Guarding the Garden: Sustainable and Resilient Landscapes

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Abstract

Creating a sustainable and resilient landscape helps users conserve valuable natural resources, manage invasive species, and reduce waste. This allows people to embrace and connect with nature and the landscape to meet aesthetic and functional needs for a prolonged time. Sustainability concepts, practices and design styles are presented to create an understanding of how to accomplish it. The concepts and ideas creating a sustainable and resilient landscape will allow users to exercise the sustainability practices to improve landscapes, construct a productive environment, and enjoy its natural beauty.

Objective

The objective of this report is to provide an overview of sustainable and resilient landscape concepts, design styles, and specific practices that benefit the homeowner, wildlife, and environment.

Introduction

Landscapes are considered as a mixed social-ecological system of humans and other species that interact and coexist through the landscape created by a community of land-owners and users (Opdam, 2018). Instead of focusing mainly on the aesthetics of the landscape, users should focus on how landscapes coexist with the surrounding environment while providing functionality and ecosystem benefits and services for the future. In order to do this, landscapes must be both sustainable and resilient.

Definitions

Sustainability is the conservation, protection, and use of natural resources in the landscape. Landscapes converted to fit our idea of a garden can be transformed back into what they once were and by doing so, can create different habitats that provide food, shelter and paths for wildlife, native plants, biodiversity, and aesthetics as well as functionality for the long term (Selman, 2008).

A resilient landscape can retain its current state without shifting into a different state that is non-sustainable. This ability allows the landscape to retain all its structural features while enduring different environmental stressors and changes (Turner et al., 2013; Resilience Alliance, 2012; Walker et al., 2004). Gardens and landscapes that adopt sustainability practices will help protect them against multiple stressors and build a stronger immunity to impending landscape processors over time.

Sustainable and resilient landscapes are not specific to one design style, but incorporate broad concepts supported through specific practices that can be utilized across many design styles. It can mean a landscape that mimics or transitions back to the natural environment or to a landscape that utilizes sustainable and resilient concepts and practices while meeting a specific function or design style. For example, a landscape may be targeted towards saving energy, but include practices for water management (Ako, et al, 2010), improving soil health for plant growth (Stoumann et al., 2011), and storm/flood protection, (A Sherov and B Soliev, 2020). Another example would be a landscape designed

to attract song birds that incorporates the practices of food, water, and habitat to support a diversity of organisms. An edible type of landscape would invite pollinators to help boost food production like incorporating native plants and pockets of shelter for protection. The European Commission's 2011 Green Infrastructure Strategy Report stated that green infrastructure reduces reliance on human infrastructure by providing less-costly and more durable structures that improve human-health and the environment (EC, 2013). This in turn helps create a sustainable and resilient landscape. The point being, that everything within a landscape is connected, and the landscape is connected to the surrounding environment. How landscapes are designed and the practices used matter.

Sustainable and Resilient Concepts

The following broad concepts make up the foundation of sustainable and resilient landscaping. These concepts create solutions and connect people to the landscapes they live in (Opdam, 2018). They can be used to create landscapes that are lower maintenance, more connected to the surrounding environment and have increased functionality for user needs or specific purposes. For example, Georgia Tech's campus landscape master plan focused on improving the campus landscape and ecosystem benefits by increasing the campus tree canopy coverage to 55%, increasing tree species diversity with more native species and creating a long-term maintenance program.

Soil Conservation

Soil supports plant life by providing vital nutrients and minerals for growth and development (Eswaran, 2001; Manivannan, 2017). Soil anchors plant roots and

supports insects, worms, microbes, fungi, and bacteria. It moderates temperatures, filters and stores water and helps prevent flooding. It is a non-renewable natural resource and is vulnerable to compaction, profile disturbance, harvesting and erosion (Kumawat, 2020). The following practices can be utilized to protect and preserve soil.

- Aerate to reduce soil compaction, create spaces for oxygen, increase water infiltration and promote root growth.
- Add compost to reduce compaction, increase water infiltration and holding capacity, add nutrients and support healthy pH and microorganism populations.
- Cover the ground with plants or organic mulch to prevent soil from eroding and to add nutrients. Many perennial native groundcovers have demonstrated they can reduce soil erosion, nutrient runoff, and nitrate leaching (Banik et al., 2020; Siller et al., 2016; Deguchi et al., 2017; Chen et al., 2020). Many groundcovers are better suited for the landscape than turf because they reduce soil erosion, reduce weeds, and are fast-growing and dense (Niemiera, 2018).
- Minimize soil disturbance. Do not till frequently or deeply which mixes the soil horizons (layers). Do not remove the topsoil.
- Companion plants can be used for aesthetic purposes, to safeguard from herbaceous predators, and increase soil nutrients. Chives for instance, produce a volatile allelochemical that deter herbivores and repel certain insects like aphids (Auger et al., 1989, 2002; Block et al., 1992; Nowbahari & Thibout, 1992; Dugravot et al., 2004).

- Create defined pathways so compaction from foot traffic is limited to those specific areas.
- Reduce or eliminate the use of synthetic fertilizers and pesticides that could contaminate the soil.

Water Conservation

Water is a limited resource and essential for life on Earth. Sustainable and resilient landscapes protect and preserve water resources. Adopting water conservation practices will improve irrigation delivery to plant roots and thus save on watering (Beller, 2015). Reducing runoff with the landscape will protect against soil erosion and will reduce flood damage. The following practices can be used to manage water in the landscape.

- Rain water harvesting decreases the use of potable water for landscape irrigation and saves money, reduces stormwater runoff, and provides water for other uses such as ornamental ponds and fountains, and household uses (Loper & Anderson, 2019, p.6)
- Use water bags instead of an irrigation system to establish trees and shrubs.
- Irrigation systems should be inspected regularly to make sure they are functioning efficiently. Connect a rain sensor to the system to turn it off when it is raining. Reduce the amount and frequency of irrigation or turn the system off in the winter when plants are not actively growing and don’t need as much water.

- Manage stormwater in the landscape with practices like rain gardens, swales, permeable paving, conservation landscaping and rooftop redirect/disconnect. (Fox et al., 2018).
- Use plant canopy layers to slow and absorb rainfall and reduce runoff. In nature, there are layers of large trees, understory trees, shrubs, perennials, and ground covers.

Habitat

Increasing plant diversity in the landscape creates habitat (Sheehan, 1986; Andow, 1991; Poveda et al., 2008; Letourneau et al., 2009; Isbell et al., 2017). Diverse plants support diverse insect and animal populations which creates a landscape community. Communities balance themselves. For example, the beneficial insects control the pest insects. That is sustainability. Communities also recover more quickly from problems like pests, drought, and floods. That is resilience. The following practices can be used to create habitat and community in the landscape.

- Use specific plants like oaks to support caterpillars which are the essential food for song birds (Tallamy, 2009).
- Plant native plants which support pollinators and other beneficial insects and animals.
- Create shelters out of brush piles, rocks and boulders, snags, and logs that offer protection from predators and raise young.
- Reduce or remove lawn to reduce water and chemical use in the landscape.

Invasive Species Management

A plant is considered invasive when it is intentionally or accidentally introduced by human activity in a region in which it did not evolve and then causes harm to natural resources, economic activity, or humans (Virginia Department of Conservation and Recreation (DCR, 2021). Many species have been introduced to North America. It is estimated that 5000 of those introduced species have become successful at reproducing in the wild and overtaking native plant species and flora (Morse et al., 1995). Invasive plants, like kudzu (Gagnon, 2020) and 'Bradford' pear trees, were introduced into the landscape for specific purposes like erosion control or ornamental value; but then became invasive. Other plants have been unintentionally transported or released and become invasive. Managing invasive plant species protects the landscape and surrounding environment from unnatural physical and genetic alterations.

All states have an invasive plant list. The best response to these plants is prevention, early detection, and quick elimination (Anderson, 2005; Baker, 2001; Leung et al., 2002; Reichard, 1997; Smith et al., 1999; Wittenberg and Cock, 2005). The following practices can be used to manage invasive species.

- Research plants before purchasing them to make sure they do not have aggressive or invasive potential.
- Become familiar with invasive species where you live.
- Remove invasive species in the landscape. If physically removing them, then dispose of them responsibly so they do not create a problem somewhere

else. If treating them with an herbicide, be sure to treat only the invasive plants and not surrounding desirable plants.

At Home Food Production

Growing edibles provide food for both the user and wildlife. Companion plants can assist edibles and vice versa with protection from insects and nematodes, fungal pathogens, and diseases. This will help users decrease the amount of pesticides and other synthetic chemicals on the landscape. Growing produce will reduce plastic waste, grocery cost, and time to travel to the store. Edible plants can be used to:

- Provide food for people, insects, and animals
- Create vegetable gardens
- Use as landscape plants. For example, fruit trees as landscape trees, marigolds as an edging plant or blueberry bushes as shrubs

Recycling and Composting

Regular recycling plastics, glass, and other nonbiodegradable manmade materials can help eliminate trash and allow these materials to be transformed into new products. Composting is a form of recycling that convert biodegradable material like food waste, cardboard, and fallen leaves into nutrient-rich soil for the landscape or garden.

- Compost food and garden waste.
- Use products made from recycled materials.
- Recycle items into different uses.

Seven Sustainable and Resilient Landscape Design Styles

1. Xeriscapes
2. Rock Gardens
3. Vertical Landscapes
4. Edible Landscapes
5. Pollinator Gardens
6. Wildlife-friendly Landscapes
7. Flood Resilient Landscapes

Xeriscapes

Xeriscaping is designed to incorporate drought-tolerant plants to save water. Xeriscaping is most seen in dry regions where soils are sandy with low nutrients and water availability, but it can be used anywhere. It is a healthier and superior alternative to turfgrass, which is an imported British landscape aesthetic that has come to symbolize prosperity, community, and good citizenship, (Mustafa et al., 2010). Turfgrass requires a great quantity of water, nutrients, and maintenance. Incorporating native drought tolerant plants in the landscape significantly reduces water use and cost.

Rock Gardens

Rock gardens mimic natural rock and stone formations. This style of gardening focuses on stones as the highlight of the landscape with plants that help to highlight the rock features (Abdulrazzaq et al., 2020). Local quarries contain many sizes, kinds, and shapes of rock or stone for the landscape. Adding groundcovers to rocks will increase aesthetic appeal. Rock gardens are adaptable to most landscapes, and when combined with the right plants and stones, create a low maintenance sustainable style of gardening.

Vertical Landscapes

Vertical gardening can be utilized in the landscape as well as inside the home. Urban dwellers can grow a variety of plants that can boost health. In several experiments performed by NASA to improve air quality, they found indoor plants were effective at removing formaldehyde and other VOCs (volatile organic compounds) (Aydogan, 2021; Giese et al., 1994). Produce grown in the kitchen or any bright area of the home using hydroponics has gained popularity by producing higher yields while making use of vertical spaces (Velazquez et al., 2022). Incorporating plants on a wall or hardscape structure can raise aesthetic appeal and more efficiently utilize small spaces. Fruit trees and vining plants can be grown on trellises, espadrilles, gazebos, decks or against walls. Growing vertically creates canopy layers that protect against erosion and provide protection for horizontally growing plants (Rao and Gupta, 2020).

Edible Landscapes

Edible landscaping has taken many forms throughout the centuries, and was first developed to provide beneficial food and medicine, (Fetouh, 2018). Incorporating edible plants in the landscape improves aesthetics, biodiversity as well as functionality. For example, the edible groundcover, red thyme, offers a beautiful carpet of red/purple foliage and provides food and habitat for smaller wildlife. Most edible plants require high light and plenty of water to produce food. Edible plants can be grown in all seasons. Combining native plants, groundcovers, and a variety of edibles can boost the number of pollinators, add diversity to the landscape, and reduce erosion.

Pollinator Gardens

Creatures are responsible for pollinating up to 90% of flowering plants (Ollerton et al., 2011), as well as 35% of our produce (Klein et al., 2007). These include certain species of birds, bats, flies, wasps, and bees. Bee populations are declining significantly due to habitat loss, pesticides, parasites, and invasive species (Goulson et al., 2015). Providing pollinators with native plants for pollen, nectar, and food and for shelter from predators and for nesting will help increase their numbers. For example, milkweed is important for monarch butterfly caterpillars because it is their only food source.

Wildlife-Friendly Landscapes

This type of landscape design supports wildlife. The intent is to form an ecological-rich sanctuary for the wildlife which then improves species diversity and creates an interconnected community that is sustainable and resilient and connects to the surrounding environment. This style of landscaping requires research on the wildlife and which variety of plants provide the food and shelter they need. Wildlife-friendly landscaping has other benefits such as: education about wildlife and native plant species, personal well-being, and a moral responsibility to nature.

Flood Resilient Landscapes

Landscapes are susceptible to flooding from northeasters, hurricanes, atmospheric rivers and even a heavy rain event. In areas prone to flooding, traditional landscapes can be difficult to maintain and costly to repair. While coastal regions are most prone to flooding, any landscape can be impacted whether near a body of water or not. Flood resilient landscapes utilize plant

canopy layers, dense plantings, native species, and shoreline stabilization practices to minimize damage and recover quickly. These practices reduce volume and velocity of water, absorb water, prevent erosion, and ultimately moderate the damage caused by flooding. For landscapes near the sea or ocean, incorporating plants that can tolerate and thrive in salty environments is important.

Summary

Sustainability and resiliency can be incorporated into any landscape. Sustainable and resilient landscapes harmonize with the surrounding environment and provide many ecosystem benefits and services. Many types of landscapes and gardens through history have incorporated sustainable and resilient practices. These include edible gardens in urban areas, conservation sites, clusters of native plants to attract wildlife and pollinators, and landscape protection for storms and flooding. Persisting in a sustainable lifestyle requires commitment, patience, and hard-work that, when done in a way that enhances the landscapes and improves lifestyle, produces a successful reward. Users can develop their landscapes into a successful opportunity to guard the planet from exhausting natural resources.

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Appendices

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