

# **Hacking Chengdu's Biodiversity**

*To Design a More Livable Garden City*

**Eve Allen**

## **Abstract**

Biodiversity is the extraordinary variety of life on Earth in all of its forms and interactions. The Mountains of Southwest China contain an incredible amount of plant and animal diversity. The area covers 10% of China but is home to over 40% of its plant species. Luxelakes is situated in the garden city of Chengdu in the most botanically rich province in China, however the site lacks an abundance of plant species. Out of 12,000 plant species native to the Mountains of Southwest China, the site contains less than 1% of this diversity. The aim of this project is to develop strategies to create novel ecosystems at Luxelakes through enriching the vegetation with 200 new species. This will provide new opportunities for community activities around the themes of art, recreation, education, and science. Additionally, increasing plant diversity can help to promote civic engagement and new forms of ecological and cultural legacy for Chengdu.

## Overview of Report

This report is about hacking Chengdu's plant biodiversity to enrich the vegetation and community at Luxelakes. Plants are more than just biomass. Plants diversity, along with microorganisms, soils, and sediments, forms the foundation of landscapes (both natural and constructed), which provide an array of supporting, regulating, provisioning, and cultural services for cities and urban regions.

This report is organized into four sections. Section 1: Introduction provides background on Luxelakes Eco City, Chengdu, Sichuan's biodiversity, and why biodiversity is important for improving urban life. Section 2: Project Overview provides an outline of the research methods that I used to carry out this project. I also introduce important concepts and models and define the problem and a set of opportunities. Section 3: Project Proposal presents the design interventions and discusses how to make increasing biodiversity a practicable pursuit through the generation of a community-led plant inventorying and monitoring system. Finally, Section 4: Future Directions explores how a project of this size and scope would need to be supported by collaborations with local institutions and an investment in the environmental horticulture industry.



01 Chengdu Garden City Model at the Urban Planning Commission in Chengdu

Source: The Author

### [1] Introduction

#### Lakeslake Eco City

Located in the burgeoning Tianfu New District of Chengdu City, Luxelakes Eco City is a new town that offers city dwellers an ecologically oriented living experience that integrates a mixture of residential, business, recreation, and entertainment areas. Located south of Chengdu's historic center, Luxelakes will support a thriving community of 100,000 residents across a 1200-hectare mosaic of wetlands, terraced orchards, forest, hills, fields, and waterways.

#### Chengdu is blossoming as China's Garden City

Since the turn of the 21st century, Chengdu has experienced a rapid burst of growth. China's "Go West" policy has been successful in encouraging development in the interior portion of the country. The city has transformed into a financial, educational, scientific, technological, commercial, and communications hub (Xiang & Wang, 1991). To deal with that growth, Chengdu's city planners have borrowed from England's garden city movement, which originated in the 1890s as a way to combat the negative impacts of

urbanization (e.g., overcrowding, congestion, and air pollution).

The history and geography of Chengdu make it a natural choice for integrating garden city concepts into its urban development plans. For over 2,300 years, Chengdu has been recognized as a “land of abundance.” The city emerged from the fertile and watery low hills and plains of the Sichuan Basin. Chengdu has a mild subtropical monsoon climate with cool, cloudy winters and hot, hazy summers. The urbanized basin is surrounded by mountains that protect the low laying area from cold northern winds. For this reason, Chengdu enjoys a relatively warm winter season with an average of 300 frost-free days (Zhao 2012).

The development of the services and technology industries require less intense human labor, and urban planners believe it is possible to create a spacious garden-like environment in Chengdu. The idea is not to build parks within a city, but a city within a park. In 2018, Xi Jinping visited Chengdu and praised the concept. Since then, Chengdu officials have accelerated the garden city project through a series of ambitious of greening initiatives. For example, the Tianfu Greenway at 16,000km is planned to be the world’s longest network of paths for people to bike and walk on. The greenway will be connected to hundreds of urban parks, gardens, and protected ecological zones. The city will also use vegetation to green existing buildings, bridges, highways, and flyovers. A new park called the Forest Park to the east of Chengdu is currently under construction and will span an area of 1,275 sq. km when it is completed in 2035. Chengdu is a city that is prioritizing environmental protection, public space, and quality of life (Ibid).

## **Biodiversity**

Biodiversity is the extraordinary variety of life on Earth in all of its forms and interactions. More formally, biodiversity is nestled into interrelated levels, beginning with genes, then individual species, then communities of creatures and finally entire habitats or ecosystems—like rain forests, mangrove swamps, or coral reefs. Biodiversity has made Earth habitable for billions of years and without it there is no future for humanity.

The air we breathe, the water we drink, and the food we eat all relies on biodiversity. It is the most complex and vital feature of our planet—and it is in crisis. The richness of life

on our planet is eroding at an alarming rate. Scientists estimate that plant and animal species are vanishing 1,000 times faster than the natural rate of extinction (Müller, Werner, and Kelcey 2010). The primary driver of loss is habitat destruction that results from human demand for food, shelter, water, timber, fiber, and fuel. When ecosystems are dismantled it reduces their ability to function and provide society with the resources and services needed to prosper.



**02** Mountain and Valley Landscape in the Mountains of Southwest China

Source: Msz010dzeta



**03** Blue Magpie a bird from the Mountains of Southwest China

Source: Dajan Chiou

## **Mountains of Southwest China**

Chengdu sits in close proximity to the Mountains of Southwest China. This area harbors an incredible amount of plant, fungi, and animal diversity. According to Mittermeier et al. (2004) the area that extends from southeast Tibet through western Sichuan and extends into central and northern Yunnan is one of 36 planetary biodiversity hotspots. The area supports the most botanically rich temperate ecosystem in the world.

The hotspot which covers less than 10% of China is home to over 40% of its plant species (~12,000) and 50% of its birds and mammal species. Rapid elevation changes of over 6,000 meters between river valleys and ridge tops create a diversity of habitats that support a complete spectrum of vegetation types. The richness in animal and plant diversity form a multiplicity of landscapes from tropical, sub-tropical evergreen forests at lower altitudes to deciduous temperate forests, mixed broadleaf conifer forests, and coniferous sub-alpine forests with a dense bamboo and rhododendron understories at higher elevations.

The biological diversity is mirrored by cultural diversity. The region is home to 17 of China's 55 ethnic minority groups who over many generations have accumulated a vast amount of traditional knowledge about this unique environment. Some of the most important rivers in Asia run through this region. These include the Bramaputra, Irawaddy, Mekong Salween, and Yangtze rivers which combined affect the livelihood of more than half of a billion people who live downstream across 3 million square kilometers (CEPF 2002).

## **Nature in Cities**

Worldwide cities are turning to nature to mitigate the economic, societal, and environmental challenges caused

by urbanization and industrialization. Urban greening areas falls under the umbrella term of nature-based solutions (NBS), sometimes called green or blue-green infrastructure. These strategies can take many forms but at their core they make use of vegetation, soils, microorganisms, sediments, hydrology, and other landscape features to build or restore ecosystem structure and function. They include parks and open spaces, intentional plantings, habitat restoration, green roofs and walls, bioswales, artificial wetlands, and storm water retention ponds (Hobbie and Grimm 2020).

Human settlements are characterized by fragmented habitats, altered hydrological regimes, homogenous plant communities, nutrients and pollutants, impervious surfaces, carbon dioxide, increased temperature, and soil compaction (Forman 2014). An expanding body of research is helping to mount evidence that nature-based solutions are a valid strategy for urban regeneration and climate change adaptation, as they help to minimize the negative effects of the built environment on human health and well-being.

Greening projects spanning from micro-scale (e.g., street tree plantings) to the macro-scale (e.g., urban forest restoration) require seeds and/or plant propagules. This physical living material forms the foundation landscapes and plays a critical role in supporting ecosystem function. Healthy functioning ecosystems are of critical importance to human populations as they provide valuable services or the benefits that we receive from nature for free ( Millennium Ecosystem Assessment 2005).

## **Health and Well-being**

Numerous studies have documented how nature improves human health and well-being. Spending time outside in biodiverse landscapes lowers blood pressure and cortisol levels, enhances mental stamina and focus, improves cognitive function, elevates mood, and reduces violence and criminal activities.

Myer (2020), in her book *Multisensory Nature and Mental Health*, explains that biodiversity is key to improving human health and well-being in two ways. The first reason is that biodiversity signals a more multisensory experience for the brain. An environment rich in diverse plants and animals offer bird and insect sounds, color, shape, and textural differences and unexpected elements. This helps to evoke a deeper and more dynamic engagement with the surroundings. The second reason is that biodiversity supports a richer community of microorganisms which are a pathway for improving human health. A growing and conclusive body of evidence is revealing that microbiota (good



**04** Jiuzhaigou landscape with green water in Sichuan, China. A Landscape from the Mountains of Southwest China.

Source: Msz010dzeta

bacteria, spores, pollen, plant biomass and dust, and fungi) is linked to improved neurological and immunological health and function.

Thus, spending time with family and friends outdoors, eating healthfully, exercising regularly, and living in a community with accessible paths to parks and gardens are essential to maintaining good health and a positive mindset. Maintaining these opportunities is important for all age groups but particularly important for children and older adults.



**04** Vegetation at Luxelakes with low diversity planting

Source: The Author

Drawing “Biodiversity Cleans the Air and Calms the Mind” shows a perspective of community members enjoying biodiversity while walking and running.

## Education

Children benefit greatly from nature exposure. Studies show that children are more creative when they spend time in nature because they can use all of their senses rather than just sight and sound. Spending time in biodiverse natural settings unlocks imagination and allows children to be engaged in a more creative and dynamic play than in traditional asphalt and structure-based playgrounds. Moreover, exposure to nature is calming and aids in concentration and decreases aggression, stress, and depression. This effect has been shown to carry over to the indoor classroom (Kahn and Kellert 2002).

Increasing plant biodiversity at Luxelakes can help to grow an outdoor classroom linked to many educational activities for children. These include things like hands-on STEM labs that utilize proximate rich plant and insect biodiversity to learn about microbiology, botany, entomology, bioengineering and more.

## Ecology for Every Generation

Older adults benefit from biodiversity as well. China and along with many other countries around the world are experiencing a rapidly ageing population. Therefore, it is critical to promote successful ageing strategies that are cost-effective, easily accessible, and liked by elderly communities. Horticultural therapy or gardening has been shown to increase cognitive function, reduce depression, and improve physical and mental health (Chan et al. 2017).

Increasing biodiversity at Luxelakes will maximize the quantity and quality of activities that fall under the category of horticultural therapy. These activities include things like gardening, harvesting fruits and vegetables, removing invasive species, painting nature scenes, nature walks, building pollinator



**05** Vegetation at Luxelakes with medium diversity planting

Source: The Author

gardens, participating in observing and counting insects and birds.

## Who is Interested in Biodiversity?

Many actors are interested in biodiversity. This diagram shows some of the actors that can benefit from increasing the plant biodiversity at Luxelakes.

## 2] Project Overview

### Field Observations

In January of 2020, I visited Luxelakes and observed the vegetation. Plantings ranged from very low diversity (~1-3 species), to medium diversity (~3-10 species), and high diversity (~10-50 species). Many areas of the site such as the visitors center and locations within the Cloud Park are planted with monocultural arrangements of trees and bushes. The richest plantings were present around the villas and in Red Rock Park. Overall, I was left with the impression that plant species diversity at Luxelakes is quite low.



### Data Analysis

My visit to Luxelakes did not allow for an in-depth survey of the plant vegetation. While back at MIT, I analyzed two plant material lists to gain more information about the number of plant species present at Luxelakes. The first was provided by Wide Horizon and is a list of all the species in the Luxelakes nursery. The second was given to me by Zhongwei Li a landscape architect from Lab D+ H. It is a master list of all the horticultural species that landscape architects working in the Chengdu area use for their projects.

06 Vegetation at Luxelakes with high diversity planting

Source: The Author

I researched the native distributional range of each species using the Flora of China ([www.efloras.org](http://www.efloras.org)), GRIN-Global Species (<https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomysearch.aspx>), and the Plant List (<http://www.theplantlist.org/>) databases. There were several species that I could not find information on. David Boufford, a botanist and expert in the flora of Sichuan from Harvard University Herbaria and Libraries, helped to provide information for those species. While we were able to identify the origins of many plant species in these lists, there are some species whose native distribution is unclear due to extirpation in the wild. Therefore, this analysis represents an approximation and the results may be subject to change with more information.

The Lakeslake nursery planting list contained 57 species. Of these species 27 (47%) were exotic or not originating in China, 22 (39%) had their native distributional range in Sichuan province,





## Biodiversity Cleans the Air and Calms the Mind:

Luxelakes residents and visitors will enjoy the calming effects of nature as they walk or jog. Additionally, biodiversity will help to keep the air clean.

**TREES CAN REMOVE 85% OF AIR POLLUTION IN A PARK AND UP TO 70% ON A STREET LINED WITH TREES (BERNATZKY 1983).**

**TIME IN NATURE REDUCES CORTISOL RATES, HEART RATES, BLOOD PRESSURE, DEPRESSION, AND ANXIETY! A WALK IN THE FOREST CAN REDUCE STRESS UP TO 50% (PARK ET AL. 2010)**

**VIEWING NATURE IS LITERALLY A PLEASURABLE EXPERIENCE!**

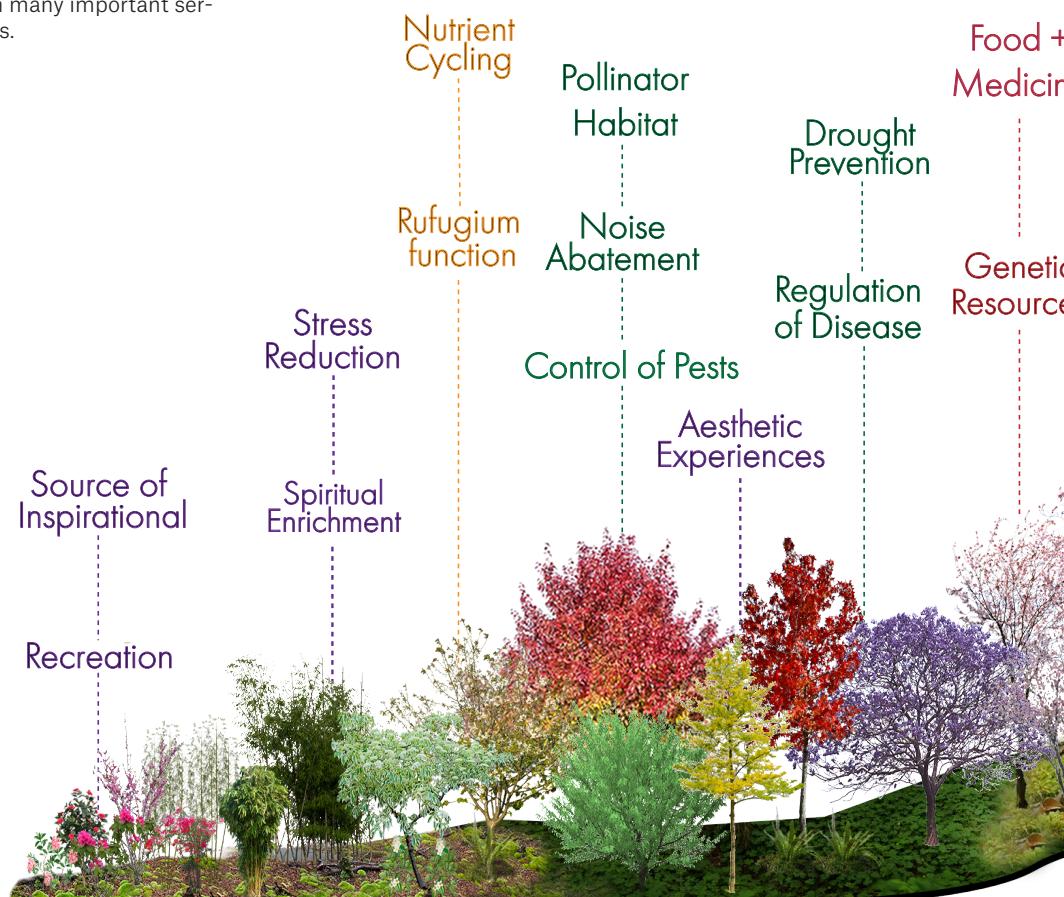
**NEUROSCIENTISTS HAVE FOUND THAT MORE COMPLEX, DYNAMIC NATURAL SCENES TRIGGER MANY MORE INTERACTIONS OF OPIOIDS RECEPTORS IN THE BRAIN THAN SCENES OF NO OR LOW NATURAL DIVERSITY!**

**(BIEDERMAN & VESSEL (2006).**

## Biodiversity Builds

### Ecosystem Services:

Cities are turning to nature to help restore ecosystem functioning. Healthy ecosystems provide humans with many important services.



### EARLY SUCCESSION

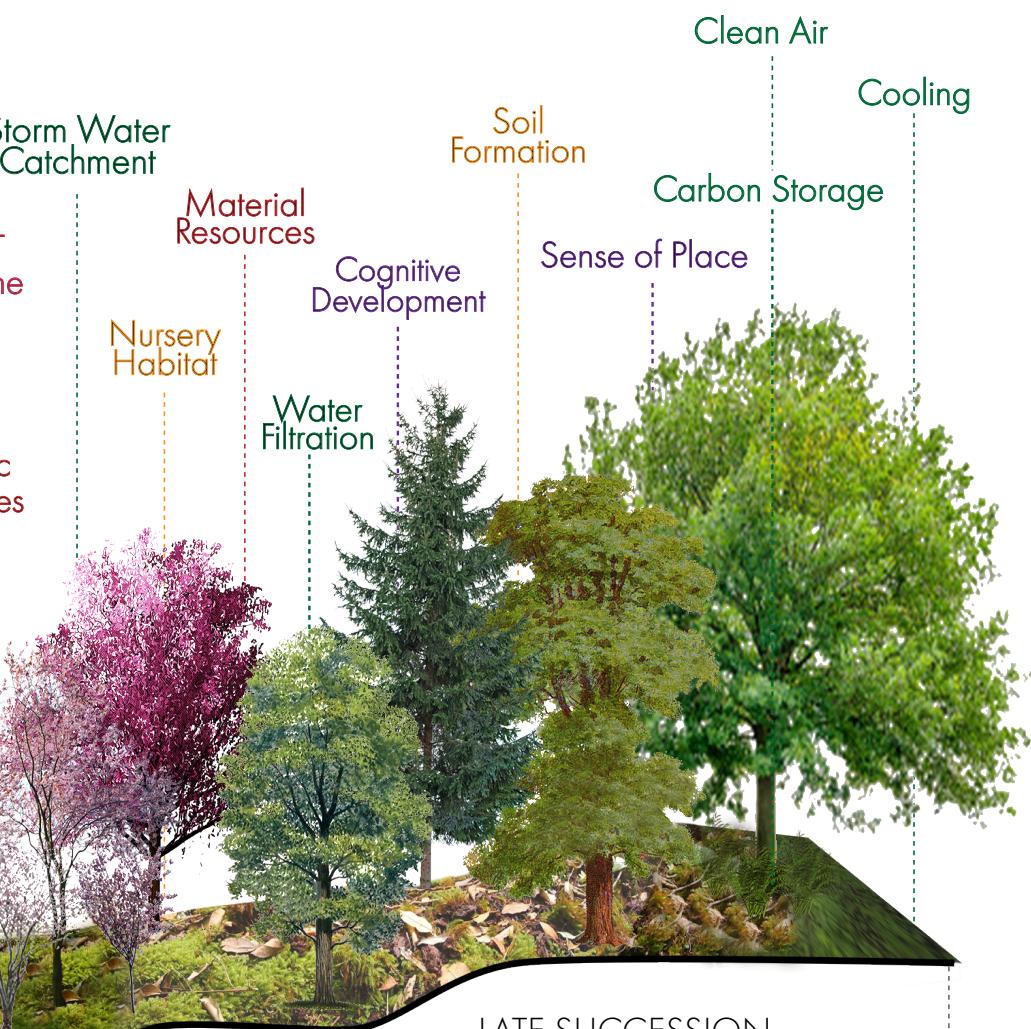


Bamboo (*Phyllostachys nidularia*), Banksian Rose (*Rosa banksiae*), Rhododendron (*Rhododendron wardii*), Tea (*Camellia reticulata*), Wild Grape.

### MID SUCCESSION



Dogwood (*Cornus controversa*), (Prunus napaulensis), Tea (*Malus hupehensis*), Ficus (*Ficus*), Willow (*Salix phoenicea*).



### LATE SUCCESSION



Bamboo-Leaf Oak (*Quercus cyclobalanopsis*),  
Snakebark maple (*Acer davidii*), Sikang Pine  
(*Pinus densata*), Walnut (*Juglandaceae spp.*),  
Elm (*Ulmaceae spp.*)

rs), Bird Cherry  
acabapple  
*us heteromorpha*,  
nnera)

**CHILDREN BENEFIT FROM BIODIVERSITY !**  
**EDUCATION FROM NATURE IS AS IMPORTANT AS EDUCATION FROM**



OUT

**EXPOSURE TO NATURE BENEFITS CHILDREN INTELLECTUALLY, SOCIALLY,  
EMOTIONALLY, AND PHYSICALLY!**



**Biodiversity provides new opportunities for education:** Exposure to nature helps children grow intellectually, emotionally, socially, and physically.

TECH-MEDIATED LEARNING

DOOR STEM CLASSROOM

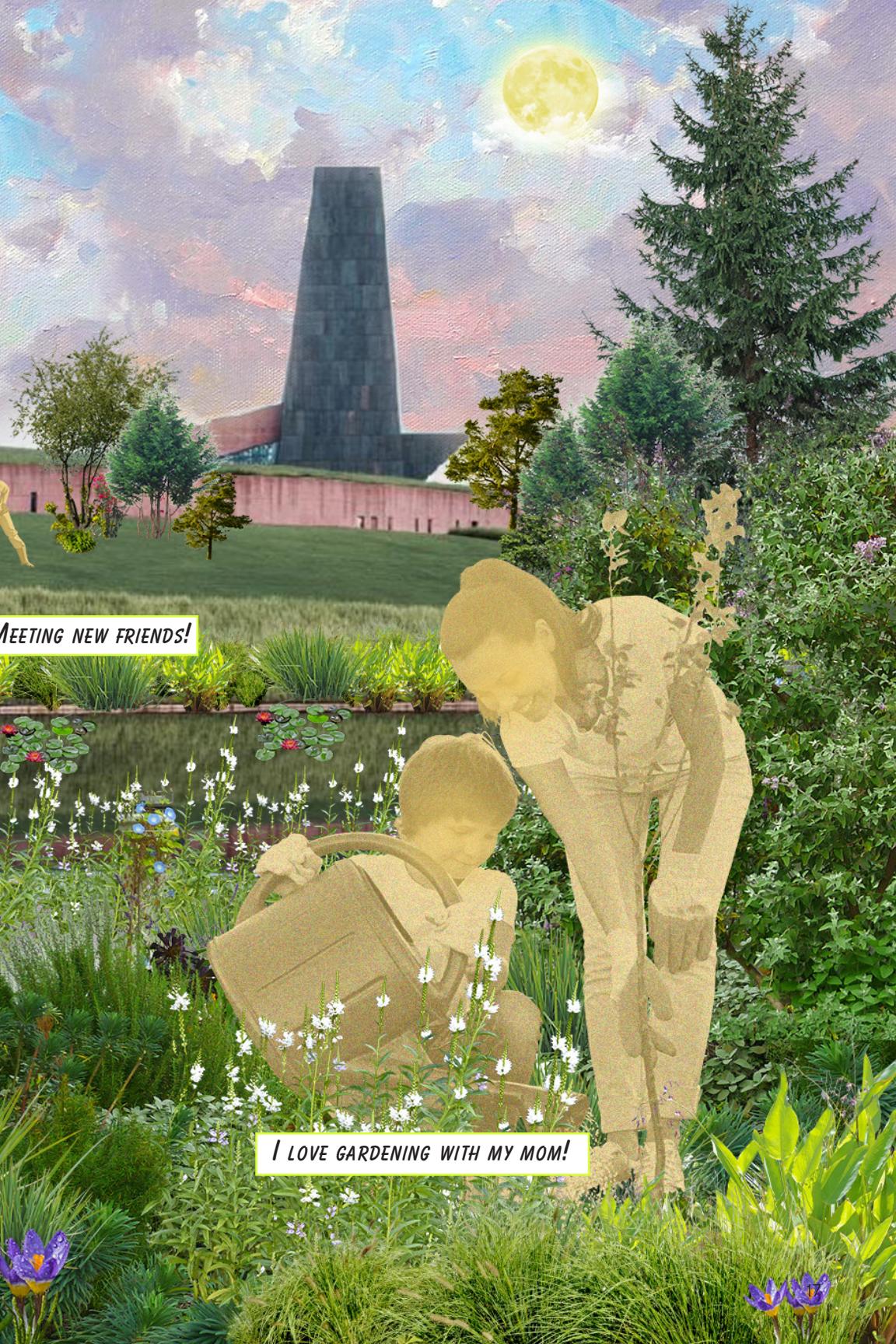
ENVIRONMENTAL ETHICS

## Biodiversity Brings Families together:

Biodiversity provides new opportunities for community engagement and bonding.

# BIODIVERSITY BRINGS FAMILIES TOGETHER!

SPENDING QUALITY TIME WITH FAMILY MEMBERS!



MEETING NEW FRIENDS!

I LOVE GARDENING WITH MY MOM!

and 8 (14%) originated from other parts of China.

The Chengdu master planting list contained 242 species. Of these species 105 (43%) were exotic or not originating in China, 98 (40%) had their native distributional range in Sichuan province, and 36 (16%) originated in other parts of China.

Collation of the two lists resulted in a total of 274 unique plant species. From analyzing these two lists, I hypothesis that Luxelakes does not contain more than 274 species. The average value of species that have their native distributional range in the Sichuan region is 108. This less than <1% of the plant diversity that occurs in the Mountains of Southwest China.

### Precedent Case Studies

There are several compelling precedent or case study examples that illustrate incorporating biodiversity into the urban context is desired and doable. For example, In Thailand a new town eco-city development called The Forestias by Magnolia Quality Development Corporation Limited (MQDC) is incorporating 500 plant and animal species into a central forest ecosystem that spans 48,000 m<sup>2</sup>. In Mexico, the Smart Forest City Cancun by Stefano Boeri Architetti is planting 7.5 million plants comprised of 350 different species. The 557-hectare site will support 130,000 residents and absorb 116, 000 tons of carbon dioxide.

In Boston the Arnold Arboretum of Harvard University provides a grounded example and conclusively demonstrates that increasing plant diversity in the urban context is not only possible but provides multiple benefits. This botanical research institution grows out over 15,000 plants that comprises 4000 different kinds of trees, shrubs, vines, and herbaceous plants. The Arnold Arboretum is also a public park that hosts numerous free activities to help encourage an understanding and appreciation of plants among the broader public.

### The Challenge

Luxelakes Eco City aspires to be an ecologically oriented new town development whose natural infrastructure promotes improved quality of life for its residents. However, Luxelakes lacks significant plant biodiversity, although it is situated in the 'Garden City' of Chengdu in the most botanically rich province in China.

### The Opportunity

However, this challenge also presents an opportunity which has three main parts:

1. How do we enrich the vegetation? How many species do we



07 Arnold Arboretum in Boston, USA

Source: Arnold Arboretum



08 Forestias New Town Development in Thailand with a central forest ecosystem.

Source: MQDC

include? How do we identify and select the species that will be introduced to the site?

2. Where are Luxelakes should the vegetation be enriched? What places at Luxelakes should receive new plantings?

3. How can we enrich the vegetation while also enriching the community? What types of community activities or programming can be connected to increasing the biodiversity?

## Expert Interviews

A series of interviews with ecologists, botanists, horticulturalists, and landscape architects helped to provide answers to the questions above. Conversations with experts generated new insight for thinking through the limitations and possibilities for incorporating more plant biodiversity at Luxelakes. Notable quotes from these interviews are presented page 21.

## Framing Concepts and Models

Two concepts and a model have been helpful in framing and conceptualizing this research. They include the novel ecosystem and civic ecology concepts and the patch-corridor-matrix landscape model.

### Novel Ecosystem Concept

Hobbs et al. (2013) define novel ecosystems as a “system of abiotic, biotic, and social components, that by virtue of human influence, differ from those that prevailed historically, having a tendency to self-organize and manifest novel qualities without intensive human management” (pg. 58). Although humans have been practicing ecological manipulation since time immemorial (e.g., controlled burning, agriculture) novel ecosystems are characterized by new sets of assemblages and their interactions that are capable of reaching certain thresholds that catalyze a trajectory where the ecosystem can sustain itself without further human management.

The novel ecosystem concept is helpful in framing this project in two main ways. First, we can never return Luxelakes or Chengdu city to its previous historical site. Rapid urbanization has accelerated the formation of novel ecosystems in the Sichuan Basin. While conservation of remnant ecologies is of the utmost importance. We should also strive to use the region’s plant biodiversity to build improved novel ecosystems that can self-sustain and provide benefits to people.

Second, the concept of novel ecosystems beckons us to widen our perspective on what a healthy ecosystem looks like. Novel ecosystems force humans to integrate cultural, social, and



**09** Cancun Smart Forest City in Mexico.

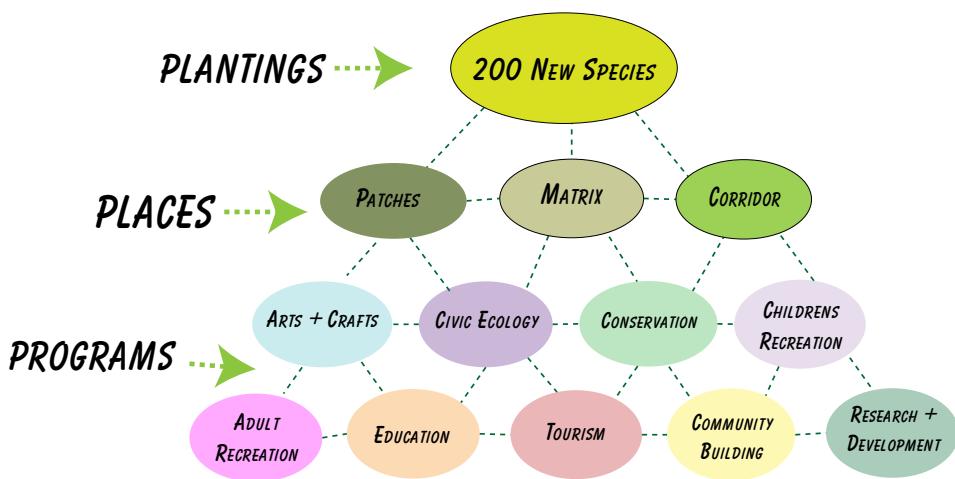
Source: Stefano Boeri Architett



**10** The novel ecosystem atop a landfill reclamation at Freshkills Park, NYC, USA.

Source: Freshkills Park

**The Proposal: Plantings, People, Places** A diagram to illustrate the proposal to increase biodiversity at Luxelakes.



**"THE UNFORTUNATE TRUTH IS THAT WE DESIGN OUR CITIES AND SUBURBAN DEVELOPMENTS AGAINST BIODIVERSITY!"**



**RICHARD T.T. FORMAN**  
"FATHER" LANDSCAPE ECOLOGY HARVARD

**"MEANINGFUL ECOLOGICAL CHANGE AND TRANSFORMATION WILL START AT THE BOTTOM. YOU HAVE TO GET PEOPLE RECONNECTED WITH NATURE. THAT STARTS WITH LEARNING THE NAMES OF PLANTS."**

**PETER DEL TREDICI,**  
HARVARD BOTANIST AND URBAN ECOLOGIST



**"INCREASING ECOSYSTEM COMPLEXITY IS IMPORTANT BECAUSE IT WILL LIKELY INCREASE THE CHANCES THAT RESTORED ECOSYSTEMS HAVE THE RIGHT FEATURES TO ADAPT AND EVOLVE IN A RAPIDLY CHANGING ENVIRONMENT."**



**DAVID MORENOS-MATEO**  
HARVARD ECOLOGIST

**"LUXELAKES CAN SERVE AS AN EXPERIMENTAL TEST BED FOR THE INTRODUCTION OF NEW URBAN PLANT SPECIES. THE SURROUNDING REGION CONTAINS A WEALTH OF PLANT SPECIES THAT HAVE NOT YET APPEARED WITHIN THE URBAN REGION OF CHENGDU."**

**DAVID BOUFFORD**  
HARVARD HERBARIA & LIBRARIES



**"LUKESLAKES CAN DIFFERENTIATE THEMSELVES FROM OTHER MAINSTREAM DEVELOPMENTS BY FOCUSING ON THE TRUE VALUE OF THE LANDSCAPE RATHER THAN JUST THE AESTHETIC APPEAL."**



**TAO ZHANG**  
LANDSCAPE ARCHITECT, SASAKI

**"LUKESLAKES CAN BE SUCCESSFUL IN INTRODUCING MORE PLANT DIVERSITY TO THE SITE IF THEY CAN FORM LONG-STANDING RELATIONSHIPS WITH ACADEMIC AND RESEARCH INSTITUTIONS. ONCE A MODEL IS CREATED THEN TECH TRANSFER CAN OCCUR."**

**MICHEAL DOSMANN**  
LIVING COLLECTIONS CURATOR, ARNOLD ARBORETUM



**"A CITIZEN-LED INVENTORYING SYSTEM WILL HELP MONITOR AND RECORD IMPORTANT DATA ABOUT THE NEW INTRODUCTIONS THAT WILL BE OF VALUE TO MULTIPLE STAKEHOLDERS ACROSS AT LOCAL, REGIONAL, NATIONAL, AND EVEN GLOBAL LEVELS."**



**KATHRYN RICHARDSON**  
CURATORIAL ASSISTANT, ARNOLD ARBORETUM

**"CHENGDU HAS A VERY MILD CLIMATE WITH A LONG GROWING SEASON. MANY PLANTS WILL GROW WELL IN THE CITY. AS A LANDSCAPE ARCHITECT, I PREFER TREES FROM THE WILD BECAUSE OF THEIR UNIQUE BRANCH STRUCTURES."**

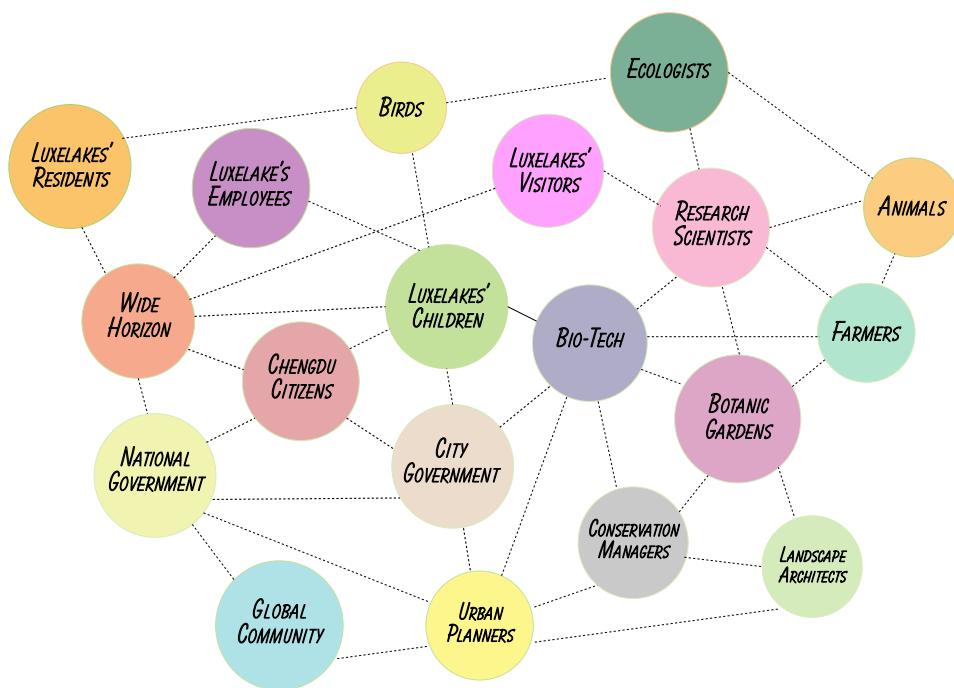
**ZHONGWEI LI**  
LANDSCAPE ARCHITECT, LAB D+H

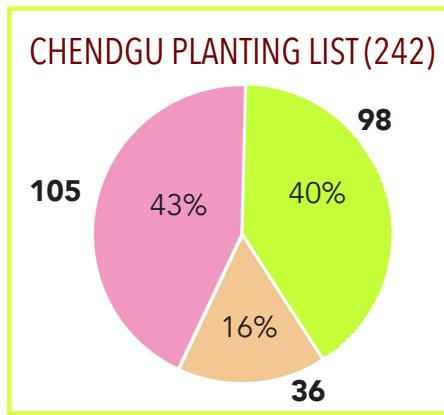
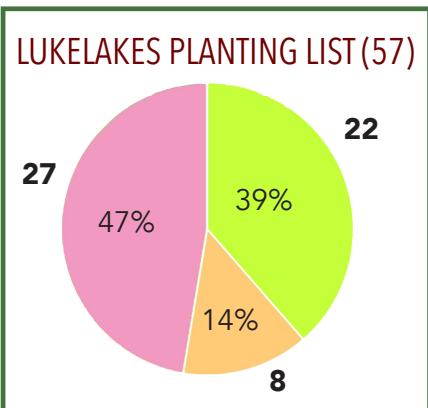


**Quotes from Interviews:** Notable quotes from experts..

## Who is Interested in Biodiversity?

This diagram shows the many actors who benefit from adding more biodiversity at Luxelakes.





EXOTIC

SICHUAN

CHINA

~274 SPECIES TOTAL

< 2.5% of 12,000

~108 SPECIES FROM SICHUAN

< 1% of 12,000

economic factors with ecological thinking which can aid in improving the well-being of humans and other species in this time of rapid environmental change.

## Civic Ecology

The concept of civic ecology is where the public self-organizes to steward urban nature in innovative ways. Civic ecology encompasses a wide variety of community-based environmental stewardship practices. Citizen science falls under the umbrella of civic ecology and has been a successful in involving the public in scientific research. There are many successful case studies. For example, the program Celebrate Urban Birds ([www.celebrateurbanbirds.com](http://www.celebrateurbanbirds.com)) has involved the public in helping to collect high-quality data from participants to help generate valuable knowledge about how different environments will influence the location of birds in cities. Utilizing civic ecology and citizen science at Luxelakes can be a viable method for engaging communities and cultivating new forms of ecological stewardship.



**11** Citizen science is a successful way to involve people of all ages in environmental stewardship

Source: SPOTTERON

## Patch-Corridor-Matrix Model

This simple model conceptualizes landscapes as heterogeneous mosaics consisting of three fundamental elements: patches, corridor, and a matrix. Patches are defined as a relatively homogenous area that differs from its surroundings (e.g., Park, remnant forest, agricultural fields). Corridors are linear landscape elements that promote connectivity (e.g., riparian environments, vegetation near a road or highway). The matrix is the dominant background fabric of a landscape (e.g., forest, urbanized, grassland, etc.) (Forman 1995). Understanding the arrangement or structural pattern of patches, corridors, and the matrix that constitutes the landscape at Luxelakes is helpful for understanding how to change its pattern and process over time.

## [3] Project Proposal

### The Proposal: Plantings, Places, and Programs

My proposal is to introduce 200 new species to the site over three phases. The species will enrich a variety of habitats at Luxelakes that fall into either the patch, corridor, or matrix categories. Community groups can then generate and link number of programs to the emerging richness of biodiversity around the themes of education, recreation, arts and crafts, horticultural therapy, tourism, science, and more. However, the central program that I am proposing is a community-led inventorying and monitoring system for new plant introductions to the urban context.

## Selecting the Plant Species

I had the pleasure of interviewing David Boufford several times. He is a botanist and senior research scientist at the Harvard University Herbaria and Libraries. He is an expert in the flora of China with a particular focus on Sichuan. Over the course of his career he has led many plant collecting expeditions in the Mountains of Southwest China. He has helped my project by proposing an initial 60 tree and shrub species that Luxelakes could introduce to the site.

David has also pointed to two databases that will be essential for helping to identify and select additional plant species for Luxelakes. These include the Flora of China ([www.eflora.org](http://www.eflora.org)) and The Biodiversity of the Hengduan Mountains project (<http://hengduan.huh.harvard.edu/fieldnotes>) databases. The Hengduan Mountain project database contains georeferenced data on plant collecting expeditions.

However, there are a number of local resources such as the Chengdu Botanic Garden, the herbaria of both Sichuan University and the Chengdu Institute of Biology, as well as the Kunming Institute of Botany in Yunnan province. There are many local experts at these institutions that could assist in helping identify and select additional species for plant introductions at Luxelakes.

## Identifying Places

The patch-corridor-matrix landscape model is useful for helping to identify places at Luxelakes to enrich the vegetation. The master plan on page 26 and 27 shows possible places where interventions can take place. However, the community members can also play an important role in identifying areas for new plantings.

## Developing Programs

Increasing biodiversity will act as a catalyst for the generation of many new community programs around the themes of recreation, education, science, and horticultural therapy. Diagram B shows how novel ecosystems and opportunities for community engagement grow in complexity together.

However, the main program that I would like to propose is that Luxelakes can serve as an experimental test bed for the introduction of new urban plant species. The surrounding region contains a wealth of plant species that have not yet appeared within the urban context of Chengdu. Luxelakes can be a first destination for new species. A citizen-led inventorying and monitoring system can help record important data about the new introductions that will be of value to multiple stakeholders across at local, regional, national, and even global levels.



**12** Citizen science and civic ecology programming can be mediated by technology.

Source: SPOTTERON

## Master Plan

This drawing shows possible areas to introduce new species.



26  
0 100 300 500 1000m



## PATCHES

1. CLOUD PARK
2. LUKEDAO
3. RED ROCK PARK

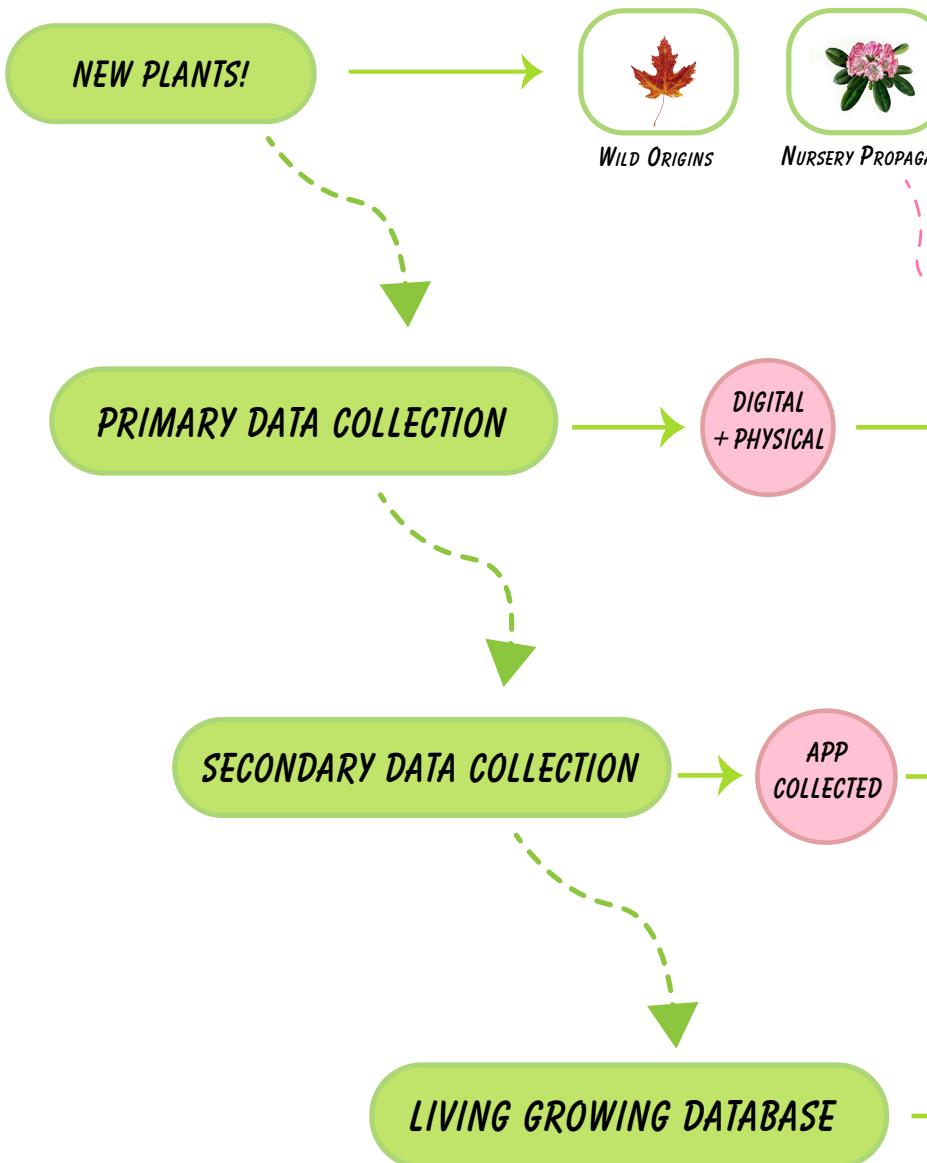
## CORRIDORS

4. Y-AXIS HIGHWAY
5. RIPARIAN AREAS
6. EDGE CONDITIONS

## THE MATRIX

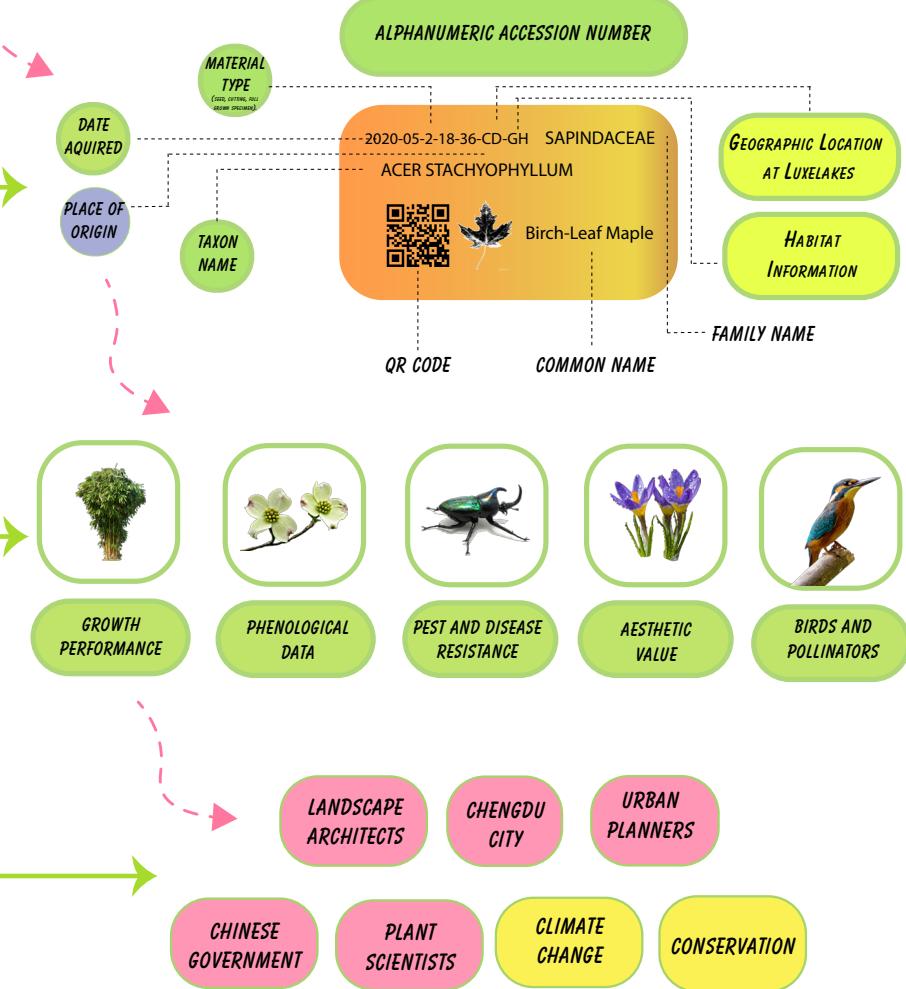
7. RESIDENTIAL AREAS
8. COMMERCIAL AREAS
9. VACANT LOTS

**Community-Led Plant Inventorying and Monitoring System:** This is a flow chart diagram illustrating how primary and secondary data would be collected for new plant introductions.





EXISTING SPECIMAN



## Community-Led Plant Inventorying and Monitoring System:

This diagram shows community members collecting secondary data on new plant introductions.





**BUILD A BIRD HOUSE**  
**PARTICIPATE IN A BIRD CENSUS**

**PRUNE A FRUIT TREE**  
**CAPTURE A PLANT**  
**GROWTH PHOTOSTORY**

**WATER NEW PLANTS**  
**MONITOR NEW SPECIES**

**ACTIVE      PASSIVE**  
**ECOLOGICAL STEWARDSHIP!**

Figure [d] shows a flow diagram of how this system would work. All new plant material whether in the form of a sapling, seed, or cutting is given a code called an accession number. Libraries, art galleries, archives, botanical gardens, and many other places use an accession number as a unique identifier assigned to each new acquisition. In the case of Luxelakes each new plant would receive an alpha-numeric number. The numeric portion of the number would correspond to information that includes the date acquired, the taxon name, the locality or place of origin, and what type of material (seed, cutting, sapling, full grown specimen, etc.) the accession is. The alphabetic portion would correspond to the geographic areas in the Luxelakes that the new specimens would be planted. The information associated with the accession number is known as primary documentation. This initial documentation would be performed by an individual or group of individuals that had some level of training to do this task. Community members could receive training to undertake this task. Additionally, at this stage a label would be made and placed on the specimen once planted in the ground.



**13** Unique vegetation at the Chengdu Botanic Garden

Source: The Author

Once a new species is planted at Luxelakes, citizens would then collect secondary data on a number of criteria including the plant's growth performance, pest and disease resilience, life cycle characteristics, pollinators or birds that visit the plant, and aesthetic value. This data could be easily collected on an app that was customized using the SPOTTERON platform (<https://www.spotteron.net/>). Which is a fully customizable and affordable citizen science IOS and Android application platform. Both primary and secondary data could be stored on BG-BASE (<http://bg-base.com>), a database application designed to manage botanical collections that is used by a wide variety of botanic gardens, arboreta, herbaria, zoos, and universities.

## **Phased Implementation**

This project requires three phases of implantation:

Phase 1: This phase focuses on education and ecological surveying.

Phase 2: This phase focuses on introducing species and beginning the community-led inventorying and monitoring system.

Phase 3: This phase focuses on environmental monitoring, education, and community activity building.

The phased implementation diagram on pages 34 and 35 shows the proposed process.

## [4] Future Directions

### Institutional Collaborations

Collaboration with various local institution will be critical to achieving the goals outlined in this report. As mentioned above there are many local resources such as the Chengdu Botanic Garden, Sichuan University, The Chengdu Institute of Biology, and the Kunming Institute of Botany in Yunnan province that can help support Luxelakes in undertaking a project of this size and scope.

### Environmental Horticulture

Once plant species are identified and selected plant material will need to be sourced and propagated sustainably. Plant material should never be collected from the wild without the appropriate permits. Luxelakes should invest in environmental horticulture, which is the science and practice of sustainably propagating plant material for landscapes. Luxelakes already has a plant nursery and could expand this infrastructure to begin the propagating a greater diversity of species. Luxelakes could also locate and hire individuals in the nursery industry to contract grow plant material for new introductions. Alternatively, space on the site that will be developed in the future could serve in the interim as temporary nursery. This would save costs and allow growing plant propagules to better adapt to the local climate at Luxelakes which will aid in improving future establishment.

### Ecological and Cultural Legacies

Where urbanization poses a challenge, it also provides an opportunity. There is a surplus of historic and contemporary evidence that demonstrates how humans have modified landscapes to enhance biological heterogeneity. Through urban planning and design and civic ecology we can innovate and find new ways to weave biodiversity into the fabric of cities while also wielding it as a tool to improve long-term human and planetary well-being.

A project like this has never been done before in China. It would be a first and its value would grow over time especially with impending climate change and land cover change which is a driver of biodiversity loss. This project reimagines the urban environment as a site for conservation instead of loss. The generation of a citizen-led inventory system will help foster connection with the landscape as people will be able to learn the names and origins of plants and help to cultivate and steward novel ecosystems.



**14** David Boufford at the Harvard Libraries & Herbaria

Source: The author



**15** Environmental horticulture nursery. Bamboo propagules for landscape restoration.

Source: Bamboo for money and environment protection

## Phased Implementation Diagram

This diagram represents the three phases of implementation.

### PHASE I: "TILLING THE GARDEN"



### PHASE I: "PLANTING THE GARDEN"



**LIGHT INTERVENTION 25 NEW SPECIES**

**HEAVY INTERVENTION 100 NEW SPECIES**

**EDUCATIONAL PROGRAMS ABOUT BIODIVERSITY**

**BIOBLITZ AND NATURE CENSUS**

**MAPPING MICROHABITATS AND ECOLOGICAL SURVEYING**

**SELECT SPECIES, IDENTIFY LOCATIONS, PROPAGATE PLANTS**

**COMMUNITY-LED PROGRAM GENERATION AND MONITORING**

**SELECT SPECIES, IDENTIFY LOCATIONS, PROPAGATE PLANTS**

**CIVIC ECOLOGY: DATA COLLECTION ON NEW PLANTINGS**

ING THE GARDEN"

PHASE I: "TENDING THE GARDEN"



25 NEW SPECIES



MEDIUM INTERVENTION 50 NEW SPECIES

ING

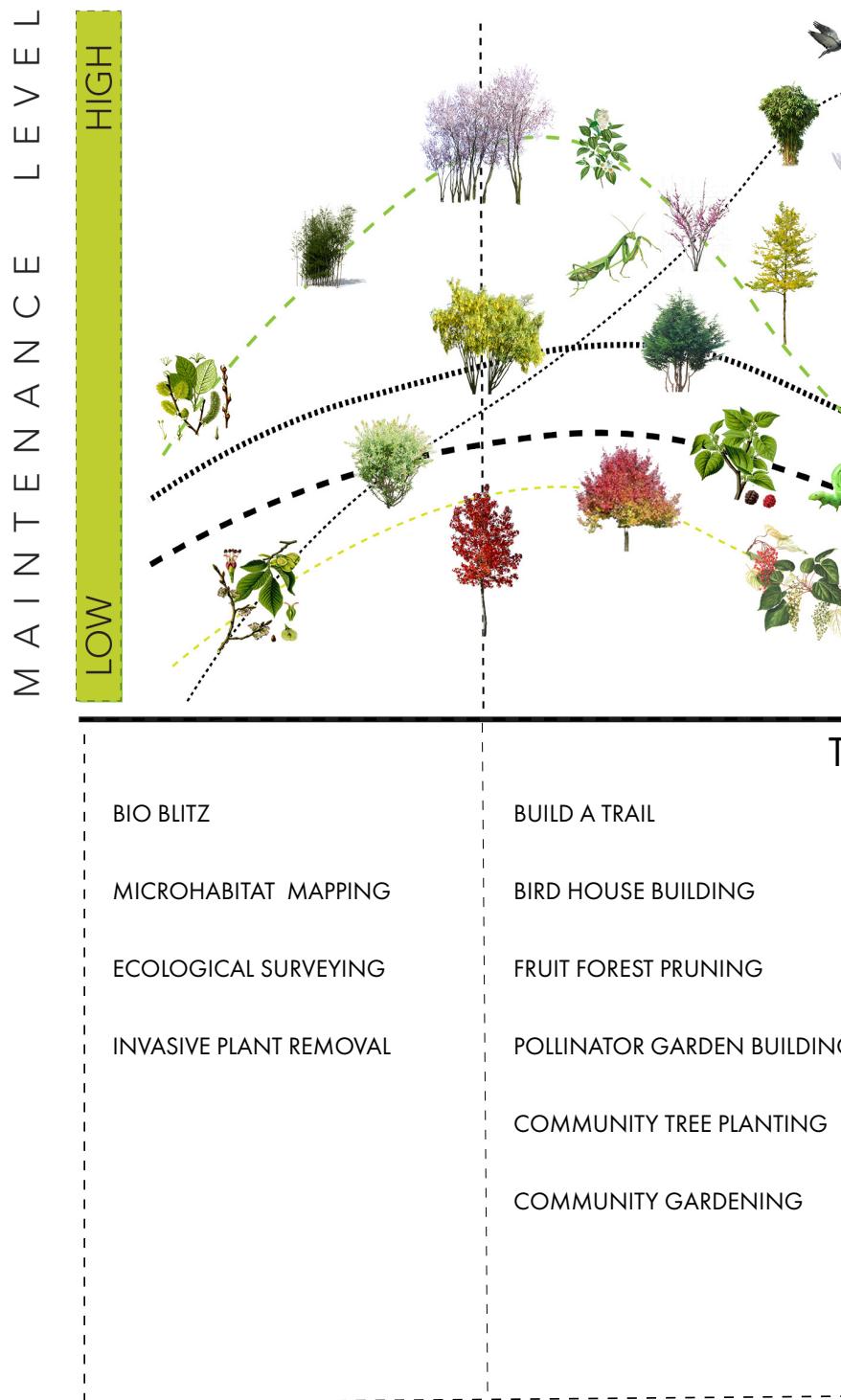
INTRODUCE PLANT MATERIAL, INTRODUCE SPECIES

ROUND NEW BIODIVERSITY

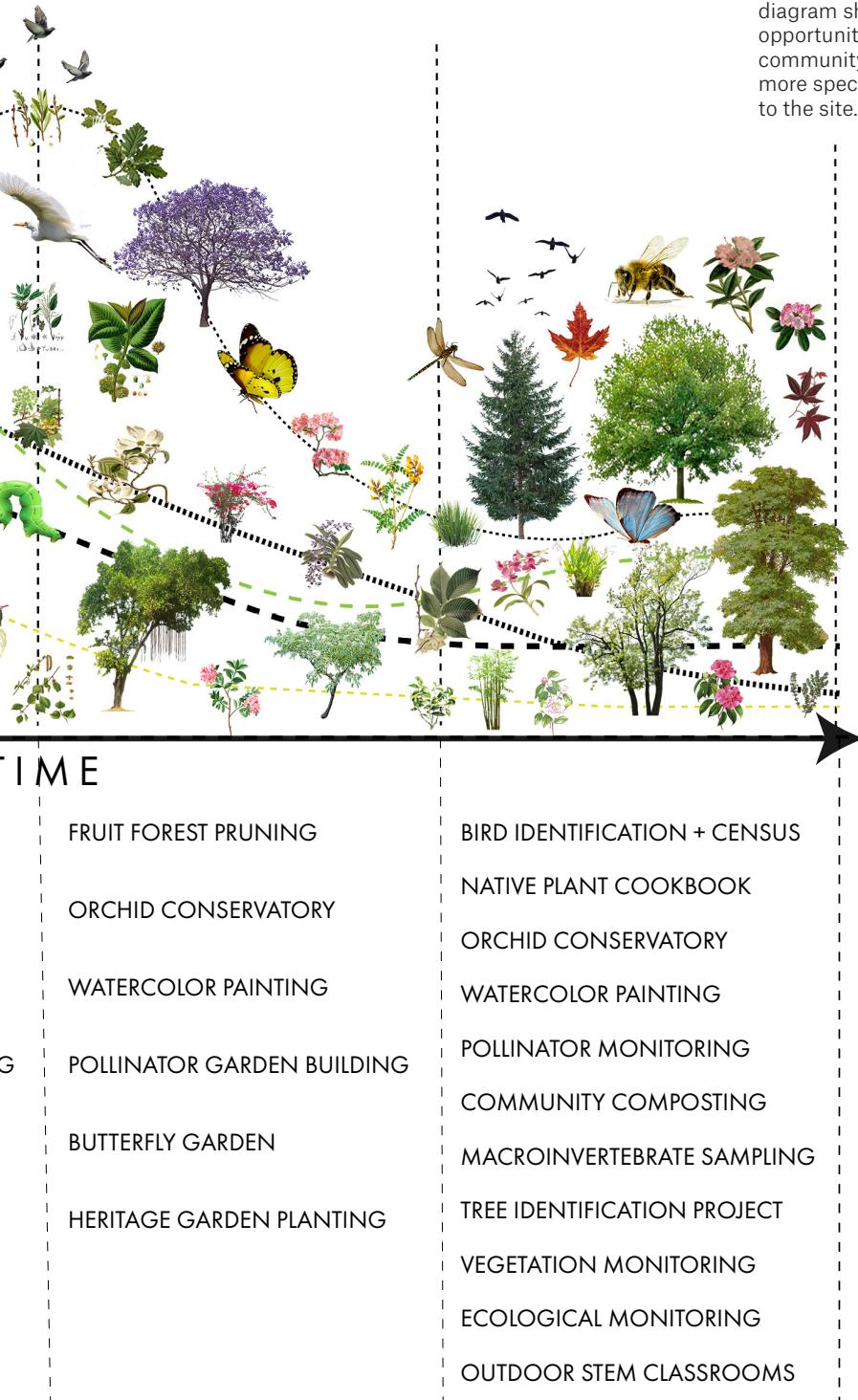
LOCATIONS, PROPAGATE PLANT MATERIAL, INTRODUCE SPECIES

NEW PLANT INTRODUCTIONS

ECOLOGICAL MONITORING + MEASURING ECOSYSTEM SERVICES



**Nature and People  
Growing Together:** This diagram shows how opportunities for community activities grow as more species are introduced to the site.

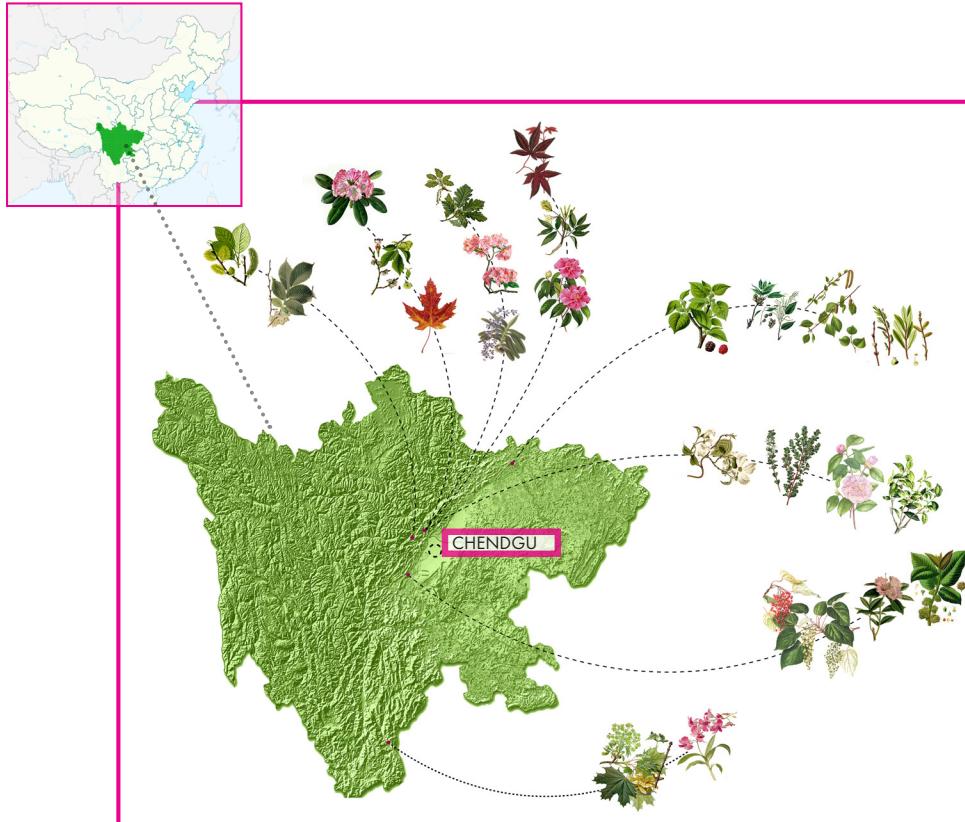


## Conclusions

The aim of this report is to persuade you that maximizing urban biodiversity is both a valuable and viable endeavour. There are infrastructural, logistical, scientific, and technological obstacles to overcome if urban planners want to build more biodiverse novel ecosystems in cities. However, from the knowledge that I have accumulated through analysing relevant case studies and speaking with experts we can tackle these obstacles. This report carves a path forward by identifying some of the available resources that would allow Luxelakes to increase plant biodiversity in a way that requires less effort, time, and money, while at the same time generating new opportunities for community engagement.

**CHINA IS THE "MOTHER OF ALL GARDENS"**

-ERNEST H. WILSON



## References

CEPF. 2002. "Ecosystem Profile: Mountians of Southwest China Hotspot," 26.

Hobbie, Sarah E., and Nancy B. Grimm. 2020. "Nature-Based Approaches to Managing Climate Change Impacts in Cities." *Philosophical Transactions of the Royal Society B: Biological Sciences* 375 (1794).

Chan, H. Y., Ho, R. C., Mahendran, R., Ng, K. S., Tam, W. W., Rawtaer, I., Tan, C. H., Larbi, A., Feng, L., Sia, A., Ng, M. K., Gan, G. L., & Kua, E. H. (2017). Effects of horticultural therapy on elderly' health: protocol of a randomized controlled trial. *BMC geriatrics*, 17(1), 192.

Forman, R. (1995). Some general principles of landscape and regional ecology. *Landscape Ecology*, 10(3), 133–142.

-(2014). *Urban Ecology: Science of Cities*. Cambridge: Cambridge University Press.

Hobbs, R., Higgs, E., Hall, C. 2013. *Novel Ecosystems: Intervening in the New Ecological World Order*. West Sussex: Wiley-Blackwell.

Kahn, P. H., & Kellert, S. R. (Eds.). (2002). *Children and nature: Psychological, sociocultural, and evolutionary investigations*. Cambridge, MA: MIT Press.

Mittermeier, R.A. & Gill, P.R. & Hoffman, M. & Pilgrim, John & Brooks, Thomas & Mittermeier, C.G. & Lamoreux, John & Fonseca, Gustavo. (2004). *Hotspots revisited: earths biologically rich-est and most endangered terrestrial ecoregions*. Cemex.

Müller, Norbert, Peter Werner, and John G. Kelcey. 2010. *Urban Biodiversity and Design: Conservation Science and Practice Series*.

Myers, Zoë. 2020. *Multisensory Nature and Mental Health. Wildness and Wellbeing*. Singapore: Palgrave Pivot.

Zhao, Nan. 2012. "Evaluation of Chengdu's Garden City Project by Ebenezer Howard's Garden City Theory," 1–72. [https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/12631/Nan Zhao Exit\\_Project.pdf?sequence=1%5Cnhttp://blf-oe.library.oregonstate.edu/catalog/oai-scholarsbank-uoregon-edu-1794-12631](https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/12631/Nan Zhao Exit_Project.pdf?sequence=1%5Cnhttp://blf-oe.library.oregonstate.edu/catalog/oai-scholarsbank-uoregon-edu-1794-12631) [Accessed April 16th, 2020].