REGIONAL GREEN INFRASTRUCTURE AT THE LANDSCAPE SCALE

American Planning Association
Making Great Communities Happen

Abstract

Forests provide a wide range of benefits—environmental, economic, and social—which can create more resilient landscapes and communities. However, forests are facing challenges from a variety of factors including development pressure, invasive species, and climate change. This green paper looks at the needs and opportunities related to addressing regional green infrastructure at the landscape scale. In particular, it focuses on the challenges posed by development in the wildland-urban interface and opportunities for increasing resilience through an integrated approach to green infrastructure. The results of this paper will be used to develop a planning framework for addressing multi-hazard resilience through regional green infrastructure planning.

Introduction

Forests provide a wide range of environmental, economic, and social benefits, which can create more resilient landscapes and communities. These include clean air and water, production of forest products, and open space for recreation, among many others.

There are 751 million acres of forest land in the United States, 56 percent of which are in private ownership and 44 percent of which are in public ownership (USFS 2008). More than 130 million acres are urban and community forests, located within urban areas.

Forests are facing challenges from a variety of trends. Urban forests face a unique set of challenges, both anthropogenic and natural, related to the urban environment. These include difficult growing conditions, pressure from development, and extreme weather (flooding, heat, etc.) (Nowak et al. 2010). Challenges to forest lands outside of urban areas include invasive species, climate change, and development in the wildland-urban interface (WUI).

The WUI is defined as the area where human development meets and intermingles with undeveloped wildland vegetation (e.g., forests and grasslands). The WUI is facing increasing development pressure, with 40 percent of all single-family homes and 60 percent of homes built since 1990—nearly 45 million homes—located in the WUI (Headwaters Economics 2014; Radeloff et al. 2012). While the WUI has been undergoing rapid development, in the western United States, only 16 percent of the land in the WUI is developed, leaving a significant area open to potential future development (Headwaters Economics 2014).

Development in the WUI can fragment habitat, impact water quality, and strain water resources. In the continental United States, 53 percent of water originates on forest land (Mockrin et. al. 2014). Development that clears forest area, grades soils, and increases impervious surface cover reduces the natural water capture and filtration functions played by forests and can increase erosion, sedimentation, and stormwater runoff. Together, these impacts can decrease water quality and reduce groundwater recharge. Additionally, development of forest lands can increase the risk of flooding and reduce resilience to other extreme weather events.

Development in the WUI also creates additional challenges related to wildfire management. Not only are human-caused ignitions more common in the WUI, due to the increased proximity and interaction between human development and wildlands, fire can spread more quickly to homes and other structures, increasing the likelihood that wildfires will threaten life and property. Development in the WUI also raises questions related to how local planning and land-use decisions impact management of public resources and vice versa.

As fires burn longer and stronger and development in the WUI puts more fires in proximity to people, wildland firefighting has become an increasingly dominant focus of the U.S. Forest Service (USFS). The *National Cohesive Wildland Fire Management Strategy* addresses the interplay between communities and fire through its three central goals: restoring and maintaining landscapes, creating fire-adapted communities, and applying an effective, risk-based response to fire.

This green paper examines needs and opportunities related to addressing regional green infrastructure at the landscape scale, with particular focus on challenges posed by development in the WUI and opportunities for increasing resilience through an integrated approach to green infrastructure. The needs and opportunities addressed in this Green Paper were identified through a scan of federal programs, interviews, and a scoping symposium and are examined with an eye toward developing a planning framework for addressing multihazard resilience through regional green infrastructure planning.

Defining Green Infrastructure and Resilience

Both green infrastructure and resilience are defined in multiple ways. Green infrastructure definitions include the landscape-scale definition of "an interconnected green space network (including natural areas and features, public and private conservation lands, working lands with conservation value, and other protected open spaces) that is planned and managed for its natural resource values and for the associated benefits it confers to human populations" (Benedict and McMahon 2006, p. 3). It also includes the U.S. Environmental Protection Agency's (EPA) definition of green stormwater infrastructure, which is focused on site-scale interventions such as bioswales, rain gardens, and permeable pavement, which help treat stormwater at its source and reduce the need for gray infrastructure interventions. Natural and nature-based systems (engineered systems, such as constructed wetlands, that replicate natural processes) are also encompassed in this definition.

Here, we use a hybrid definition which spans from the regional to the site scale and encompasses the full range of green infrastructure practices that can be applied at those scales (Table 1). Through this definition, green infrastructure can be thought of as a system made up of component practices and organized into a pattern, which connects these components and their functions from the site scale to regional scale (Rouse and Bunster-Ossa 2013).

Table 1. Green Infrastructure Examples Across Scales

Regional Scale	City Scale	Neighborhood Scale	Site / Building Scale
Working farms and forests	Urban forest / tree canopy	Local parks	Bioswales
Regional parks and nature preserves	Urban parks	Constructed wetlands	Rain gardens
River corridors and greenways	Parkways and boulevards	Green streets	Permeable pavement

Resilience is also defined in multiple ways though the definitions have, at their root, the ability of a system (e.g., community, ecosystem, infrastructure system) to recover and adapt to or from a set of circumstances. The National Academies of Sciences defines resilience as "ability to prepare and plan for, absorb, respond, recover from, and more successfully adapt to adverse events" (NAS) while the Rockefeller Foundation focuses on the idea of both single events (shocks) and ongoing challenges (stresses): "the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience" (100 Resilient Cities).

Green infrastructure plays an increasing role in conversations about resilience, both for addressing shocks, such as flooding from major storm events, and stresses, such as air quality and nuisance flooding. Green infrastructure practices are increasingly used in the fields of floodplain and coastal zone management to reduce the impacts of flooding and major storm events, address erosion, and improve water quality. In the field of wildfire management, the conversation has mostly focused on reducing the risks posed to lives and properties.

Identifying Needs and Opportunities

Needs and opportunities were identified through an inventory of federal programs that address green infrastructure, a scoping symposium with participants from the public, private, and nonprofit sectors, and a series of follow-up interviews that delved more deeply into questions posed and needs identified during the symposium.

Inventory of Federal Programs

Green infrastructure is addressed through multiple programs across federal agencies. The American Planning Association (APA) conducted an inventory of federal programs that address green infrastructure, including green stormwater infrastructure/low-impact development and natural and nature-based systems (Appendix A). Through this inventory, we found that federal programs exist to support both the planning and implementation of green infrastructure practices. Some programs are regional in scale, while others incentivize regional collaboration. A number of these programs, such as the U.S. Department of Housing and Urban Development's (HUD) Community

A Word Cloud Summary of the Symposium

Development and Disaster Recovery Block Grant Disaster Recovery program (CDBG-DR) do not have green infrastructure as their central focus, but may be used to support green infrastructure practices.

Regional Green Infrastructure Symposium
In May 2016, APA convened a symposium on the opportunities and needs surrounding regional green infrastructure planning at the landscape scale with support from the USFS. The symposium brought together representatives of federal agencies, nonprofit organizations, and the private sector. During the symposium, attendees focused on the topics of green infrastructure, land use and development, and hazards; worked to define the needs and opportunities related to planning for green infrastructure and resilience at the landscape scale; and determined priorities for future action, including the role that the USFS can play related to regional green infrastructure to support resilience.

Through the conversation, symposium attendees identified needs, challenges, and opportunities. The central challenges identified were issues related to 1) scale mismatch (i.e., aligning challenges and solutions at different scales of concern) and 2) allocation of risk related to addressing, combatting, and recovering from wildfire and other hazards.

Needs include identifying both incentives and disincentives that exist for land that has already been developed as well as land that has not yet been developed. They also include addressing mapping needs—both data availability and community capacity and resources. Effectively framing and communicating in a way that resonates with stakeholders, whether that be water quality or economic development, was also identified as a need. Partnerships represent both a need and an opportunity. There is a need for more collaboration across agencies, which also creates opportunities for new partnerships that can advance activities around green infrastructure for resilience. There are also opportunities to build and strengthen partnerships at the regional and local levels and with the private sector. Leveraging existing incentives (e.g., financial assistance, technical assistance, regulatory tools), and using existing tools at the local level, were also identified as opportunities.

Interviews
APA conducted seven interviews to further explore how federal programs address green infrastructure, incentives that exist to encourage green infrastructure at the local level, as well as potential opportunities to take lessons learned from the fields of coastal and floodplain management and apply them to the wildland-urban interface. Interviews included conversations with three federal agencies: HUD, the Federal Emergency Management Agency (FEMA), and the National Oceanic and Atmospheric Administration (NOAA), as well as the Florida Forest Service and the Wasatch Front Regional Council.

U.S. Department of Housing and Urban Development
HUD administers the Community Development Block Grant program. The program, which was established in 1974, provides flexible funds that communities can apply toward addressing local community development needs (e.g., economic development, infrastructure, public services). Since 2001, more than $45 billion dollars has been appropriated through the CDBG-DR program, which primarily allocates funds for unmet recovery needs following a disaster declaration.

Rebuild by Design and the National Disaster Resilience Competition (NDRC) were both funded through disaster recovery appropriations, but funds were awarded on a competitive basis rather than using the unmet needs-based formula allocation. Rebuild by Design focused on recovery from Hurricane Sandy while NDRC focused on all disaster declarations from 2011–2013, which included all states except South Carolina and Nevada. Both competitions involved partnerships with philanthropic organizations.

The Rebuild by Design competition focused on regional risk assessment, identifying "nodes of risk" where strategic interventions would produce the greatest return on investment and allow solutions to be developed based on local risk conditions. The competition also took a multibenefit approach, looking both at the multiple benefits (e.g., social, economic) that could be provided by green infrastructure and the multiple benefits of other project

interventions (with a recognition that benefits are often dependent on local context). The projects also had a strong focus on "implementability," addressing potential regulatory hurdles during the design phase to improve the feasibility of implementation and reduce the likelihood of running into regulatory walls.

Federal Emergency Management Agency

FEMA requires hazard mitigation planning as a condition of receiving certain types of nonemergency disaster assistance. FEMA also administers a Pre-Disaster Mitigation Grant Program, which provides planning and project grants to reduce overall risk from future hazard events. Mitigation activities are inherently local and every state and local community has its own ways and means of addressing hazards such as floods, hurricanes, or wildfires.

Many communities with Hazard Mitigation Plans also have Community Wildfire Protection Plans (CWPPs). However, CWPPs are usually developed separately from the local Hazard Mitigation Plan and, as a result, there isn't necessarily a level of support between these planning efforts. FEMA has not seen a truly integrated planning effort and suggests that this is, in part, because communities complete plans in compliance with grant requirements and integration between plans is not a requirement. Increasing coordination between federal agencies can help reduce redundancies across these plans.

Through the interview, specific differences between floodplain management and wildfire management were addressed. While floods and wildfires both often affect high-amenity areas, wildfires tend to be in sparsely popu-lated areas and even massive wildfires may affect many fewer people and homes than a small hurricane or a flood. Additionally, it is more difficult to quantify the return period on wildfires (i.e., the period in which another wildfire may occur, compared to, for example, a 100-year flood). This can make justifying hazard mitigation for wildfire as a cost-effective activity challenging.

National Oceanic and Atmospheric Administration

NOAA has been engaged in green infrastructure efforts through the Great Lakes Restoration Initiative, through train-ing efforts (including those focused on green infrastructure for coastal resilience), and through work with partners.

The Great Lakes Restoration Initiative was started in 2010 to promote efforts at Great Lakes protection and res-toration. Through this program, NOAA piloted an economic assessment of green infrastructure for climate change adaptation in Green Bay, Toledo, and Duluth. A central focus of this assessment was who pays when there are flood events and how communities can offer incentives to reduce impacts and be better prepared for coastal flooding.

The pilot studies looked at different green infrastructure solutions to see if they are economically viable for addressing flooding. Through these pilot studies, NOAA found that green infrastructure is a financially viable, long-term approach.

Green infrastructure also provides a multibenefit approach. In addition to addressing flooding, green infra-structure can provide economic, livability/quality of life, and water quality cobenefits (particularly on the western side of the Great Lakes). Some communities need the economic piece to justify investment in green infrastructure; for other communities, another focus may be more central.

Through green infrastructure trainings, NOAA emphasizes the importance of a common vocabulary. It's also important to building partnerships around green infrastructure (as well as to have committed local partners) for ongoing project implementation and success.

Florida Forest Service

Florida is the lightning capital of the United States and has, on average, the second most wildfires per year of any state. The state is a fire-evolved climate and nearly one-third of its population lives in the WUI.

The Florida Forest Service has made significant efforts to address wildfire mitigation. Florida leads the nation in prescribed fire, burning 2.3 to 2.4 million acres a year, which reduces fuel build-up both in and out-side the WUI and reduces the threat of wildfire. It has also been an active participant in the Firewise and Fire Adapted Communities programs. Through these programs, communities complete a wildfire hazard assess-ment and a CWPP.

In addition to wildfires, Florida experiences other hazard events, including hurricanes. One of the challenges of addressing hazards is that preventative measures taken to address hurricanes are the least preventative for wildfires and vice versa. This poses the question of how to coordinate efforts where one type of landscape intervention is needed to reduce the threat of one disaster, but a different landscape intervention is needed to reduce the threat of another disaster.

Often, getting communities to recognize the threat of wildfire poses a significant challenge. Communicating that a risk exists and that there is a reason behind mitigation activities is important to their success. If a hazard event hasn't occurred recently, people often think that it cannot or will not happen where they live. Hazard events, including wildfires, can build community support for mitigation measures when they happen.

In efforts to address wildfire risk, Florida has focused on incentivizing and educating, in part due to the strong landowner rights perspective in the state. This contrasts with the more regulatory approach taken by California and other western states.

Wasatch Front Regional Council

The Wasatch Front Regional Council (WFRC) is the regional planning organization for the greater Salt Lake City area, representing 60 cities and five counties. In February 2012, WFRC adopted *(Re)Connect: The Wasatch Front Green Infrastructure Plan*. *(Re)Connect* provides a strategic framework for land conservation, preservation, and protection in the region and takes a multibenefit approach to evaluating elements of the green infrastructure network. The overarching goal of the plan is to "plan, design, and manage an interconnected network of regionally significant landscape features that retain ecological function, maintain or improve water quality and habitat, provide recreational opportunities, preserve working land productivity, and sustain the high quality of life and enjoyment of the Wasatch Front" (WFRC 2012). The plan takes an asset-based approach and is accompanied by a series of five asset network maps focused on community and culture, ecological, hydrological, recreational, and working lands assets.

In 2003, WFRC completed the Regional Open Space Planning Study and *(Re)Connect* notes that a conclusion of this report was that people within the region want to preserve the full range of natural resources and to protect communities from hazard risks. *(Re)Connect* addresses the environmental benefits of green infrastructure, including reduced flood risk and resilience to climate change, as well as minimizing the inversion (when normal atmospheric conditions become reversed and cold air becomes trapped underneath warm air). The plan's conceptual network design addresses "lands of significant public safety risk" near developed areas as high priority/risk under the community and culture asset. The data layers included in the asset network maps also include hazard risks such as fault lines, floodplains, landslide areas, problem soils, fire hazards, and the WUI. The plan also emphasizes coordinated resource management and stewardship approach to effectively manage and maintain the network, ensuring that the network itself is resilient.

While *(Re)Connect* creates a regional framework, there are challenges to implementing green infrastructure at the local level. Many local governments within the region see green infrastructure as an amenity rather than a necessity, which makes it important to be able to quantify and communicate the economic development benefits of green infrastructure.

Communicating economic benefits is also important when talking to state legislators about green infrastructure and conservation. There is often a disconnect at the state level—Utah has a robust tourism industry and people visit the state because of its natural beauty, but decisions about land management often focus on the economic potential of resource use and extractive industries.

(Re)Connect was primarily grant funded, and WFRC has not received ongoing funding, which creates a challenge for both committing to and tracking local-level implementation efforts. However, the data layers (asset network maps) are widely used by county and municipal governments in their planning work.

Toward a Planning Framework

Several key components of a planning framework to address multihazard resilience through green infrastructure planning were identified through the inventory of federal programs; the challenges, needs, and opportunities

identified at the symposium; and the follow up interviews. These can be broadly grouped into the areas of communications and actions.

Communications

Creating a common vocabulary. As the multiple definitions of green infrastructure and resilience show, the same terms mean different things in different fields and contexts. Addressing multihazard resiliency for green infrastructure brings together different fields and disciplines, including planning, emergency management, conservation, and forestry. There is a need for common terminology and clear definitions to improve communication between fields, as well as to ensure that information is being clearly and consistently communicated to the public and decision makers.

Articulating a multibenefit approach to green infrastructure. Green infrastructure can provide a range of benefits at different scales. While environmental outcomes (e.g., protecting water quality) may be the intended result of an intervention, other benefits, such as economic benefits or recreational opportunities may resonate more clearly with decision makers and community members.

Mapping local hazard risks and green infrastructure assets. While available data can be a challenge, maps are an effective tool for visualizing and communicating hazard risk and green infrastructure assets. Mapping local hazard risks and green infrastructure assets can identify key areas for actions or interventions, such as conservation easements or site-scale green infrastructure, as well as be used to communicate these actions and the risks they address to community members and decision makers.

Actions

Building partnerships. Building strong partnerships— between landowners and local governments, between local agencies, between the levels of government, between the public and private, and nonprofit sectors—is important to successfully planning for and addressing potential hazards and risks in a community. In addition to increased collaboration around defining hazards and approaches to addressing them, strong partnerships provide networks for sharing outcomes and results.

Taking a holistic approach to hazards. Impacts of one hazard event may have cascading effects, leading to or exacerbating other hazard events (e.g., increased likelihood of flash flooding on fire scarred landscapes. Alternately, actions taken to reduce the impacts of one hazard may increase the risk related to another. As a result, it is important to take a complete look at the potential hazards that may affect a community, the risks they pose, and their potential impacts, together with interventions to mitigate these risks and find a balanced approach for the community.

Understanding and addressing scale. Hazard risk is often regional or interregional in scale. A single flood, hurricane, or wildfire can affect a large area extending across the boundaries of multiple jurisdictions. Local actions can also have impacts that extend beyond jurisdictional boundaries, whether those are development decisions that impact water quality or increase flood risk downstream, or green infrastructure interventions that reduce stormwater runoff and improve water quality. However, people understand and experience benefits and risks locally. How does a specific risk impact their community? What are the local benefits of an intervention and what is the cost-benefit trade-off? And is there a spatial mismatch between the perceived cost and associated benefit. (For example, could conservation measures in a rural area aimed at protecting water quality within a region be perceived as limiting rural economic development potential?)

Integrating hazards and green infrastructure into plans and creating alignment between plans. There are a range of plans across scales that may address green infrastructure, hazards, and resilience. These include local comprehensive and regional long-range plans, parks and recreation plans, green infrastructure plans, urban forestry plans, hazard mitigation plans, climate adaptation plans, and CWPPs, as well as subarea plans. It is important that goals and policies related to hazards and green infrastructure be reflected in goals and policies included in the local comprehensive plan. It is also important to create alignment between plans, as well as coordination across planning scales.

Use regulations and incentives to increase resiliency. Planning tools, such as zoning regulations and incentives (e.g., density bonuses) are the primary tools for implementing the policy recommendations in local plans.

They can be used to direct development in ways that reduces hazard risks while also incentivizing land conservation, the incorporation of green stormwater infrastructure into new developments, and other practices that address hazard risk.

Conclusion

Through an inventory of federal programs, the scoping symposium, and a series of follow-up interviews, APA identified needs and opportunities related to regional green infrastructure at the landscape scale. These needs and opportunities, discussed above, can be described in terms of communications and planning actions. The next step in this process is to develop these components into a planning framework that addresses multihazard resilience through green infrastructure planning. This framework will provide more concrete recommendations for how communities can evaluate hazard risks and green infrastructure benefits through the planning process, policy, and implementation.

The symposium and conversations that followed also identified areas for USFS engagement. These include increasing collaboration with partner agencies around green infrastructure, hazard mitigation, and wildfire protection; engaging key stakeholders at the local, regional, and national levels; and providing tools and resources to help communities address challenges and incorporate best practices. These potential areas of USFS engagement will be further developed in a future green paper.

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