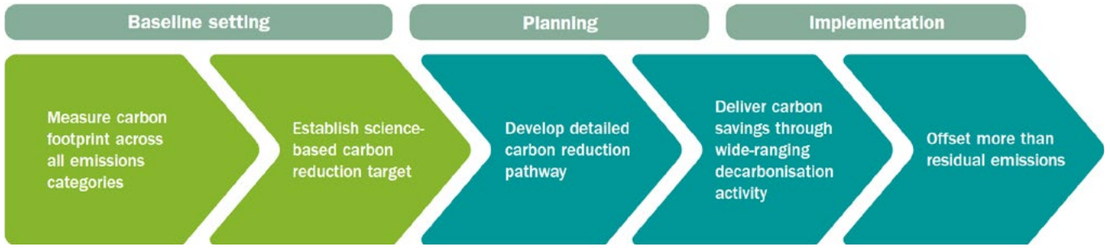
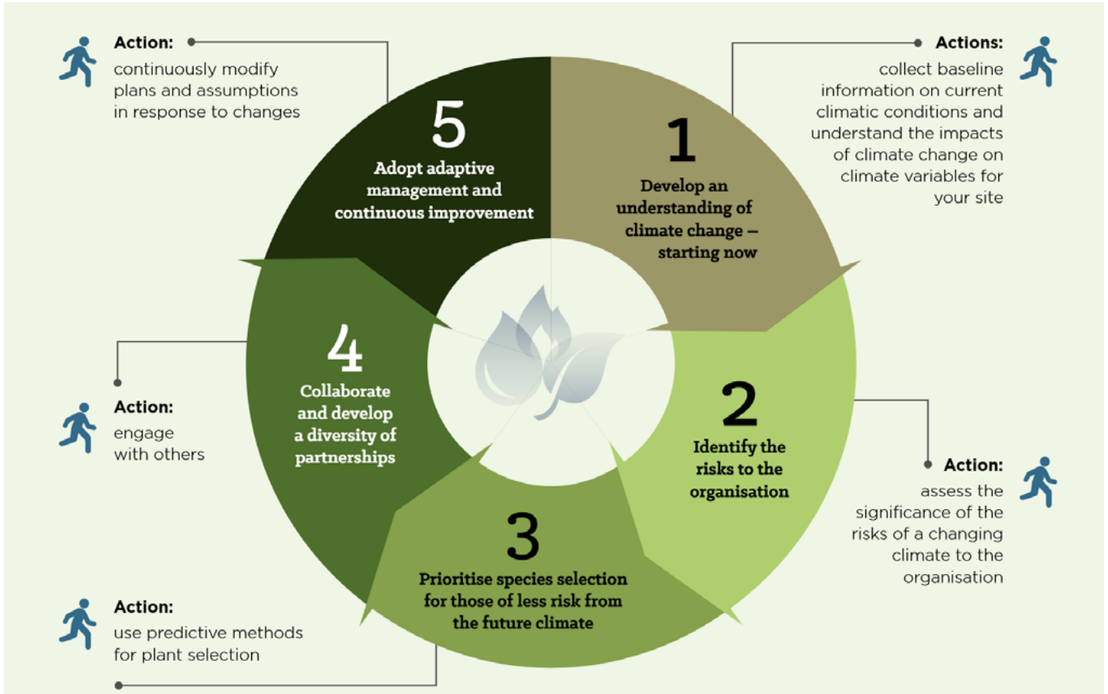


Figure 2: Landscape Succession for 'Climate Ready' Botanic Gardens: A Landscape Succession Toolkit
SOURCE: CLIMATE CHANGE ALLIANCE OF BOTANIC GARDENS 2022:7



conservation and their proactive engagement in climate adaptation strategies. In this research, we studied thoroughly the published strategies applied by both botanic gardens and highlighted the different approaches, priorities and implementation measures with respect to climate change adaptation. Additionally, both botanic gardens have published detailed documentation, allowing for a reliable comparison within the scope of this research.

RESULTS AND DISCUSSION

1 – Climate Positive, Royal Botanic Gardens, Kew

Climate change in the UK

Due to its large and vulnerable plant collection, Kew Gardens is a significant target for climate change. In fact, according to the UK Climate Impacts Programme, the UK will have a significantly warmer climate by the end of the 21st century. Based on their projections, if carbon emissions remain high, yearly average summer temperatures will increase by between 0.9 °C and 5.4 °C (Lowe et al, 2018: 4).

Climate Positive by 2030

Kew Gardens have been on the world heritage list since 2003, with several elements showing different styles of landscape design from the 18th to the 20th century (UNESCO World Heritage Centre:1). It has been a scientific centre since 1759. For the last 250 years, it has focused on documentation and plant conservation, and now possesses the world's largest fungal collection (Hopper, 2015: 1).

The institution has launched several programmes and strategies both on global and local levels to ensure the sustainability of the garden and its elements. In 2021, Kew Gardens launched their climate change mitigation project, "Climate Positive by 2030", the main objective of which is to act urgently to tackle the climate change crisis and biodiversity loss (Royal Botanic Garden Kew, 2021: 4).

The strategy is based on three main aspects: firstly, taking tangible action to achieve sustainability and minimise the impacts of climate change; secondly, to leverage their expertise to apply the planned actions and reach their goals; and lastly, to use their global network to raise awareness about climate change and also encourage their partners and collaborators to participate (Royal Botanic Gardens, Kew, 2021: 18).

Action

Kew Gardens' management drew up an action plan to reach climate positivity by 2030, framed within a five-step approach. The first step involves establishing a baseline, which will enable accurate tracking and quantification of the carbon footprint in all categories of emissions. The plan includes a promise to show annual emissions and works to cut the carbon footprint as fast as it can to reach the expected targets for reducing emissions. The outline highlights continuous cuts in carbon emissions by using energy-efficient practices, adopting electric heating and vehicles, and making all stakeholders more aware of green behaviours (Royal Botanic Gardens, Kew, 2021: 16).

Also, the plan aims to improve maintenance within the garden. This includes updating the irrigation strategies and the collection of rainwater; moreover, the plan aims to offset carbon emissions by introducing sustainable means of transport for visitors and the garden's staff. Lastly, the strategy plans to launch a recycling programme, along with setting strict sustainability key performance indicators in investment contracts (Royal Botanic Gardens, Kew, 2021: 19).

Expertise

Kew Gardens is using its internationally recognised expert knowledge in plant science to promote environmentally sustainable solutions that tackle both the impacts of climate change on global ecosystems and the loss of biodiversity. Kew's strategy includes increasing biodiversity, informing governmental policy and providing innovative sustainable solutions. Staff members also play an important role in supporting environmental initiatives at Kew Gardens and enhancing the capacity of the organisation to provide improved monitoring and reporting on all activities taking place at the site (Royal Botanic Gardens, Kew, 2021: 36).

Voice

Royal Botanic Gardens, Kew is a leading global institution, renowned for its cultural, historical and scientific contributions. Its strategy focuses on promoting sustainability best practices worldwide, raising awareness of environmental threats and encouraging urgent action. Kew Gardens emphasises fostering a respectful relationship with nature and plans to engage in public debates on sustainability by offering practical solutions and highlighting their impacts on communities. The garden also aims to showcase its scientific advancements in sustainability to inspire visitors to become advocates for climate and biodiversity (Royal Botanic Gardens, Kew, 2021:44).

Conclusion

Royal Botanic Gardens, Kew used its expertise to evaluate the impacts of climate change on its premises by measuring carbon emissions and assessing its day-to-day activities. This study resulted in the development of the climate-positive strategy, intending to further sustainability within the gardens. Moreover, the garden is committed to raising awareness, sharing expertise and engaging their partners, staff and visitors in tackling biodiversity and environmental issues.

2 – Landscape succession, Royal Botanic Victoria Gardens

The Royal Botanic Gardens Victoria, Melbourne has been a significant botanic research centre worldwide since it was created in 1846. It presently hosts more than 8,000 taxa from all over the world, representing habitats of vast ranges. The garden covers an area of 38 hectares and is a

typical example of the landscape style of the 19th century, which integrates a picturesque garden art style with both botanic and collection elements (the Victorian Heritage Database, 2002: 1).

The botanic garden and its plant collections have been sources of research, education and conservation activities, but also an area of high aesthetic and cultural entertainment value (Symes, 2017: 138). The garden hosts living collections of local and rare flora as well as a repository for plants at risk of extinction. Thematic plantings in the garden relate to different geographical, horticultural and ecological themes (the Victorian Heritage Database, 2002: 2).

Climate change in Melbourne

The climate projection assessment in Melbourne's botanic gardens was based on the global Representative Concentration Pathway (RCP) developed and adapted by the Intergovernmental Panel on Climate Change (IPCC). The gardens based their strategy on two scenarios, (4.5) and (8.5) (Kendal & Farrar, 2017: 7). The scenarios anticipate a slightly different temperature increase; by 2050, the temperature will rise by 1.7 °C for RCP (4.5) and by 3 °C for RCP (8.5) (Kendal & Farrar, 2017: 9; Met Office, 2018: 1).

The landscape succession strategy

In 2018, the Royal Botanic Gardens hosted the "Botanic Gardens Climate Change" summit, where 13 representatives from several universal botanic gardens launched the Climate Change Alliance of Botanic Gardens (CCABG), aiming to tackle the climate change impacts on fragile sites like botanic gardens (Climate Change Alliance of Botanic Gardens, 2021: 8). The CCABG published a "Landscape Succession Toolkit" and promoted it as an adaptative solution to the projected climate change. Moreover, the gardens documented a step-by-step process to achieve optimal results (Climate Change Alliance of Botanic Gardens, 2021: 8).

The toolkit developed by the CCABG contains five main actions within a process to achieve the ultimate goal of landscape succession (Climate Change Alliance of Botanic Gardens, 2021: 6):

① Conduct a scientific assessment of projected climate impacts by comparing historical data with future scenarios and analysing their effects on the garden's ecosystem.
② Evaluate the existing plant collection to determine which species are vulnerable and which are likely to be resilient under future climate conditions.
③ Prioritise the protection and use of plant species with a higher resilience to projected temperature increases.
④ Promote collaborative action by engaging in partnerships and networks to share expertise and strengthen collective responses to climate change.
⑤ Apply continuous adaptive management by setting goals, implementing actions, monitoring outcomes and adjusting strategies as needed.

In 2016, the Royal Botanic Gardens Victoria launched their landscape succession strategy, which will run over the next 20 years. It aims to preserve the diversity of the plant species within the gardens and to enable 75% of the total plant species to transition and thereby adapt to the projected climate of Melbourne in 2090 (Entwisle et al., 2017: 342).

In order to achieve the landscape succession goals, the Royal Botanic Gardens Victoria developed, documented and published their landscape succession strategy. They will firstly focus on building databases, improving assessment methods and partnering with others to conserve the botanic garden's rare flora and orient plant collections towards future climates. They plan to have more than 8,400 taxa of varied ages by 2036 for plant diversity, meet all irrigation needs sustainably by 2020 and improve landscape design for climate resilience. They will also strengthen public engagement and communication to raise awareness in the community about climate change, biodiversity and environmental benefits (Royal Botanic Gardens Board Victoria, 2016: 5).

The implementation of the landscape succession strategy will be ongoing in the Melbourne Botanic Gardens until 2036. While the final results of the project are not yet available, the garden's management is confident that the garden is fully ready to adapt to the projected climate and the upcoming changes (Entwisle et al., 2017: 342).

3. Conclusion

Because of their fragile collections and their history of expertise, botanic gardens are more committed globally to the conservation of biodiversity and climate change mitigation (Ali & Trivedi, 2011: 295). This paper has collected two precedents showcasing the implementation of science-based technologies to either adapt to the future climate or readjust carbon emissions to achieve sustainable site management. Moreover, both precedents prioritised documenting and sharing their knowledge and expertise as a core objective, which indicates that the more we rely on science-based solutions globally, the more effective and measurable climate change mitigation becomes for long-term sustainability.

Kew Gardens' strategy places greater emphasis on organisational decarbonisation, energy reduction and global advocacy, while the focus of the Melbourne Botanic Gardens is on achieving a long-term transformation of their landscape through progressive species replacement and climate-ready horticulture.

Furthermore, both gardens provide examples of different but complementary philosophies of adaptation. While Kew Gardens display a mitigation-oriented institutional model incorporating research, policy influence and hardware improvements, the Melbourne Gardens exhibit an ecological-design approach that focuses on planting for future climate conditions and creating climate-resilient communities.

Finally, both strategies represent successful examples of how scientific and experimental methods can be integrated and show how these methods will help create resiliency within an institution during periods of climate change. ⦿

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