Building Biodiverse Urban Forests in the Post-Soviet City

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Abstract

This visual essay outlines how Ruderal, a studio based in Tbilisi, Georgia, has developed new approaches to urban forestry applicable to the legacy of Soviet-era forests. The collapse of the Georgian Soviet Socialist Republic and the resulting rapid privatization led to the reduction and degradation of Tbilisi's public spaces. Ruderal's approach to urban forestry is presented in three projects: the Mtatsminda Pilot Project (including Narikala Ridge), the Betania House Forest Garden, and the Arsenal Oasis Project. The projects illustrate how a new practice of urban forestry has grown from the limitations and opportunities of Tbilisi's urban context. Ruderal's practice pursues interventions at multiple scales along the following forestry principles: 1) grafting into baseline conditions; 2) utilising and expanding the 'fertile section'; 3) incorporating genetic diversity and species competition.

Keywords

Biodiversity, Georgia, Landscape architecture, Tbilisi, urban forestry, urban soils, species competition, forest management.

DOI

https://doi.org/10.47982/spool.2025.1.05

Introduction

Contemporary urban forests are products of a city's history, revealing material conditions, scientific histories, and politics. Understanding these conditions, which are entangled with the growth of an 'urban forest,' can reveal opportunities to amplify the biodiversity and ecosystem health of future urban forests (Nilsson, 2012). This visual essay outlines how Ruderal, a studio located in Tbilisi, Republic of Georgia, has developed approaches to urban forestry specific to the history and milieu of a post-Soviet city.

Ecologists use the term *ruderal*, from the Latin *rudus* (rubble), to describe disturbance-adapted species. By naming our studio Ruderal, we open a field of practice that probes multiple interpretations of the term: thriving in a context of scarcity; resilience in the face of disturbance; and privileging adaptation over stasis. Ruderal's work is about 'making do' within and 'doing more' beyond what is at hand to rebuild and adapt forestry knowledge networks.

In the 20th century, as Tbilisi grew, environmental planners applied Soviet-standard methods to improve the city's environment. From the 1920s–1930s, foresters planted pine trees throughout the city and surrounding areas, continuing through the 1950s–1960s. During this period, Stalin ordered the mobilization of the 'Great Plan for the Transformation of Nature,' an afforestation project to combat erosion and unstable water supplies throughout the semi-arid landscapes of the eastern USSR. Stalin's Plan endorsed the 'nest-method' approach of the agronomist Trofim Denisovich Lysenko, who advanced the now-disproven theory that individuals within a species could act collectively and even sacrifice themselves to protect plantations (Brain, 2010). In this context, officials in Tbilisi established a monoculture of *Pinus nigra* on Mtatsminda and Narikala Ridge, using dynamite to blast terraces of planting 'pockets' into the mountain's steepest slopes.

Anecdotal evidence suggests Tbilisi's Soviet city planners intended for this afforestation to address issues like wind speed, air quality, summer temperatures, and landslide hazards, and even designated swathes of land for the flow of fresh air and rainwater infiltration zones to prevent catastrophic flooding. Several large-scale landscapes, such as Lisi Lake, Tbilisi Sea, and Mtatsminda Mountain, were afforested to provide these ecosystem services. The pine plantations are now experiencing infestations of pests and fungi, causing their decline. These landscapes are further threatened by privatization and development of housing and commercial use, attenuating the climate services once provided and weakening the efficacy of state-sponsored urban afforestation.

A result of the dissolution of the Soviet Union and the subsequent period of political chaos was a loss of institutional and individual knowledge of forestry; Georgia suffered mass emigration and brain drain; experts and instructors had to find work elsewhere. There are gaps in local knowledge and materials necessary to design and build biodiverse urban forests.

More recently, the Georgian Dream party (elected 2013) has directed attention and funding to renew urban open spaces. This attention to public space has been both political—to win votes for the party by promoting parks and greening—and situational—in response to disturbances such as the Vere Ravine flood of 2015 and the die-off of monocultural pine plantations that surround the city.

Ruderal was established in 2018, during the period of renewed interest and attention to public open space. Tbilisi Mayor Kakha Kaladze's agenda includes greening and renewal of the city's major boulevards and renovations of Vake Park and Miziuri Park, destroyed in the 2015 flood. These projects are co-funded by donor banks and city development agencies, such as the Tbilisi Development Fund and the Municipal

Development Fund, which are in turn funded by international funds such as the World Bank and Asian Development Bank (under the Liveable Cities Initiative).

Biodiverse afforestation projects present a logistical and cultural challenge for cities that have been shaped by monocultural approaches and economic collapse. Ruderal's Mtatsminda Pilot Project, the Betania House Forest Garden, and the Arsenal Oasis Project are presented as case studies in which local and technical knowledge are combined with a landscape architectural approach to create a more biodiverse, spatial, and beautiful urban forest practice.

This visual essay illustrates the Soviet planting projects around Tbilisi in the mid-20th century and the firm's approach to urban forestry projects between 2020–2023. Our research, design, and material practice in these projects have provided several key takeaways for contemporary practices of urban forestry. We organise these takeaways into three approaches to urban forestry, presented in the visual essay.

FIGURE 1

Terraced planting in the hills above Tbilisi, 1951.
Ruderal's Approach 1: **Grafting into Baseline Conditions**: Most post-Soviet cities were designed with robust urban and some degree of peri-urban forestry. Attending to the species composition, formal conditions (e.g. terraces, rows, allees), planting methods, and environmental context of Tbilisi's existing urban forest plantings allowed us to amplify existing plant communities rather than replace them entirely. Native forests of oak, beech, hornbeam, and ash that once blanketed the hills surrounding Tbilisi are limited to steep riparian zones. Soviet methods of afforestation focused on replacing deforested and overgrazed slopes around the city's perimeter with a limited range of evergreen species organized on keyline rows. The predominance of *Pinus nigra* in this planting approach has led to an abundance of pine-dominated patches interspersed between heavily grazed pasture land. These monocultural patches are vulnerable to pest and fungal infections, which have increased drastically over the past 20 years.
Ruderal's Approach 1a/ **Interpreting soils and planting histories**: On Mtatsminda and Narikala, the monoculture of pines altered the chemical composition of the soil, facilitating their dominance and precarity as a vulnerable monocultural forest. Ruderal uses strategies that shift these soil cultures by introducing understory and "cover crop" layers, nurse plantings, and temporary irrigation. These strategies are crucial to the success of new forest communities. (Photo: National Archives of Georgia, 1951)

FIGURE 2

Plantations around Tbilisi. Several plantations around Tbilisi include multiple species, complicating the evidence of Moscow's influence over forestry projects within the Georgian SSR. In some areas, such as Lisi Lake near Tbilisi, planting was organized in rows segregated by species, which established more diverse plant communities that now support a wider range of species. (Photo: National Archives of Georgia)

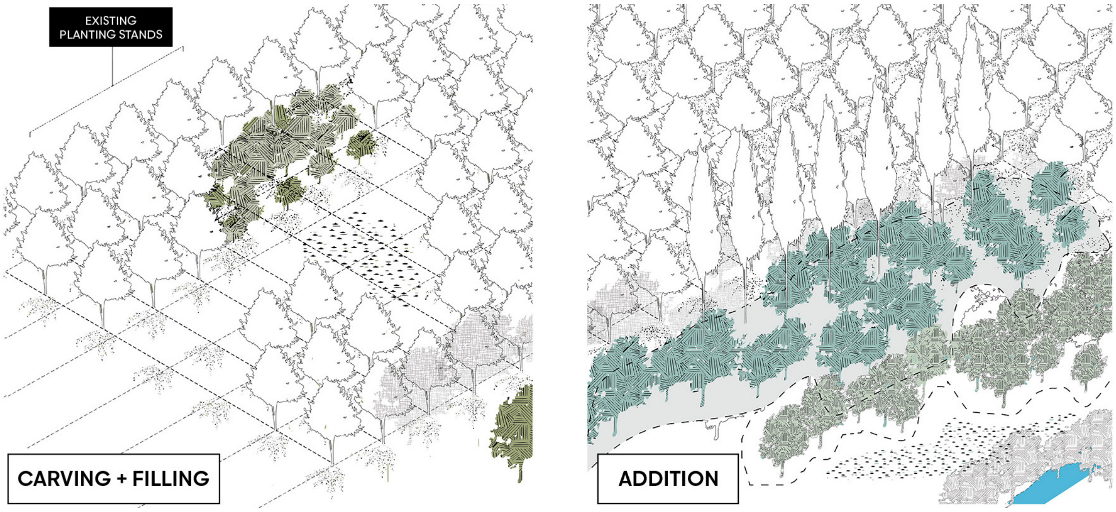


FIGURE 3

Mtatsminda Pilot Project.
Ruderal's Approach 1b/ **Plant communities approach**: In our projects, local botanists and biologists recommend species adapted to the specific conditions of each project. Ruderal selects from the palette of suitable trees and shrubs provided by these experts to showcase culturally important species in ecologically compatible plant communities (Gustavsson 2004). These plant communities were further adapted to create novel planting communities interplanted with existing patches of trees. The Mtatsminda Pilot Project was an exercise in carving out swathes of dying pines and partially filling in the gaps left behind with a diverse array of saplings to create patches of greater biodiversity that grow alongside the remaining pines. The project also incorporated 'additional' planting communities in response to wetter areas. (Diagram: the authors)

FIGURE 4

Narikala Ridge in Spring 2023. Patchwork of plant communities.
Ruderal's Approach 2/ **Utilising and Expanding the "Fertile Section"**: Much of Tbilisi's peri-urban landscape is steep and rocky. Historical practices of deforestation and over-grazing have fundamentally altered soil conditions in these landscapes, and heavily mixed and compacted soils of the city's dense neighborhoods lack the necessary nutrients for a healthy forest. Improving pockets of soil fertility can help small patches of forest thrive in built areas. Pockets of "fertile section" are areas of fertile soil in the milieu of compacted and sealed urban soils. These fertile pockets already exist within the city, and many more can be inserted, uncovered, and nurtured.
Ruderal's Approach 2a/ **Utilising the fertile section**: In order to create the midcentury pine plantations, Soviet workers created planting pockets and terraces in the rocky and steep slopes. On Mtatsminda, these pockets of fertile soil host a range of plantings, including new saplings, extant *Cedrus deodara*, and pioneer species including *Celtis caucasica* and *Cercis occidentalis*. (Drone photo: Luka Tavzarashvili, 2023)

FIGURE 5

Narikala Ridge, in central Tbilisi in Spring 2023. In the existing urban condition, hot, dry, exposed patches are directly adjacent to cooler, darker, and wetter patches hidden under well-established stands of *Cedrus deodara*. (Drone photo: Luka Tavzarashvili, 2023)

FIGURE 6

Narikala Ridge, in central Tbilisi in Spring 2024. (Photo: Ejvind Spence, 2024)

FIGURE 7

Narikala Ridge. Narikala Ridge: New planting is interspersed between the stands of *Cedrus deodara* and areas dominated by *Celtis caucasica*, establishing productive competition through a diverse range of plant adjacencies and species layering. These specimens, along with a pioneer herbaceous layer, intensify an interplay of light and dark spaces along the existing path. (Photo: Ejvind Spence, 2024)

FIGURE 8

Narikala Ridge. (Photo: Ejvind Spence, 2024)

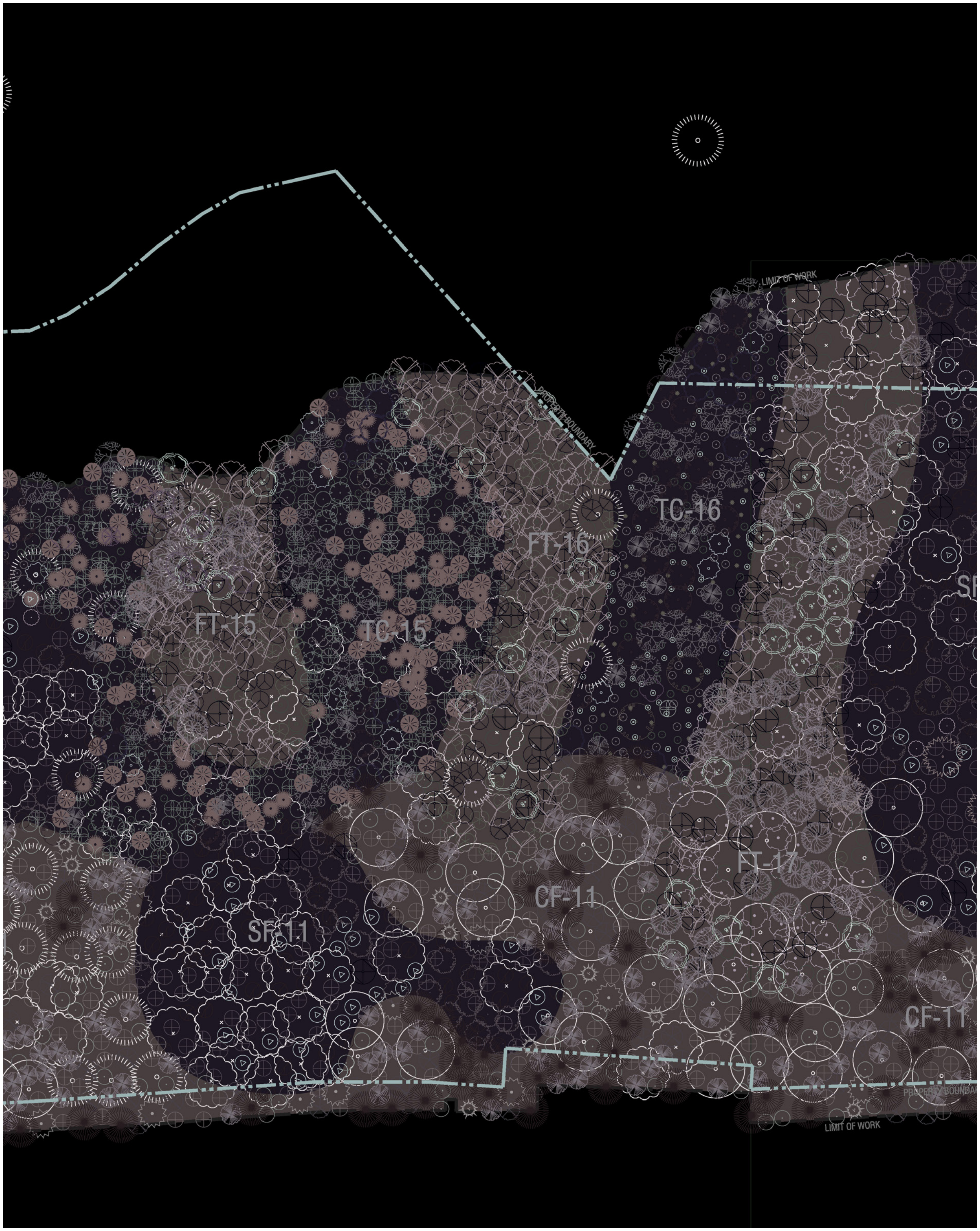


FIGURE 9

Scripting with Grasshopper. Scripting with Grasshopper facilitated rapid modelling of forest patches on the digital terrain model to account for the existing trees and plant communities that the new forest would be grafted into. The script also allowed us to adjust the species composition of each 'zone,' test species adjacency rules, and retrieve planting quantities instantly. This facilitated rapid iteration and communication between stakeholders and allowed us to design with aesthetic, technical, and logistical concerns simultaneously. (Drawing: the authors)

FIGURE 10

Okrokana South Slope. Pre-planting condition of the Okrokana South Slope, immediately after the removal of diseased patches of Pinus nigra. The patterned herbaceous layer reveals spillover from the nutrient-rich soil from Soviet-era planting pockets, organized along the original planting terraces and reinscribed by the movement and grazing patterns of local pasture animals. These pockets of fertile soil provide important footholds in which new plant communities establish. (Photo: Christian Moore)


A.2
A.3
A.1
B.1
B.2

FIGURE 11

Arsenal Oasis, Fall 2022.
Ruderal's Approach 2b/ **Expanding the fertile section**: In many cases, existing soils must be rehabilitated, often without the intensive use of soil amendments. Ruderal utilizes early-succession plant communities to strategically build organic material and microbial communities within these soils. Intervening in existing water flow patterns represents an impactful means of grafting into baseline conditions and initiating ecosystem processes that expand the fertile section. On a former military base that looms over the centre of Tbilisi, the removal of one section of a ruined concrete foundation allowed water from a broken pipe to flow across one of the terraces and into a series of lateral channels cut through the dry plateau before rejoining a wetter area below. Where water was pushed laterally along the terraced landscape, it now flows across the plateau, establishing a new wet ecosystem on a dry terrace.

(A.1) 20–30-year mid-successional dry terrace edges.

(A.2) 20–30-year mid-successional terrace edge fed by 2-year water channels;

(A.3) early-successional 2-year water channels;

(A.4) 10–20-year wet terrace edge. An eroded roadside ditch runs along the lower part of the image;

(B.1) 20–30-year mid-successional wet ditch with established woody species;

(B.2) early-successional ditch with few species;

(B.3) an informal impoundment pond with reedy species. Experimenting with links between these topographical elements informs the placement or removal of new terrace edges with a goal of densifying the patterns of the future forest by amplifying the fertile section. (Drone photo with annotation: the Authors, 2022)

FIGURE 12

Arsenal Oasis, Fall 2020. Platanus specimens anchor a new bosque planting, with *Salixs* takes prepared for understory planting to follow. A micro-scale pocket of 'fertile section' anchors the *Platanus* and kick-starts the accumulation of the herbaceous layer. (Photo: the authors, 2020)

FIGURE 13

Arsenal Oasis, Summer 2021. The expanded herbaceous layer starts to build up organic material and superficial roots, collecting wind-eroded soil and seeds, adding nutrients and establishing a seed bank within the previously sealed base course of the demolished building's concrete pad. (Photo: the authors, 2021)

FIGURE 14

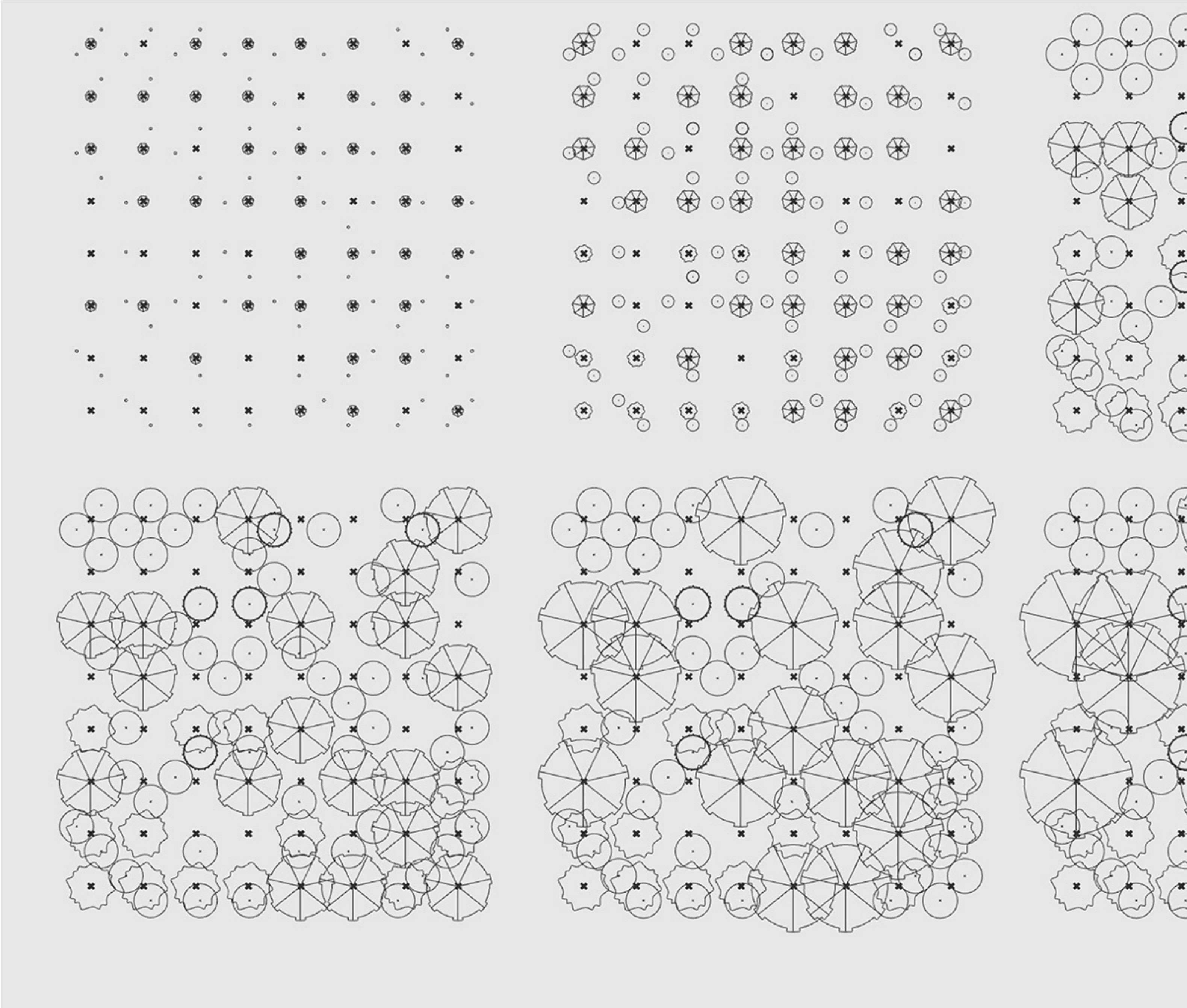
Arsenal Oasis, Spring 2023. The annual organic layer dies, decomposes, and accumulates around rocks and piles of soil surrounding the *Platanus* plantings. As the *Salix* grow large enough to compete with the *Platanus* canopy, they will be coppiced. (Photo: the authors, 2023)

FIGURE 15

Arsenal Oasis, all 2020 and Summer 2023. The 2-year-old channels demonstrate the impact that topography, particularly the practice of counter-sloping, has on spontaneous vegetation. On the north side, these trenches detain water from the cascade, while most on the south receive only runoff from precipitation. (Drone photo's: the authors 2020, 2023).

FIGURE 16

Malkhaz Sardlitsshvili's nursery. Malkhaz Sardlitsshvili's nursery in Didi Toneti in early spring, nestled on a south-facing plateau 30 km southeast of Tbilisi. Where traditional afforestation projects rely on the limited genetic stock of industrial nurseries, new urban forests can integrate the genetic diversity of the rural landscape. Project information and rapid visualization tools help incorporate multiple, smaller nurseries and allow for adjustments based on changing numbers of available trees in a complex sourcing network. This flexibility and complexity supports a meaningful level of genetic diversity in urban forest projects. (Photo: Giorgi Kolbaia)



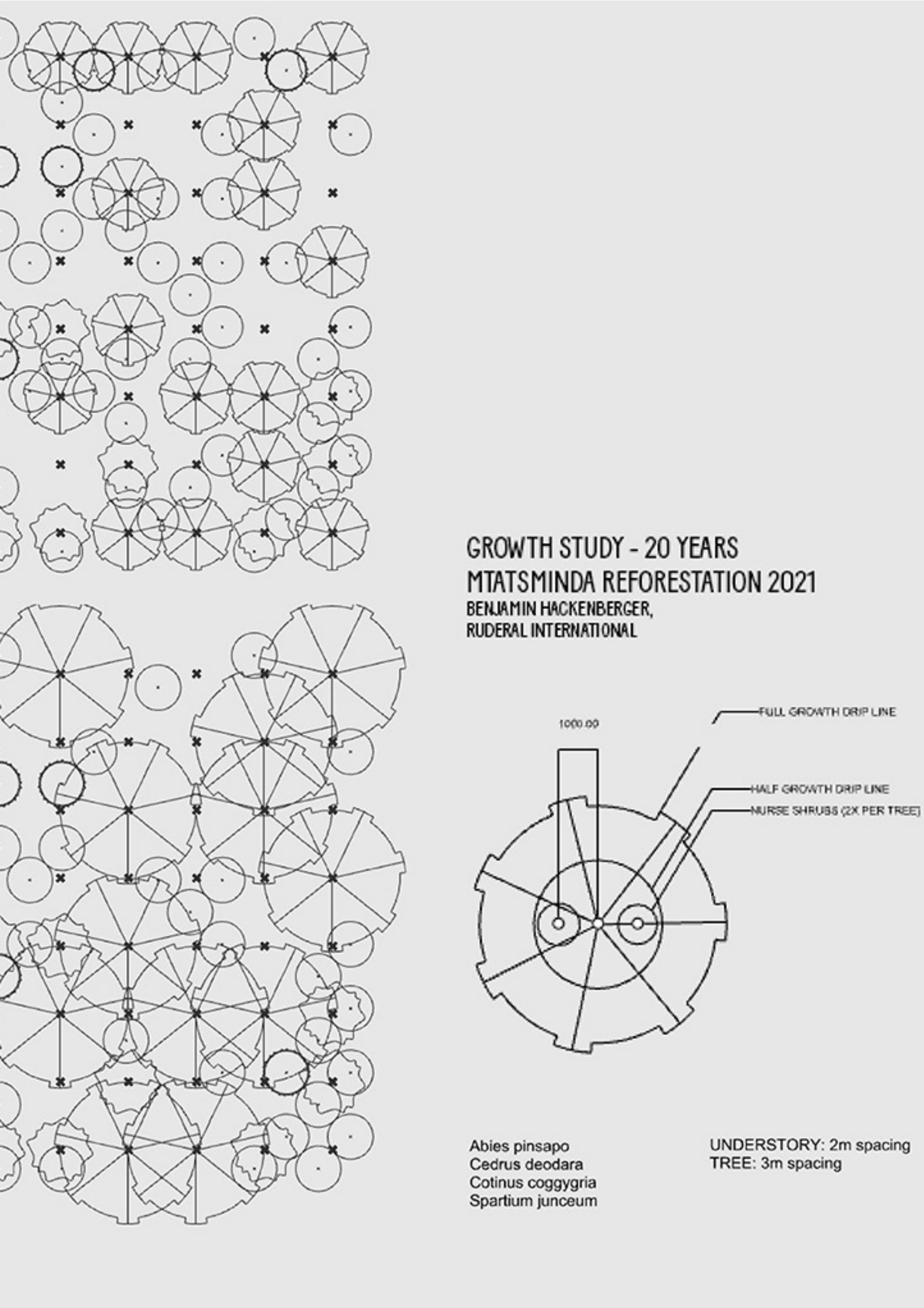


FIGURE 17

Growth simulations with simplified parameters.
Ruderal's Approach 3/ **Incorporating Genetic Diversity and Species Competition**. Urban trees in Tbilisi are typically planted in anticipation of full growth stage, and sourced from foreign nurseries with limited genetic diversity, creating a divide between the diverse landscapes of rural Georgia and the new urban canopy. Designing with species growth behaviors in mind and planting species from a wider network of Georgian nurseries can improve genetic diversity, and strategic competitive relationships can maintain biodiversity. Growth simulations with simplified parameters allow for rapid vizualisation of species composition at different stages of succession. These models allow us to study and communicate key time-based principles such as nurse planting and shade and nutrient-based competition. Conventional forestry approaches suggested a wider spacing of trees, but these models enable closer planting of younger trees by facilitating planned succession and tree removals. They also allowed us, in a context of supply limitations, to optimize the survival chances of less available species
Ruderal's Approach 3a/ **Quantity and genetic diversity of tree supply**: Suppliers for ecological planting in Georgia are limited, but are scaling up to meet new demand, as at Malkhaz Sardlitsshvili's nursery in Didi Toneti. A diversity of small suppliers introduces logistical complexity but bolsters genetic diversity. Ruderal responded to the challenge of working with several suppliers with limited inventories by linking models of forest plantings in Grasshopper to quantities of available plants. This helps to account for nursery lead times and allows us to quickly adapt to inventory changes and add new suppliers. In addition to incorporating information about complex nursery stocks, planting projects can employ digital tools to model this complexity over time. (Drawing: the authors)

FIGURE 18

Pollard Park. An experimental drawing exercise completed by Michael Cafiero, Kira Clingen, and Benjamin Hackenberger within the framework of Teresa Gali-Izard's course 'Erasing the Line While Drawing' at the Harvard University Graduate School of Design in Fall 2019. The drawing visualises a set of rules for incremental planting, pollarding, and coppicing that respond to the growth behaviour of olive and poplar trees. These types of drawing exercises inform sets of dynamic planting and management rules to be tested against actual growth patterns. With a grasp of these tools for management, designers can plan for a dynamic plant community, supporting a wider range of species and a deeper engagement with the carbon cycle. (Drawing: Michael Cafiero, Kira Clingen, and Benjamin Hackenberger)

FIGURE 19

Pre-planting condition of the Betania project, in an exurb of Tbilisi. Like many in Tbilisi's expanding peri-urban territory, this residential plot is situated on former pasture land between forest and a small valley swale. After its conversion to residential, the plot was maintained as low-intensity turf for several years.
Ruderal's Approach 3b/ **Anticipating and incorporating shorter tree lifecycles**: Ruderal's work includes planning for the introduction of other practices of management including coppicing, pollarding, and harvesting (Jönsson and Gustavsson 2022). These practices can anticipate tree life cycles and are less catastrophic than community collapse caused by unanticipated senescence or disease. In the Mtatsminda Forest Project, removing and disposing of wide swaths of vegetation cover was a shock to the wider community. Planned maintenance can anticipate succession and allow for the benefits of increased biodiversity in the five to ten year mid-successional period while reducing the risk of catastrophic community collapse. Encouraging some degree of early- and middle-stage succession by designing occasional coppicing, pollarding, and tree removal can lead to a more spatially dynamic and biodiverse urban canopy. (Drone photo: the authors)

FIGURE 20

A new forest thicket. An intensive planting of forest species brings the foliage and canopy of the surrounding forest into the territory of the residence. This new forest thicket is composed of *Fagus orientalis, Corylus spp., Fraxinus orientalis, Acer campestre, Carpinus orientalis, Tilia caucasica, Prunus cerasifera*, and *Quercus iberica*, among others, juxtaposed against the existing forest behind, composed mainly of *Carpinus* and *Fagus orientalis*. Overplanting smaller forest patches in anticipation of thinning through competition, pruning, and coppicing leverages plant behaviour to establish forest soil conditions. 'Cover-cropping' with a nitrogen-fixing herbaceous layer accelerates this process in nutrient-poor soils. The intensive planting also brings the forest to the house, providing a novel proximity to forest species that celebrates the textures of the forest and avoids an overly domestic or picturesque composition. (Photo: the Authors)

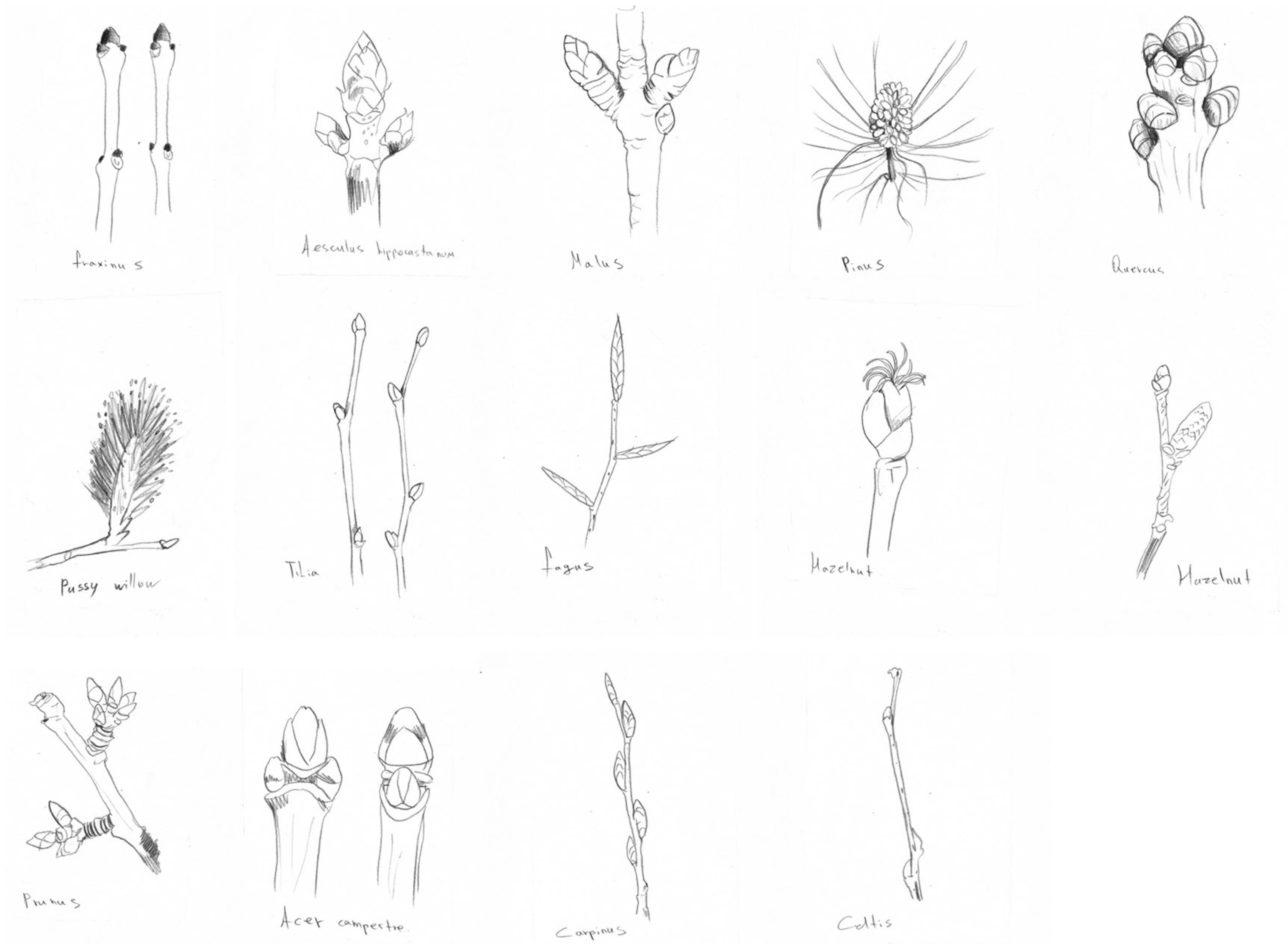


FIGURE 21

Field documentation. Field documentation carried out before and during planting identifies species by their dormant bud forms and records their location in the mini-forest, relative to other species. This documentation became the basis of studio-based experimentation in plan diagrams (see opposite page). (Field sketches: Iveta Chxikvadze)


Bottom
170 tree
95 tree
265
Tree
Acer
FaGus
prunus
Celtis
Fraxinus
Carpinus
Tilia
MaLus
ULMUS
Hazelnut
Quercus

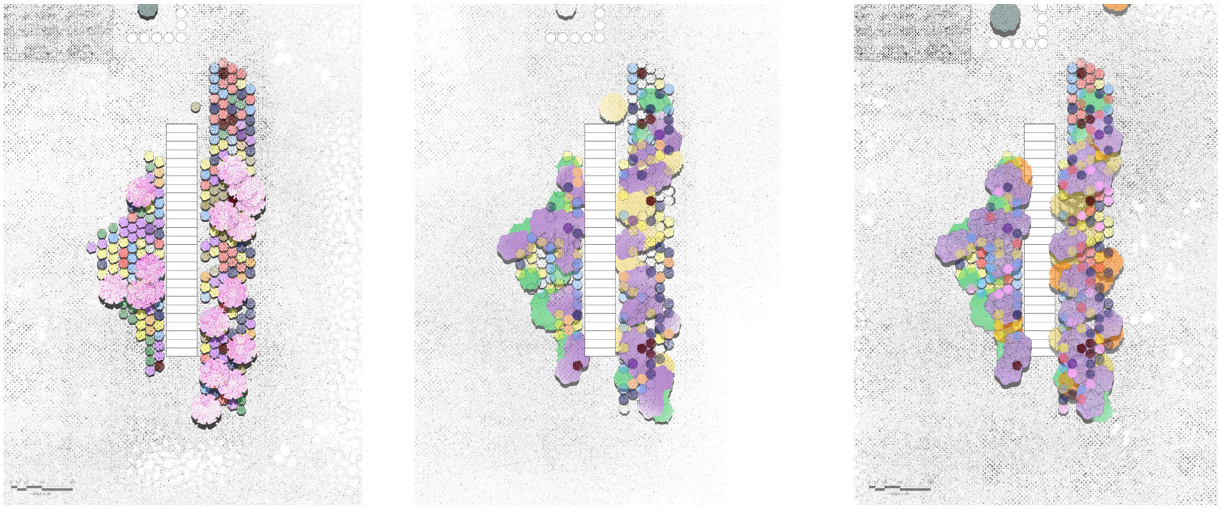


FIGURE 22

Possible scenarios. Diagram of possible scenarios for species growth and intervention over time. Planned pruning, coppicing, and pollarding allow us to speculate on competitive species behaviours and create scenarios for canopy succession. In this scenario, *Prunus cerasifera* (light pink) is coppiced before 'Phase 2,' allowing for the potential emergence of *Fagus*, *Acer*, and *Carpinus* as dominant species. These drawings are to be compared to actual growth rates in the field to plan for future canopy phases. (Drawing: Iveta Chxikvadze)

FIGURE 23

Up-close observation of the stages of plant growth and competition. The exaggerated density and close proximity of the planting encourage up-close observation of the stages of plant growth and competition, bringing a small slice of forest complexity into the spaces we live. By facilitating this proximity and designing with strategies that understand plant communities as dynamic ecosystems, we can amplify the biodiversity and value of urban forests. (Photo composition: the authors)

Acknowledgments

Christian Moore and Giorgi Nishnianidze for contribution to the planting design for Mtatsminda and Arsenal Oasis. Ana Petriashvili and the team at GeoGraphic for ecological consultation. Iveta Chxikvadze for contribution to the planting design for the Betania Forest Garden. Ejvind Spence, Luka Tavzarashvili, and Giorgi Kolbaia for photo contribution. Angela Wheeler for consulting on Soviet environmental history, Ruso Maisuradze for archival research. Michael Cafiero, Kira Clingen, and Teresa Gali-Izard for contributions to the development of the forest patch management approach.

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