

County-Level Risk Assessment: Putnam County, Illinois

Guide to the Report

Table 1: This table contains basic statistics of the county as a whole which helps set the context for the rest of the analysis and visualizations as described below.

Table 2: This table describes the number of census tracts grouped by their computed resilience levels. The basic resilience values of each tract are grouped into 5 quantiles (resilience levels), where 5 (very high resilience) covers counties having resilience values in the top 20

Table 3: This table contains the Indicator Group Rankings, which contain a five-point rating across five indicator themes: housing, economy, community health, infrastructure, and environment. It shows where the current county falls compared to other counties in the state (Low Risk means the resilience value for the current county is in the top 20

Table 4: This table contains the Indicator Group Rankings computed across all tracts in the county which correspond to rural areas, similar to Table 3. The resilience values across all tracts are aggregated at the county level, which is then converted into quantiles which serve as rankings.

Table 5: This table describes the Census Places in the county grouped by their resilience categories. This is similar to Table 2, the resilience values are categorized into 5 levels and aggregated over all the Census Places over the county.

Table 6: This table contains the Indicator Group Rankings computed across all census places in the county, similar to Table 3. The resilience values across all census places are aggregated at the county level, which is then converted into quantiles which serve as rankings.

Figure 1: This maps plots each census tract in the entire county and color-codes each tract with its computed resilience levels.

Figure 2: This pie chart shows the composition of the county on the basis of percentage of census tracts in each resilience category.

Figure 3: This map shows the rural resilience of all tracts which can be classified as 'rural', i.e. they are assigned a USDA RUCA code different from 1. Rural resilience is computed across all rural tracts in the state.

Figure 4: In this map, the census places within the state are shown and the subject county is highlighted using a red border that outlines the county boundary.

Figure 5: This figure is a map of the subject county showing all the census places inside it, color coded with the places resilience levels. Place resilience is computed across all census places in the state, similar to rural resilience.

Figure 6: This is a pie chart and table showing composition of the county on the basis of percentage of census places in each disaster resilience category.

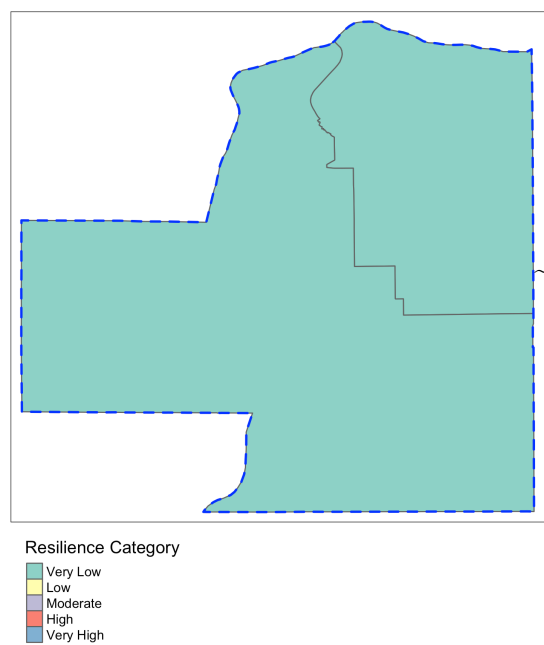
Appendix A: This table contains the different indicators used in the analysis, their definition, what it means when the indicator is said to be at low or high risk, and the risk level computed for this indicator at the county level. The risk level is computed by comparing the value of the indicator across all counties in the state and converting the raw values into quantiles: Very High, High, Moderate, Low, and Very Low.

Appendix B: This table contains the different indicators used in the analysis and their computed risk level for all rural census tracts as well as the census places present inside the county. The risk level is computed across all counties in the state and converted into quantiles: Very High, High, Moderate, Low, Very Low.

Disclaimer: Variables from County health patterns, EQI and County transportation patterns might have aggregation errors at the tract, rural and census place levels owing to unavailability of data beyond the county level.

Census Tracts within Putnam County, Illinois

Figure 1



Basic Statistics

Table 1: Basic Statistics (County level)

Information	Value
Population	5720 persons
Area sq. miles	160.4 sqm
Gross Density(persons/sq mil)	36 p/sqm
Avg HH Size	2.35 persons
Median HH Income	64694 USD

Count of Tracts in each Category

Figure 2

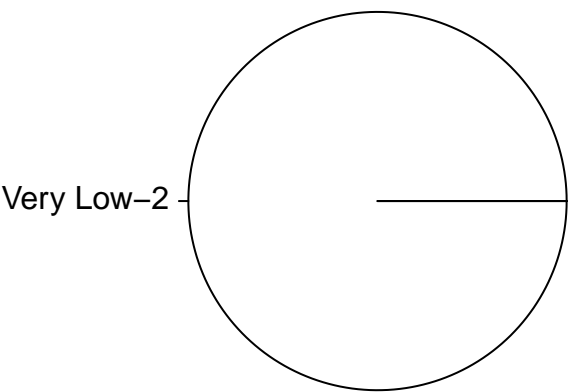



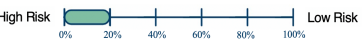
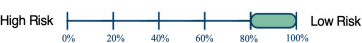


Table 2: Percentage of Census Tracts under each Resilience Category(County level)

Very High	High	Moderate	Low	Very Low
0	0	0	0	100

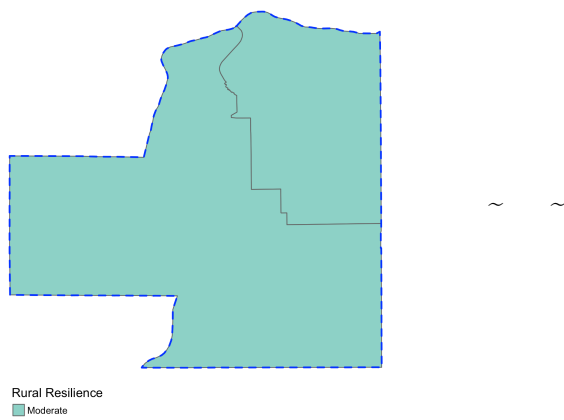
Indicator Group Rankings

Table 3: Overall Indicator Group Rankings

Indicator Group	High Risk Areas	Low Risk Areas
Community 	Population, Percent Commuters, Percent BachelorsDegree Percent NoHealthIns, Food Environment Index, Violent Crime Rate, Inadequate Facilities, COVID-19 death rate, Percent Limited Access to Healthy Foods, Percent Disconnected Youth, Segregation index	
Economy 	Unemployment percent, Service LQ, Agri, Management LQ, Others LQ	Healthcare related business rate
Housing 	Total, Rented, GroupQuarters	
Environment 	std sandandgravel prim pop, Facilities Rate, AvgOfD3 ave, W Cd, W Cr, W CN, W HG, W SE, W SB, W ENDRIN, W METHOXYCHLOR, W DALAPON, W DEHA, W SIMAZINE, W DEHP, W PICLORAM, W DINOSEB, W 24D, W PCP, W PCB, W DBCP, W EDB, W CHLORDANE, W DCM	co, pct disease acres, Radon
Infrastructure 	No Pubtrans, Protective Services	Pubtrans heavilyDependent


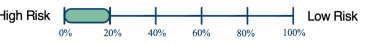
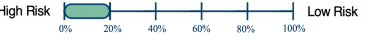
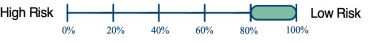
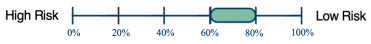
Rural Resilience within Putnam County, Illinois

Figure 3



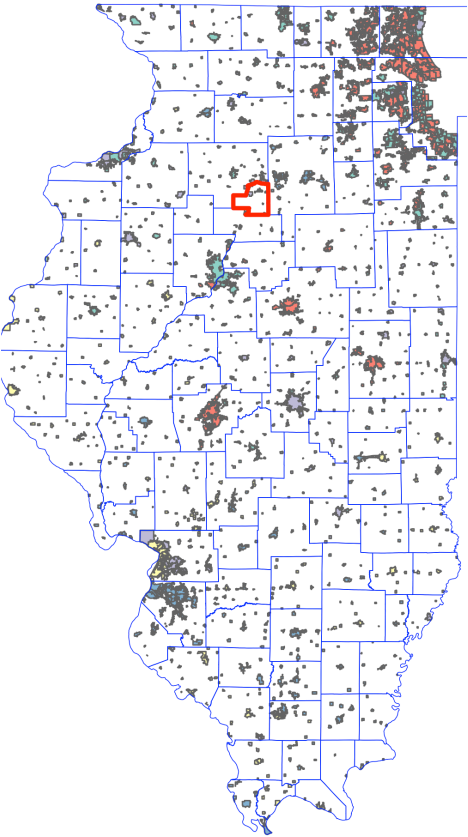
Rural Indicator Rankings

Table 4: Rural Indicator Group Rankings

Indicator Group	High Risk Areas	Low Risk Areas
Community 	Percent NoHealthIns, Food Environment Index, Inadequate Facilities, COVID-19 death rate, Percent Limited Access to Healthy Foods	NonWhite Percent, FemaleHeaded HHs Percent, Working Nonworking ratio, HelperPool
Economy 		construction, Healthcare related business rate
Housing 		Total, Renters Cost IncomeRatio
Environment 	pm10, std sandandgravel prim pop, Facilities Rate, AvgOfD3 ave, W DCM	co, Radon, Pct BS, Per PSWithSW, Pop Density 2010
Infrastructure 	Protective Services	Pubtrans Dependent

State-Level Places Map

Figure 4

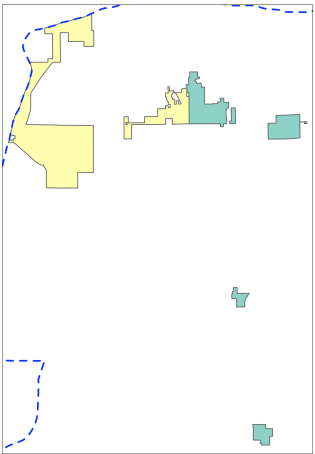


Resilience Category

- High
- Low
- Moderate
- Very High
- Very Low

Places Map within Putnam County, Illinois County, IL

Figure 5



Resilience Category

- Low
- Moderate

Count of Places in each Category

Figure 6

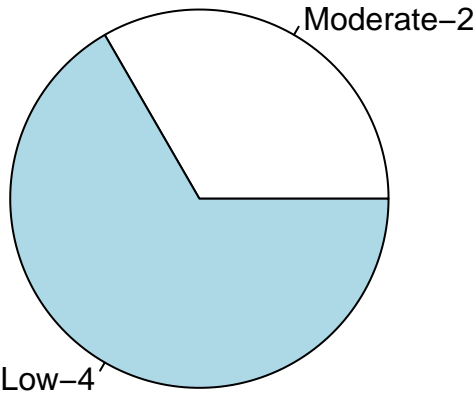

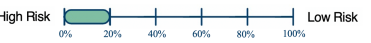
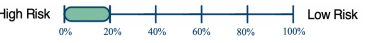
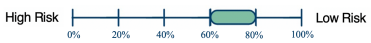
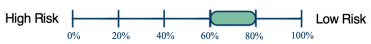


Table 5: Percentage of Census Tracts under each Resilience Category(County level)

Very High	High	Moderate	Low	Very Low
0 %	0 %	33 %	67 %	0 %

Places Indicator Rankings

Table 6: Places Indicator Group Rankings

Indicator Group	High Risk Areas	Low Risk Areas
Community 	Disabled Percent, Skilled Percent, Percent AssistanceNeed, Food Environment Index, Violent Crime Rate, Inadequate Facilities, COVID-19 death rate, Percent Limited Access to Healthy Foods, Segregation index	NonWhite Percent, LargeFam Percent
Economy 	poverty, Unemployment percent, Sales LQ, construction LQ, Retail LQ, Transport LQ, Edu LQ	PT, Wholesale, Transport, Healthcare related business rate
Housing 		Rented
Environment 	std sandandgravel prim pop, Facilities Rate, AvgOfD3 ave, W DCM	co, pct disease acres, Radon, Per PSWithSW
Infrastructure 		

Relevant Resources

The following represent key areas of concern (in order of importance) at the county level:

- Infrastructure

The resources below have been extracted from the Disaster Planning Library to facilitate planning for high-risk areas observed through the assessment. Please go through the following tools as a starting point for your planning process and feel free to search the Disaster Planning Library for further information, if required. The resources here are included to facilitate the process of hazard mitigation planning, through the Planning for a Purpose Model of Illinois Extension (see Toolkit).

Infrastructure

Green Infrastructure

- **Green Infrastructure: Smart Conservation For The 21st Century**

Organization : Renewable Resources Journal

Year : 2002

Document_type : General Resource/ Foundational Research, Planning Tool

Disasters : Flood, Man-Made Disasters

Abstract : “Green infrastructure” is a term becoming more commonly used among natural resource professionals. While it means different things to different people, depending on the context in which it is used, for the purposes of this article, green infrastructure is an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations. Green infrastructure is the ecological framework needed for environmental, social and economic sustainability- our nation’s natural life support system. Planning utilizing green infrastructure differs from conventional open space planning because it looks at conservation values in concert with land development, growth management and built infrastructure planning. This article introduces green infrastructure as a strategic approach to land conservation that addresses the ecological and social impacts of sprawl and the accelerated consumption and fragmentation of open land. It describes the concept and value of green infrastructure and presents seven principles for successful green infrastructure initiatives.

Plan_Components : Planning Processes

- **Mitigation Assistance: Building Resilient Infrastructure And Communities**

Organization : FEMA

Year : 2022

Document_type : Policy

Disasters : Tornado, Flood, Drought, Extreme Weather, Earthquakes, Wildfires, Man-Made Disasters, Biological Disasters, Soil Erosion/Landslides

Abstract : The purpose of this policy is to establish the framework and requirements for BRIC while allowing flexibility to promote continuous program improvement through priorities and criteria set forth in the annual Notice of Funding Opportunity (NOFO).

The BRIC program is designed to promote a national culture of preparedness and public safety through encouraging investments to protect the nation’s communities and infrastructure and through strengthening national mitigation capabilities to foster resilience.

Plan_Components : Strategies, Funding Mechanisms

- **What Is Green Infrastructure?**

Organization : EPA

Year : 2022

Document_type : Web-based Resource, Manual for an Local Organization

Disasters : Flood, Drought, Extreme Weather

Abstract : Description of green infrastructure with examples of different types of green infrastructure.
Plan_Components : Strategies

- **Green Infrastructure Modeling Tools**

Organization : EPA

Year : 2022

Document_type : General Resource/ Foundational Research, Web-based Resource, Planning Tool

Disasters : Flood, Extreme Weather

Abstract : Modeling tools support planning and design decisions on a range of scales from setting a green infrastructure target for an entire watershed to designing a green infrastructure practice for a particular site.

Plan_Components : Strategies, Tools, Green Infrastructure

- **Overcoming Barriers To Green Infrastructure**

Organization : EPA

Year : 2022

Document_type : General Resource/ Foundational Research, Web-based Resource

Disasters : Flood, Drought

Abstract : Communities across the country are experiencing the benefits of green infrastructure. They have adopted performance standards or incentives promoting green infrastructure while others have built demonstration projects. Here we identify some of the barriers to adopting green infrastructure approaches and suggest strategies to overcome them.

Plan_Components : Strategies, Green Infrastructure

- **Operation And Maintenance Of Green Infrastructure Receiving Runoff From Roads And Parking Lots**

Organization : EPA

Year : 2016

Document_type : General Resource/ Foundational Research, Manual for an Local Organization

Disasters : Flood

Abstract : Operation and maintenance is a challenge that when not addressed properly can lead to failure of green infrastructure and high costs associated with restoration. This memorandum addresses common operation and maintenance questions and provides recommendations for evaluating the need and providing maintenance for green infrastructure, specifically bioretention and bioswales, that serves highly impervious roadways and parking lots.

Plan_Components : Strategies, Tools, Green Infrastructure

- **Green Infrastructure Funding Opportunities**

Organization : EPA

Year : 2022

Document_type : Web-based Resource, Funding Opportunities

Disasters : Flood, Extreme Weather, Soil Erosion/Landslides

Abstract : Federal funding sources and funding resources from the EPA for green infrastructure

Plan_Components : Funding Mechanisms, Tools

- **Green Infrastructure Grant Opportunities**

Organization : Illinois EPA

Year : 2021

Document_type : Web-based Resource, Funding Opportunities

Disasters : Flood, Drought, Soil Erosion/Landslides

Abstract : The new Green Infrastructure Grant Opportunities (GIGO) Program funds projects to construct green infrastructure best management practices (BMPs) that prevent, eliminate, or reduce water quality impairments by decreasing stormwater runoff into Illinois' rivers, streams, and lakes. Projects that implement treatment trains (multiple BMPs in a series) and/or multiple BMPs within

the same watershed may be more effective and efficient than a single large green infrastructure BMP.
Plan_Components : Funding Mechanisms, Green Infrastructure

- **Managing Wet Weather With Green Infrastructure Municipal Handbook Funding Options**

Organization : EPA

Year : 2008

Document_type : Manual for an Local Organization, Funding Opportunities

Disasters : Flood

Abstract : The Municipal Handbook is a series of documents to help local officials implement green infrastructure in their communities. This chapter identifies and discusses the two most common funding options communities are using for green stormwater infrastructure – stormwater fees and loan programs.

Plan_Components : Strategies, Funding Mechanisms, Case Studies, Green Infrastructure

- **Managing Wet Weather With Green Infrastructure Municipal Handbook Green Infrastructure Retrofit Policies**

Organization : EPA

Year : 2008

Document_type : Planning Tool, Manual for an Local Organization, Policy

Disasters : Flood

Abstract : The Municipal Handbook is a series of documents to help local officials implement green infrastructure in their communities. This chapter is about creating policies for green infrastructure.

Plan_Components : Strategies, Planning Processes, Tools, Green Infrastructure

- **Managing Wet Weather With Green Infrastructure Municipal Handbook Green Streets**

Organization : EPA

Year : 2008

Document_type : Planning Tool, Manual for an Local Organization, Policy

Disasters : Flood

Abstract : The Municipal Handbook is a series of documents to help local officials implement green infrastructure in their communities. This chapter looks at green streets.

Plan_Components : Strategies, Green Infrastructure

- **Managing Wet Weather With Green Infrastructure Municipal Handbook Rainwater Harvesting Policies**

Organization : EPA

Year : 2008

Document_type : Planning Tool, Manual for an Local Organization, Example Ordinances and Codes

Disasters : Flood, Drought

Abstract : The Municipal Handbook is a series of documents to help local officials implement green infrastructure in their communities. This chapter looks at rainwater harvesting

Plan_Components : Strategies, Case Studies, Tools, Green Infrastructure

- **Managing Wet Weather With Green Infrastructure Municipal Handbook Incentive Mechanisms**

Organization : EPA

Year : 2009

Document_type : Planning Tool, Manual for an Local Organization, Example Ordinances and Codes, Funding Opportunities

Disasters : Flood

Abstract : The Municipal Handbook is a series of documents

to help local officials implement green infrastructure in their communities.

This chapter looks at incentive mechanisms

Plan_Components : Funding Mechanisms, Case Studies, Green Infrastructure

- Green Infrastructure Modeling Toolkit

Organization : EPA

Year : 2022

Document_type : Web-based Resource

Disasters : Flood, Drought

Abstract : EPA has developed innovative models, tools, and technologies for communities to manage water runoff in urban and other environments. The resources in this toolkit incorporate green or a combination of green and gray infrastructure practices to help communities manage their water resources in a more sustainable way, increasing resilience to future changes.

Plan_Components : Tools, Green Infrastructure

- Green Infrastructure Methods

Organization : EPA

Document_type : General Resource/ Foundational Research, Funding Opportunities

Disasters : Flood, Drought

Abstract : FEMA is encouraging communities to incorporate methods to mitigate the impacts of climate change into eligible Hazard Mitigation Assistance (HMA) funded risk reduction activities by providing guidance on mitigating flood and drought conditions.

Plan_Components : Strategies, Funding Mechanisms, Tools, Green Infrastructure

- Equity Guide For Green Stormwater Infrastructure Practitioners

Organization : Greenprint Partners

Year : 2022

Document_type : General Resource/ Foundational Research, Planning Tool, Manual for an Local Organization, Policy

Disasters : Flood, Drought

Abstract : The Equity Guide for Green Stormwater Infrastructure Practitioners is a resource developed by and for green infrastructure program managers representing local public sector stormwater management organizations across the United States and Canada. It offers an action and evaluation roadmap that defines: our industry's shared long-term equity goals, best practices that will move the needle, and sample metrics that help us track progress toward those goals over time. It also offers a variety of tools to support practitioners in customizing community-informed equity work plans and evaluation plans to local contexts

Plan_Components : Surveys/Assessments, Strategies, Planning Processes, Tools, Green Infrastructure, Information

- Cape Cod Green Infrastructure Guide

Organization : Tufts University

Year : 2015

Document_type : General Resource/ Foundational Research, Web-based Resource

Disasters : Flood

Abstract : In 2015, this Green Infrastructure Guide was developed by Tufts University graduate students in the Water: Systems, Science & Society program to provide accessible opportunities for stakeholders and the public to learn about green technologies and the unique benefits they offer.

Plan_Components : Green Infrastructure, Information

- Professional Practice Green Infrastructure: Constructed Wetlands

Organization : American Society of Landscape Architects

Document_type : General Resource/ Foundational Research, Web-based Resource

Disasters : Flood

Abstract : Constructed wetlands mimic the functions of natural wetlands to capture stormwater, reduce nutrient loads, and create diverse wildlife habitat. They are often created in engineered growth media in trenches, small islands, and pools. They are designed to contain water at all times – either standing water on the surface or water saturated just below the soil surface.

Plan_Components : Tools, Green Infrastructure, Information

- Minnesota Green Stormwater Infrastructure Guide

Organization : MN Department of Natural Resources, NOAA

Year : 2022

Document_type : General Resource/ Foundational Research, Planning Tool, Manual for an Local Organization

Disasters : Flood, Drought, Extreme Weather

Abstract : The purpose of this guide is to help homeowners and small business owners who are not subject to stormwater permits identify ways to improve and protect their property and the area's water quality through installation and management of green stormwater practices. The designs of these practices can be customized to fit specific needs and site-specific constraints.

Plan_Components : Strategies, Planning Processes, Tools, Green Infrastructure, Information

- The Green Infrastructure Guide Planning For A Healthy Urban And Community Forest

Organization : The Regional Planning Partnership

Year : 2001

Document_type : General Resource/ Foundational Research, Planning Tool, Manual for an Local Organization

Disasters : Flood, Drought, Biological Disasters, Soil Erosion/Landslides

Abstract : This handbook builds the case for the value of green infrastructure and provides suggestions about how to integrate green infrastructure planning with planning for development.

Plan_Components : Planning Processes, Tools, Green Infrastructure, Information

- Approved Green Infrastructure Master Plan

Organization : Prince George's County Planning Department

Year : 2002

Document_type : Specific Plan, Policy

Disasters : Flood, Drought, Man-Made Disasters

Abstract : This document contains text and maps of the Approved Countywide Green Infrastructure Plan for Prince George's County, Maryland. Green infrastructure is defined as an interconnected network of waterways, wetlands, woodlands, wildlife habitats, and other natural areas of countywide significance. The plan identifies a contiguous network of environmentally sensitive areas throughout the county and sets forth a goal, objectives, policies, and strategies to preserve, protect, and enhance these elements by the year 2025. The plan supports the desired development pattern in the General Plan. This is the first comprehensive functional master plan ever developed for environmental ecosystems in Prince George's County.

Plan_Components : Planning Processes, Green Infrastructure

- Kane County 2040 Green Infrastructure Plan

Organization : Kane County Board, Quality of Kane, Greening Infrastructure, IDNR

Year : 2012

Document_type : Specific Plan

Disasters : Flood, Soil Erosion/Landslides

Abstract : The ultimate goal of the Kane County 2040 Green Infrastructure Plan is to lay the groundwork for green infrastructure planning and projects at the regional, community, neighborhood and site levels addressing current issues of water resource management, biodiversity, conservation, water supply, public health, climate change and economic development.

Plan_Components : Surveys/Assessments, Planning Processes, Funding Mechanisms, Green Infrastructure, Information

- Green Infrastructure Partnership Opportunity Program

Organization : Metropolitan Water Reclamation District of Greater Chicago

Year : 2022

Document_type : Specific Plan, Funding Opportunities

Disasters : Flood, Extreme Weather

Abstract : MWRD encourages and supports implementing green infrastructure (GI), which includes a range of engineered installations that store, infiltrate, and/or evaporate stormwater, thereby mimicking the natural water cycle. The MWRD recognizes that GI practices can be effective in reducing wet-weather flows to combined sewer systems, reducing combined sewer overflows to local waterways, and reducing runoff volumes

and improving water quality in separate sewer service areas. The MWRD also recognizes the vital role of local government in addressing flooding concerns through the innovative use of GI.

Plan_Components : Planning Processes, Funding Mechanisms, Tools, Green Infrastructure

- Kishwaukee River Corridor Green Infrastructure Plan

Organization : Chicago Wilderness, Illinois Department of Natural Resources

Year : 2013

Document_type : Specific Plan, Policy

Disasters : Flood, Soil Erosion/Landslides

Abstract : The Kishwaukee River Corridor Green Infrastructure Plan is based on an area in Winnebago County that has significant natural and recreation resources and has been identified for a new industrial development corridor. The assets and opportunities presented at this location made it an ideal site to incorporate green infrastructure into development plans. Chicago Wilderness recognized this opportunity, and Boeing funded a project to provide green infrastructure consulting and technical assistance to municipalities with jurisdiction over the development corridor. The result was a series of meetings and presentations over the past year and a half with municipalities, landowners, environmental organizations, press, and interested local citizens. During these meetings, consultants and environmental organizations explained green infrastructure and its benefits, presented examples, inventoried and mapped local resources, identified opportunities and challenges of local ordinances, listened to concerns and needs, and provided recommendations for protecting valuable assets and incorporating green infrastructure. This plan documents this process and provides a compilation of inventories, reviews, and recommendations.

Plan_Components : Surveys/Assessments, Strategies, Green Infrastructure, Information

- McHenry County Green Infrastructure Plan

Organization : McHenry County, Chicago Wilderness, Grand Victoria Foundation

Year : 2012

Document_type : Specific Plan

Disasters : Flood

Abstract : The McHenry County 2030 Comprehensive Plan, adopted in April 2010, makes recommendations for the development and adoption of a green infrastructure plan for the county. To that end, and with the continued support of the County Board and Planning and Development Committee, this plan was undertaken in late 2010 by the Department of Planning and Development with the assistance of the Chicago Wilderness Sustainable Watershed Action Team (SWAT) and green infrastructure expert Dennis Dreher, who provided project coordination and technical and policy guidance

Plan_Components : Surveys/Assessments, Strategies, Planning Processes, Green Infrastructure, Information

- Green Infrastructure: Green Roofs And Walls

Organization : The American Society of Landscape Architects

Year : 2022

Document_type : General Resource/ Foundational Research, Web-based Resource

Disasters : Flood, Extreme Weather, Man-Made Disasters

Abstract : Green roofs can help regulate a building's internal temperature, reduce stormwater runoff, and mitigate the urban heat island effect. Green roofs offer significant economic benefits, including a longer roof life and heating and cooling energy savings. Green roofs also provide an opportunity for urban food production, and increasing urban biodiversity. If well-designed and cared for, green roofs can offer people the psychological benefits of nature.

Plan_Components : Tools, Green Infrastructure, Information

- Professional Practice Green Infrastructure: Wildlife Habitat And Corridors

Year : 2022

Document_type : General Resource/ Foundational Research, Web-based Resource

Disasters : Flood, Man-Made Disasters, Biological Disasters, Soil Erosion/Landslides

Abstract : An array of independent and uncoordinated land-use decisions often leads to a landscape comprised of fragmented wildlife habitats which serve both human and wildlife needs poorly. Landscape ecology proposes instead to design landscape mosaics – matrices of patches, corridors, and ecological edges – to serve a broader and more diverse range of ecological systems and functions. Comprehensive land-use planning and design done in this way will better promote the enhancement, protection, and management of landscapes

that support wildlife and provide ecosystem services to human populations.

Plan_Components : Tools, Green Infrastructure, Information

- Professional Practice Green Infrastructure: Overview

Organization : American Society of Landscape Architects

Year : 2022

Document_type : General Resource/ Foundational Research, Web-based Resource

Disasters : Flood, Man-Made Disasters

Abstract : With rapid global population growth and increasing urban and suburban density, green spaces are sometimes seen as a luxury. However, high-performing green spaces, or green infrastructure, provides real economic, ecological, and social benefits. Integrating green infrastructure into the built environment must be a priority.

Plan_Components : Tools, Green Infrastructure, Information

- Green Infrastructure: A Landscape Approach

Organization : American Planning Association

Year : 2013

Document_type : General Resource/ Foundational Research, Planning Tool

Disasters : Flood, Extreme Weather, Man-Made Disasters, Biological Disasters, Soil Erosion/Landslides

Abstract : From the beginning, the landscape has determined where and how people live. Over time, people embellished the natural landscape with an infrastructure of roads, aqueducts, bridges, ports, power plants, and more. Now communities are turning their attention to the central planning challenge of our time: sustainability. And they are discovering, or rediscovering, the benefits of green infrastructure — infrastructure that takes advantage of the natural landscape.

This well-grounded report shows how green infrastructure cleans the air and water, replenishes aquifers, reduces flooding, and moderates the climate. And the benefits go beyond improving the environment. Green infrastructure also promotes healthy exercise and access to more locally grown food. It makes communities safer and even helps reduce crime. It also boosts the economy as it attracts business, raises property values, and lowers energy and healthcare costs.

Plan_Components : Green Infrastructure, Information

- Environmental Benefits Of Clean Water State Revolving Fund Green Infrastructure Projects

Organization : EPA

Year : 2018

Document_type : General Resource/ Foundational Research, Funding Opportunities

Disasters : Flood, Man-Made Disasters

Abstract : Across the United States there is increasing awareness of the need to address pollution generated by stormwater runoff. As stormwater moves through the landscape it captures and carries trash, bacteria, heavy metals, and other pollutants from the urban environment. These pollutants degrade the quality of receiving waters and threaten public health. Stormwater can also cause erosion and flooding, damaging wildlife habitat, property, and infrastructure. This resource offers case study examples of different practices throughout the country using green infrastructure to help mitigate flooding and stormwater runoff.

Plan_Components : Funding Mechanisms, Case Studies, Green Infrastructure

- Woodstock Green Infrastructure Plan

Organization : City of Woodstock

Year : 2013

Document_type : Specific Plan, Example Ordinances and Codes

Disasters : Flood, Man-Made Disasters, Biological Disasters

Abstract : This Plan provides a further demonstration of the City's ongoing commitment in this area. Its purpose is to inventory and map natural resources in and around Woodstock and to show how they can be connected. It is intended to "start the conversation" and provide direction for natural resource protection and buffer creation efforts. It can also be used to identify the location of sites that should be protected and managed as open space, and to show how our natural features relate to future land use and development within Woodstock and its planning jurisdiction.

Plan_Components : Strategies, Planning Processes, Tools, Green Infrastructure, Information

- Ahead Of The Curve – Implementing Green Infrastructure In Rural And Growing Commu-

nities

Organization : EPA

Year : 2015

Document_type : General Resource/ Foundational Research

Disasters : Flood

Abstract : Green infrastructure is often framed as an approach to improving communities and addressing water quality in large urban areas, where high concentrations of impervious surfaces can result in large volumes of stormwater runoff. However, green infrastructure can also provide multiple benefits for small, growing communities and communities in rural areas. This webcast will showcase two such communities, Monona, Iowa and Clarkesville, Georgia, that are ahead of the curve in using green infrastructure to address some of their stormwater management challenges. Rural communities and small MS4s in particular will want to tune in to learn how to replicate these projects at home.

Plan_Components : Green Infrastructure, Information

- Incorporating Green Infrastructure Into Hazard Mitigation

Organization : Texas A&M

Document_type : Web-based Resource

Disasters : Flood

Plan_Components : Surveys/Assessments, Case Studies, Tools, Green Infrastructure, Information

- Spatial Planning For Multifunctional Green Infrastructure: Growing Resilience In Detroit

Year : 2017

Document_type : Scientific Article

Disasters : Flood

Abstract : Cities are expanding green infrastructure to enhance resilience and ecosystem services. Although green infrastructure is promoted for its multifunctionality, projects are typically sited based on a particular benefit, such as stormwater abatement, rather than a suite of socio-economic and environmental benefits. This stems in part from the lack of stakeholder-informed, city-scale approaches to systematically identify ecosystem service tradeoffs, synergies, and ‘hotspots’ associated with green infrastructure and its siting. To address this gap, we introduce the Green Infrastructure Spatial Planning (GISP) model, a GIS-based multi-criteria approach that integrates six benefits: 1) stormwater management; 2) social vulnerability; 3) green space; 4) air quality; 5) urban heat island amelioration; and 6) landscape connectivity. Stakeholders then weight priorities to identify hotspots where green infrastructure benefits are needed most. Applying the GISP model to Detroit, we compared the results with the locations of current green infrastructure projects. The analysis provides initial evidence that green infrastructure is not being sited in high priority areas for stormwater abatement, let alone for ameliorating urban heat island effects, improving air quality, or increasing habitat connectivity. However, as the Detroit GISP model reveals, it could be developed in locations that simultaneously abate stormwater, urban heat island, and air pollution. Tradeoffs exist between siting to maximize stormwater management versus landscape connectivity. The GISP model provides an inclusive, replicable approach for planning future green infrastructure so that it maximizes social and ecological resilience. More broadly, it represents a spatial planning approach for evaluating competing and complementary ecosystem service priorities for a particular landscape.

Plan_Components : Research

- Sustainable Hazard Mitigation: Exploring The Importance Of Green Infrastructure In Building Disaster Resilient Communities

Organization : Columbia University

Year : 2016

Document_type : Scientific Article

Disasters : Flood

Abstract : Natural disasters continue to plague the United States, undermining the nation’s ability to build disaster resilient communities. Although structural and non-structural mitigation measures are currently in place to lessen the impact natural disasters have on society, little attention has been given to the construction of green infrastructure as a sustainable hazard mitigation strategy. The purpose of this article is to explore the benefits of green infrastructure as a sustainable hazard mitigation strategy and offer recommendations to public sector entities to build disaster resilient communities.

Plan_Components : Research

- A Systematic Review Of The Human Health And Social Well-Being Outcomes Of Green Infrastructure For Stormwater And Flood Management

Year : 2019

Document_type : Scientific Article

Disasters : Flood

Abstract : The increase in frequency and intensity of urban flooding is a global challenge. Flooding directly impacts residents of industrialized cities with aging combined sewer systems, as well as cities with less centralized infrastructure to manage stormwater, fecal sludge, and wastewater. Green infrastructure is growing in popularity as a sustainable strategy to mimic nature-based flood management. Although its technical performance has been extensively studied, little is known about the effects of green stormwater infrastructure on human health and social well-being.

Plan_Components : Research

Appendix A

Interpretation of High Risk and Low Risk Areas at County Level

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
Population	Total Population	A small number of people will be affected by a disaster	A large number of persons will be affected by the disaster	Very Low
Young_percent	Percentage of Young Persons	A small percentage of children would mean less vulnerability to disasters	A large percentage of children would indicate a greater vulnerability to disasters	Low
Old_percent	Percentage of Elders**	A lower percentage population of elders indicates a lower vulnerability.	A higher percentage of elder population indicates a greater vulnerability, owing to physical infirmities, functional limitations and care needs.	Very High
NonWhite_Percent	Percentage of Non-White Population**Minority Populations, add Hispanic Population	A lower population of ethnic minorities might indicate a less diverse population. However, in case of disaster vulnerability, a lower population of racial minorities has been represented as a lower vulnerability, owing to its correlations with poverty and health care outcomes.	Race and ethnicity are highly correlated with poverty and thus often with health outcomes. Owing to historical, systemic and structural barriers, racial minorities are often more susceptible to disasters and often lack the support mechanisms required to cope. As a result, a higher population of racial or ethnic minorities might (in conjunction with income, poverty, employment, education and other indicators) represent a greater vulnerability.	Low

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
Females__Percent	Percentage of Females	A good percentage of women represent a stable sex ratio for the area and is therefore a positive indicator	A low percentage of women could indicate an unstable sex ratio, thereby showing that there are fewer opportunities for women in the area. This could have negative consequences during a disaster	Very High
NotMarried__Percent	Percentage of Unmarried Persons	A lower percentage of unmarried individuals could indicate a lower vulnerability to disasters owing to the availability of social support that comes with having a family	A higher percentage of unmarried individuals could indicate lack of family and social support.	Very Low
Disabled__Percent	Percentage of Disabled Persons	A lower percentage of disabled individuals in the community indicates a lower risk owing to reduced requirements for preparation, disaster and accessibility planning	A higher percentage of disabled individuals is associated with a high risk. They are disproportionately affected owing to inaccessible evacuation, response and recovery efforts and could often be left behind.	Very Low
FemaleHeaded__HHs__Percent	Percentage of Households with Female Householder	A lower percentage of female headed households indicates a lower disaster risk, a more stable family and household structure, greater social integration and family support, and higher socio-economic status at the community level	A higher percentage of female headed households could indicate a higher disaster risk owing to greater chances of poverty, and particular risk from housing shocks and stresses, hunger and food insecurity owing to gender discrimination	Very High

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
LargeFam_Percent	Percentage of Large Families as part of all Families	In case of smaller family sizes, a greater investment of the family's resources is possible leading to greater achievements. Therefore a smaller proportion of big families is a reduced social vulnerability during disasters	In case of large families, the same limited resources are shared by a large group of individuals owing to less investment per person. This can result in differential academic achievements and occupational performance. Thus prevalence of a bigger family size would indicate a higher disaster risk.	Very Low
SingleParent_Percent	Percentage of Single Parent Households	A lower proportion of single parent households indicates a lower disaster vulnerability, owing to lesser probability of financial, academic and behavioural problems which have been correlated with single parent households.	Children living in single-parent households have greater risks to their physical and social health and wellbeing compared with other family structures such as two parent or grandparent headed households. Thus, a greater proportion of single parent households represents a higher disaster risk	Moderate
Educated_percent	Percentage of Educated Persons	A greater person of educated individuals is interpreted as low disaster risk	Lack of education is associated with social marginalization, lack of preparation and disaster planning. Therefore a lower percentage of educated individuals is interpreted as high risk.	Low

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
Skilled_Percent	Percentage of Skilled Persons	A higher number of skilled individuals represents a lower disaster risk	Lack of occupational skill is associated with lower incomes and employment benefits and therefore less resources for disaster recovery. Therefore, a lower percentage of skilled workers indicates a greater disaster risk.	Low
Elderly_growth_percent	Growth Percent of Elderly Population	A lower percentage of older adults represents a lower disaster risk.	Older adults are more vulnerable to disaster risks owing to functional problems, health and medication concerns. A greater percentage of older adults represents a higher risk.	Very High
Working_Nonworking_Ratio	Ratio of Working to Non-working Population	A high ratio indicates lower risk	This ratio indicates the amount of labor resources available in the market, and signals unemployment, income and other economic factors. A low ratio indicates a lower economic resilience to market shocks and is therefore high risk.	Very High
HelperPool	Percentage of Helpers in a time of crisis	A higher proportion of helpers indicates a lower risk, since a greater number of persons will be available for disaster recovery and mitigation efforts.	A good number of participants in the helper pool could indicate greater support and emergency management in the community. A lower percentage of helpers represents a high risk.	Very High

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
FemaleLaborforce_percent	Percentage of Labor Force constituted by Women	A higher participation of females in the workforce indicates increased incomes, and lowers or leads to sharing of unpaid care-work with other members of the family, leading to a more economically resilient community. Thus a higher female workforce participation indicates a low disaster risk	A lower participation of women in the labour force is associated with lower household incomes and poverty. Therefore a lower female workforce participation means a higher disaster risk owing to lower economic support.	Moderate
PrimeWorkingAge_percent	Percentage of population in Prime Working Age	A greater number of persons of working age indicates a greater labour pool available for the local economy. Therefore a higher ratio indicates a lower risk.	A lower number of persons of working age represents a greater number of dependents on the existing workfore and is hence a high risk.	Low
Avg_HHsize	Average Household Size	A smaller average household size indicates a greater proportion ofhousehold resources available to every individual in the household and is therefore a lower risk	Household sizes relate with the distribution of resources among individuals with the household. A greater average household size indicates a lesser propotion of resources available to individuals and is therefore interpreted as a high risk	Moderate

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
Percent_BachelorsDegree	Percentage of Population with Bachelors' Degree	A greater proportion of persons with bachelors' degree indicates a greater likelihood of being employed by a variety of employers, along with a higher concentration of high skilled high income positions. Therefore it is interpreted as a lowrisk	A lower porportion of persons with a bachelor's degree indicates a lower number of persons with skills for career advancement. It indicates lack of skilled labour in the workforce and tehrefore lower incomes and social mobility. Therefore it is interpreted as a high risk factor	Moderate
Percent_LanguageBarrier	Percentage of Population facing Language Barrier	A lower proportion of persons with language problems indicates greater accessibility to disaster relief efforts and is therefore an area of lowe risk	A higher proportion of persons with language barriers could indicate a higher percentage of people suffering due to communication problems, interpretation of instructions and emergency rescue operations. Therefore it is interpreted as a high risk	Low
Percent_AssistanceNeed	Percentage of Population with Assisstance Need	A lower percentage of people withfood assistance indicates higher incomes and economic resilience, and is therefore a low risk area	A high proportion of persons with assistance needs indicates poverty and lack of socio-economic resilience. Therefore it is interpreted as a high risk.	Low

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
Percent_Commuters	Percentage of Population who Commute to work regularly	A lower percentage of commuters indicates that most workers live near where they work and can continue their jobs irrespective of transportation network disruptions. Therefore it is an area of low risk	Natural disasters invariably affect transportation routes and make it difficult for persons requiring commutes to their workplace to continue their employment. Therefore a greater proportion of commuters indicates a disaster risk	Very Low
Percent_NoHealthIns	Percentage of Population without Health Insurance	Greater health insurance coverage is correlated with better health conditions and higher economic productivity. Therefore a higher number of persons with health insurance is a low risk	Lack of health insurance coverage has negative impacts on health as patients are less likely to receive preventive health care, or affordable medical care during a disaster. A greater proportion of persons without health insurance indicates a higher disaster risk.	Very Low
Physically_Unhealthy_Average	Average number of physically unhealthy days per year for the population	A Lower value is associated with low risk	A higher value is associated with high risk because people are more prone to being affected by disaster risks	Very Low
Food_Environment_Index	Index of factors that contribute to a healthy food environment, from 0 (worst) to 10 (best).	A higher value is associated is low risk	A poor food environment reduces the physical and mental vitality of a community. A lower value is associated with high risk.	Very Low

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
Percent_Exercise_Access	Percentage of population with adequate access to locations for physical activity.	A higher value is associated is low risk	Lower physical exercise increases health risks with age. A lower value is associated with high risk	Very High
PrimaryCare_Physician_Ratio	Ratio of population to primary care physicians.	A higher value is associated is low risk	A lower proportion of physicians indicates that community members may not have access to medical help during disasters and have to rely on external support. A lower value is associated with high risk	Very High
MentalHealth_Provider_Ratio	Ratio of population to mental health providers.	A higher value is associated is low risk	A lower proportion of physicians indicates that community members may not have access to mental health resources during disasters. A lower value is associated with high risk	Very High
Percent_Vaccinated	Percentage of Households vaccinated against Covid-19 and other diseases	A higher value is associated is low risk	A high proportion of vaccination indicates that the community is safe against the Covid-19 pandemic. A lower value is associated with high risk	High
Social_Association_Rate	Number of membership associations per 10,000 population.	A higher value is associated is low risk	A high rate of social associations indicates healthy relationships and community life. A lower value is associated with high risk	Very High

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
Violent_Crime_Rate	Number of reported violent crime offenses per 100,000 population.	A Lower value is associated with low risk	A high of crimes indicates safety issues within the community. A higher value is associated with high risk	Very Low
Inadequate_Facilities	Percentage of households with inadequate infrastructure within their housing unit	A Lower value is associated with low risk	Inadequate infrastructure within the household lowers quality of life and residents' health. A higher value is associated with high risk	Very Low
COVID-19_death_rate	All deaths occurring between January 1, 2020 and December 31, 2020 due to COVID-19, per 100,000 population (age-adjusted).	A Lower value is associated with low risk	A greater number of deaths owing to Covid-19 indicates pre-existing health conditions and comorbidities within the community. A higher value is associated with high risk	Very Low
Percent_Food_Insecure	Percentage of population who lack adequate access to food.	A Lower value is associated with low risk	Access to food indicates community health. A higher value is associated with high risk	Very Low
Percent_Limited_Access_to_Healthy_Food	Percentage of population who are low-income and do not live close to a grocery store.	A Lower value is associated with low risk	Persons who are low income lack access to healthy food, especially if they live away from grocery stores and lack transportation. A higher value is associated with high risk	Very Low

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
Percent_DisconnectedYouth	Percentage of teens and young adults ages 16-19 who are neither working nor in school.	A Lower value is associated with low risk	Teens and young adults need to either be in school, or part of the workforce, to be able to cultivate a healthy, self-sufficient lifestyle, involved hopeful and forward looking endeavours. Disconnected youth have been positively associated with poverty, unemployment and crime. A higher value is associated with high risk	Very Low
Percent_rural	Percentage of population living in rural areas	A Lower value is associated with low risk	Rural areas often lack access to resources and are geographically isolated. A higher value is associated with high risk	Very High
Agro_Percent	Percentage Employment in Agriculture and related Sectors	A lower percentage of workers in the agricultural sector indicates a greater economic diversity, lower dependence on weather conditions, higher resilience and lower risk	Agricultural sector is most directly affected by natural disasters and extreme weather events such that their productivity goes down drastically. Therefore a predominantly agrarian economy represents lower economic resilience and greater disaster risk	Very Low

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
LowIncome_Percent	Percentage Low Income Population	A lower proportion of low income families indicates a greater access to resources for preparation and recovery from disasters and is hence a low disaster risk	A higher proportion of low income households lack of adequate access to resources to prepare for and recover from disasters, contingency funds, personal vehicles and abilities to arrange for alternate housing arrangements during disasters. It is therefore a high risk.	Very Low
poverty	Percentage Below Poverty Line	A lower poverty indicates less exposure to disaster risks and greater accessibility to exigency funds. It is therefore a low risk	Poverty can be both a cause and consequence of disaster risk. A greater poverty is associated with a higher risk	Very Low
Unemployment_percent	Percentage of Unemployed Persons	A lower rate of unemployment indicates a more stable and resilient economic environment and is therefore associated with lower disaster risks	A high rate of unemployment could indicate a range of socio-economic vulnerabilities and political struggles. It indicates lower economic resilience during disasters and is therefore associated with high risk	Very Low
WorkNearby_percent	Percentage Workers who live near their place of work	A greater proportion of persons who live near their place of work indicates a lower dependence on commute and transportation networks and a more robust resilient economy. Therefore it is a low risk	A lower proportion of persons who live near their place of work indicates a high dependence on transportation networks for economic activities and a greater risk of disruption during disasters. It is therefore a high risk	High

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
MBS	Percentage Employed in Management, Business and Science Occupations	Management, Business and Science jobs are invariably correlated with greater incomes, social mobility and lower dependence on place-based work. Therefore they are more resilient during disasters and higher employment in these sector represent lower risks	A lower proportion of employees in Management, Business and Science professions indicates lower incomes and a low skill economy and is therefore indicative of higher disaster risks	Very High
MBS_LQ	Location Quotient of Management, Business and Science Occupations	A high Location Quotient for Management, Business and Science professions indicates a more specialized, high income economy. It is indicative of low disaster risk	A low LQ for Management, Business and Science professions indicates a less specialized economy and is therefore indicative of lower economic diversity, lower incomes and high risk	High
Service	Percentage Employed in Service	Service sector is a huge contributor to the economic productivity and bolsters the primary and secondary economic sectors as well and provides a huge source of employment. A higher employment in the service sector signals greater economic resilience and lower risk.	A lower proportion of workers in the service sector indicates a less developed and resilient economy with greater dependence on place-based work. It is therefore an area of high risk.	Very High
Service_LQ	Location Quotient of Service Occupations	A higher LQ for the service sector indicates a high risk	A lower LQ for the service sector indicates a lower resilience and higher risk	Very Low

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
Sales	Percentage Employed in Sales Occupations	Employment in sales is associated with higher pay greater skills and organizational support. It signals greater economic resilience and low risk	A lower employment in sales industries could indicate a less entrepreneurial economy, lower resilience and therefore higher disaster risk	Very High
Sales_LQ	Location Quotient of Service Occupations	A higher LQ for the service sector indicates a low risk	A lower LQ for sales industries is associated with high risk	Low
construction	Percentage Employed in Construction Occupations	Construction and allied industries represent possibilities for robust economic growth and government investment. A greater employment in the construction industry also signals potential for development of local infrastructure. A higher employment in this sector is therefore a low risk	Lower employment in the construction sector indicates lower investment in built environment and infrastructure and high disaster risks	Very High
construction_LQ	Location Quotient of Construction Occupations	A higher LQ for the construction industry indicates a low disaster risk	A lower LQ for the construction industry indicates a high disaster risk	Moderate
PT	Percentage Employed in Production and Transportation Occupations	A lower concentration of production and transportation industries indicates a lower dependence of the economic base on land, location and natural resources. It is therefore more economically resilient and a low risk	Both production and transportation industries are dependent on availability of local natural resources and are therefore more susceptible to natural disasters. A higher employment in such industries signals greater disaster risk.	Very Low

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
PT_LQ	Location Quotient of Production and Transportation Occupations	A lower concentration of the production and transportation industry indicates a low risk	A higher LQ for the Production and Transportation Industry indicates a high risk	High
Agri	Percentage Employed in Agricultural Occupations	A lower percentage of workers in the agricultural sector indicates a greater economic diversity, lower dependence on weather conditions, higher resilience and lower risk	Agricultural sector is most directly affected by natural disasters and extreme weather events such that their productivity goes down drastically. Therefore a predominantly agrarian economy represents lower economic resilience and greater disaster risk	Very Low
Agri_LQ	Location Quotient of Agricultural Occupations	A lower LQ for the Agricultural Sector indicates a low risk	A higher LQ for Agricultural Businesses indicates a higher risk	Very Low
Manufacturing	Percentage Employed in Manufacturing Occupations	A lower concentration of manufacturing industries/employment indicates lower chances of disruption during disasters. It is therefore an area of low risk	Manufacturing industries are directly affected by natural disasters. Extreme events cause great damage to the manufacturing units and their associated supply chains. A higher concentration of Manufacturing Industries is associated with high risk	Very Low
Manufacturing_LQ	Location Quotient of Manufacturing Occupations	A lower LQ for manufacturing industries indicates a low risk	A higher LQ for manufacturing industries indicates a high risk	High

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
Wholesale	Percentage Employed in Wholesale Trade	A lower employment in wholesale businesses signals a greater economic resilience and low risk	Wholesale and retail businesses are more vulnerable to natural disasters and are more likely to close after disasters. They are also more likely to be low mitigators. A higher proportion of employment in the wholesale industry signals a high disaster risk	Very Low
Wholesale_LQ	Location Quotient of Wholesale Trade Occupations	A lower LQ in wholesale industries is associated with low risk	A higher LQ is associated with high risk	Very High
Retail	Percentage Employed in Retail Occupations	Although prone to natural disasters, retail industries generally show a higher resilience to natural disasters than wholesale industries. This is because they are less likely to be low mitigators and often associated with having a plan unlike wholesale industries. Thus a higher employment in retail industries is associated with low risk.	A lower employment in retail industries signals lower economic resilience and is associated with higher risk	High
Retail_LQ	Location Quotient of Retail Occupations	A higher LQ in retail industries is associated with low risk	A lower LQ in retail industries is associated with high risk	Low

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
Transport	Percentage Employed in Transportation Occupations	Like retail, transportation businesses are often associated with having business plans, more structurally sound and meets standards. Thus a higher employment in transportation indicates a low risk	A lower employment in transportation business could mean that the businesses are not widely spread out and less economically resilient. It is interpreted as a high risk.	Very High
Transport_LQ	Location Quotient of Transportation Occupations	A higher LQ in transportation industries is associated with low risk	A lower LQ in transportation industries associated with high risk	Low
Info	Percentage Employed in Information-based Occupations	Information industries are positively associated with mitigation planning and have the ability to shift to remote working during a disaster. Therefore, such a higher employment in such industries poses a low risk	A lower employment in information industries signals a less diverse economic base and a higher susceptibility to natural disasters. It is therefore associated with higher disaster risks	Very High
Info_LQ	Location Quotient of Information-based Occupations	A lower LQ in the information sector signals a low risk	A lower LQ in information sector signals a high risk	Very High

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
Finance	Percentage Employed in Finance Occupations	Finance, real estate, etc. jobs are positively correlated with high incomes, job security and high economic resilience during disasters. Therefore a greater employment in such industries poses a low risk and indicates a diverse economic base. A higher employment in such industries is associated with a low risk	A lower employment in finance, real estate etc. signals lower incomes and less resilient jobs. Therefore, a lower employment in this sector is associated with high risk	Very High
Finance_LQ	Location Quotient of Finance Occupations	A high LQ in finance, real estate, etc. signals a low risk	A low LQ in finance, real estate, etc. signals a high risk	Moderate
Management	Percentage Employed in Management Occupations	Management, Business and Science jobs are invariably correlated with greater incomes, social mobility and lower dependence on place-based work. Therefore they are more resilient during disasters and higher employment in these sector represent lower risks	A lower proportion of employees in Management, Business and Science professions indicates lower incomes and a low skill economy and is therefore indicative of higher disaster risks	Moderate
Management_LQ	Location Quotient of Management Occupations	A higher LQ in management, business, or science indicates a low risk	A lower LQ in Management, business or science indicates a high risk	Very Low

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
Edu	Percentage Employed in Education-related Occupations	A higher employment in the education sector signals a more skilled economy, which is typically more resilient to natural disasters. It is therefore a low risk	A lower employment in the education sector signals a less resilient, less skilled economy, and is therefore associated with high risk	Very High
Edu_LQ	Location Quotient of Education-related Occupations	A high LQ in the education sector signals a higher economic resilience and low risk	A lower LQ in education sector signals a lower economic resilience and high risk	Very High
Arts	Percentage Employed in Arts Occupations	A lower employment in the arts sector could indicate higher resilience to economic shocks and higher incomes and is therefore associated with lower risk	Although a higher proportion of artists could signal a greater economic diversity, arts occupations are highly susceptible to natural disasters. Therefore a greater employment in arts industries could signal a higher disaster risk.	Very Low
Arts_LQ	Location Quotient of Arts Occupations	A low LQ in the arts sector is associated with low risk	A high LQ in the arts sector is associated with higher risk	High
Others	Percentage Employed in Other Occupations	Employment across other sectors represents diversification of the economic base and is therefore positively correlated with economic resilience. It is therefore a low risk	A lower employment in other sectors represents a less diverse and creative economy. It is therefore associated with high risks	Low
Others_LQ	Location Quotient of Other Occupations	A higher LQ in other industries is associated with low risk	A lower LQ in other industries is associated with high risk	Very Low

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
CommuteTime	Time it takes from home to go to work in minutes	A Lower value is associated with low risk	Time spent in commute is associated with lack of productivity and extra expenses. A lower commute time is associated with a health local economy. A higher value is associated with high risk	Very High
Walkability_Score	Walkability score (ordinal)	A higher value is associated is low risk	High walkability scores indicate greater community vitality and economic accessibility. A lower value is associated with high risk	Very High
Vice_related_business_Rate	Ratio of vice-related businesses per county as proportion of total businesses	A Lower value is associated with low risk	Greater proportion of vice-related business indicate heightened economic instability during disasters. A higher value is associated with high risk	High
Civic_related_business_Rate	Ratio of civic-related business per county	A higher value is associated is low risk	Civic-related businesses indicate a strong, built-environment and development industry. A lower value is associated with high risk	Very High
Education_related_business_Rate	Ratio of education-related business per county	A higher value is associated is low risk	Education-related businesses enable a community to obtain access to education and child development resources. A lower value is associated with high risk	Very High

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
Healthcare_related_Businesses	Business rate healthcare-related businesses per county	A higher value is associated is low risk	Availability of health care businesses indicate access to medical resources during disasters. A lower value is associated with high risk	Moderate
Recreation_related_Businesses	Business rate recreation-related businesses per county	A lower value is associated with low risk	Greater proportion of recreation-related business indicate heightened economic instability during disasters. A higher value is associated with high risk	Very Low
Total	Total Housing Stock	A lower number of housing units indicates less damage during a disaster and is associated with low risk	A higher number of housing units indicates the possibility of greater risk during disasters	Very Low
Homewownership	Perecentage Homewowners	A higher percentage of homeownership is associated with greater income and family stability and greater access to relief during a disaster. It is therefore a low risk	A lower percentage of homeownership signals lower incomes and support during disasters. It is therefore a higher risk.	High
OldHomes	Percentage of Old Homes as part of Total Housing Stock	A lower proportion of old homes signals new construction that is more structurally resilient to natural disasters. It is therefore associated with low disaster risk	A higher proportion of houses that are built more than 30 years ago signals an old housing stock in need of repair and reconstruction. It is therefore associated with high disaster risk.	Low

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
NewHomes	Percentage of New Homes as part of Total Housing Stock	A higher proportion of new homes indicates a greater structural resilience to natural disasters and is associated with a low risk	A lower proportion of new homes indicates the possibility of greater structural damage during disasters. It is therefore associated with a high risk	Low
Rented	Percentage Renters	A lower proportion of renters signals greater homeownership, higher incomes and access to resources. This is therefore an area of low risk	Renters are associated with higher vulnerability during disasters owing to lower incomes, and lesser accessibility to disaster relief. A high proportion of renters is therefore associated with a higher risk	Very Low
Vacancy	Percentage Vacant Units	A lower proportion of vacant units signals greater utilization of available built environment resources, greater maintenance and lower probability of structural damage. It is therefore associated with low risk	A high proportion of vacant units signals a weak economic base and possibilities of blight and structural damage. It is therefore associated with a high risk	Very High
Units_SingleFamily	Percentage of Single Family Units	A lower proportion of single family units signals greater housing mix, affordability and greater housing resilience. It is therefore associated with low risk	A greater proportion of single family homes signals lesser housing diversity and therefore higher risks for low income populations. It is associated with higher risk	Moderate
MobileHomes	Percentage of Mobile Homes as part of Total Housing Stock	A lower proportion of mobile homes indicates greater structural resilience of the housing sector and more stable economy	A greater proportion of mobile homes is associated with greater risk owing to structural problems and lower incomes.	Low

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
Overcrowding	Percentage of Overcrowded Homes as part of Total Housing Stock	A lower proportion of overcrowded units signals higher incomes and well-maintained, structurally sound housing units which are resilient to disasters. It is therefore associated with low risk	In an overcrowded housing unit, available resources are distributed among a higher than average number of individuals which could lead to familial, socio-economic and structural inadequacies over a period of time. It is therefore associated with high risk.	High
Rental_Overcrowding	Percentage of Rental Units that are Overcrowded	A lower proportion of overcrowded rental units indicates a more affordable rental housing stock, and a more resilient rental population. It is a low risk	A higher proportion of rental units which are overcrowded signals lower incomes, structural and maintenance issues associated with the rental housing stock. It indicates that the rental stock is inadequate and unaffordable and is therefore associated with high risk	Low
Cost_IncomeRatio	Ratio of Housing Cost to Household Income	A lower cost to income ratio indicates that households are successfully able to meet their financial demands and are more resilient to disasters. It is therefore a low risk.	A higher cost to income ratio indicates that households are unable to meet their financial needs and are more likely to suffer adversely during disasters. It is therefore associated with high risk.	Very Low

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
Renters_Cost_Income_Ratio	Ratio of Renter Housing Cost to Household Income	A lower cost to income ratio for renters indicates that rental households are successfully able to meet their financial demands and are more resilient to disasters. It is therefore a low risk.	A higher cost to income ratio for renters indicates that rental households are unable to meet their financial needs and are more likely to suffer adversely during disasters. It is therefore associated with high risk.	Very High
Rental_CostBurden_Helow20000	Percentage of renters whose incomes are below 20,000 USD	A lower proportion of cost-burdened low income households indicates greater economic resilience among low-income renters. This is an asset during natural disasters and is a low risk area	A higher proportion of low income rental households who are housing cost burdened signals a higher concentration of highly vulnerable households in the community. This is an area of high risk, structurally, financially and socially	Very Low
Renter_MHHI	Monthly Household Income of Renters	A higher income indicates greater capacity to cope with disasters. It is therefore associated with low risk.	A lower income indicates a lower capacity to cope with disasters and is associated with high risk	Low
MedianHomeValue	Median Home Value	A higher home value indicates higher incomes, higher accessibility to funds during disaster and is therefore associated with low risk	A lower home value indicates lower incomes and is therefore associated with high risk	Low
NoVehicle_Pop	Percentage of Households without a Vehicle	A lower percentage of households without a vehicle indicates greater socio-economic stability within the community and is therefore associated with low risk	Vehicles count as additional economic assets which add to household mobility. A higher percentage of households without a vehicle is therefore associated with a high risk	Very High

(continued)

Indicator	Definition	Low Risk Interpretation	High Risk Interpretation	Risk Level
GroupQuarters	Percentage of GroupQuarters as part of Total Housing Stock	A lower concentration of group quarter residents is a low risk owing to greater access to recovery resources and social support	Group quarters consist of unrelated persons sharing a living space, either in institutionalized or non-institutionalized settings. Thus they lack the social support of a family and a high percentage of group quarter population is associated with high risk	Very Low
Percent_Section8	Rate of low-rent + section-eight units in county	A Lower value is associated with low risk	Greater proportion of low income housing indicates poverty and declining housing quality. A higher value is associated with high risk	Very High

Appendix B

High Risk and Low Risk Areas at Rural and Census Place Levels

Indicator	Risk Level (Rural)	Risk Level (Places)
Population	Low	Low
Young_percent	Very Low	Low
Old_percent	Very High	Very High
NonWhite_Percent	Moderate	Moderate
Females_Percent	High	Very High
NotMarried_Percent	Low	Low
Disabled_Percent	Low	Very Low
FemaleHeaded_HHs_Percent	Moderate	High
LargeFam_Percent	Low	Moderate
SingleParent_Percent	High	Low
Educated_percent	Low	Very Low
Skilled_Percent	Low	Very Low
Elderly_growth_percent	Very High	High
Working_Nonworking_ratio	Moderate	Low
HelperPool	Moderate	Low
FemaleLaborforce_percent	Low	Very High
PrimeWorkingAge_percent	Low	Low
Avg_HHsize	Low	Moderate
Percent_BachelorsDegree	Moderate	Low
Percent_LanguageBarrier	High	Very Low
Percent_AssistanceNeed	Low	Very Low
Percent_Commuters	Low	Low
Percent_NoHealthIns	Very Low	Very Low
Physically_Unhealthy_Days	Very Low	Very Low
Food_Environment_Index	Very Low	Very Low
Percent_Exercise_Access	Very High	Very High
PrimaryCare_Physicians_Rate	High	Very High
MentalHealth_Provider_Rate	Very High	Very High
Percent_Vaccinated	High	High
Social_Association_Rate	Very High	Very High

(continued)

Indicator	Risk Level (Rural)	Risk Level (Places)
Violent_Crime_Rate	Very Low	Very Low
Inadequate_Facilities	Very Low	Very Low
COVID-19_death_rate	Very Low	Very Low
Percent_Food_Insecure	Very Low	Very Low
Percent_Limited_Access_to_Healthy	Very Low	Very Low
Percent_Disconnected_Youth	Very Low	Very Low
Segregation_index	Very Low	Very Low
Percent_rural	Very High	Very High
Income	Very High	Very High
Agro_Percent	Very Low	Moderate
UnstableEmployment_percent	Very High	Low
LowIncome_Percent	Low	Very Low
poverty	Very Low	Very Low
Unemployment_percent	Low	Very Low
WorkNearby_percent	High	Low
MBS	High	High
MBS_LQ	High	Low
Service	Low	High
Service_LQ	Low	Very Low
Sales	Low	High
Sales_LQ	Low	Very Low
construction	Moderate	High
construction_LQ	High	Very Low
PT	High	Moderate
PT_LQ	High	High
Agri	Very Low	Low
Agri_LQ	Very Low	Moderate
Manufacturing	High	Low
Manufacturing_LQ	High	Very High
Wholesale	Very High	Moderate
Wholesale_LQ	Very High	Very High

(continued)

Indicator	Risk Level (Rural)	Risk Level (Places)
Retail	Very Low	Moderate
Retail_LQ	Very Low	Very Low
Transport	Low	Moderate
Transport_LQ	Low	Very Low
Info	High	High
Info_LQ	Very High	Moderate
Finance	Moderate	High
Finance_LQ	Low	Low
Management	Low	Low
Management_LQ	Low	Low
Edu	High	High
Edu_LQ	High	Very Low
Arts	High	Low
Arts_LQ	High	High
Others	Low	High
Others_LQ	Low	High
Percent_Children_in_Poverty.x	High	High
Gender_Pay_Gap.x	Very High	Very High
Percent_income_required_for_childca	Very High	Very High
CommuteTime	Very High	Very High
Walkability_Score	Very High	Very High
Vice_related_business_rate	High	High
Civic_related_business_rate	Very High	Very High
Education_related_business_rate	Very High	Very High
Healthcare_related_business_rate	Moderate	Moderate
Recreation_related_business_rate	Very Low	Very Low
Total	Moderate	Low
Homewownership	Very High	High
OldHomes	Low	High
NewHomes	Low	High
Rented	Low	Moderate
Vacancy	Very High	Low

(continued)

Indicator	Risk Level (Rural)	Risk Level (Places)
Units_SingleFamily	Low	High
MobileHomes	Low	Low
Overcrowding	High	Moderate
Rental_Overcrowding	Very High	Low
Cost_IncomeRatio	High	Low
Renters_Cost_IncomeRatio	Moderate	Very High
Rental_CostBurden_below20000	Low	High
Renter_MHHI	Moderate	Very Low
MedianHomeValue	Low	Low
NoVehicle_Pop	Low	High
GroupQuarters	Low	Low
Percent_Children_in_Poverty.y	Very High	Very High
Gender_Pay_Gap.y	Very High	Very High
Percent_income_required_for_childca	Very High	Very High
Percent_Section8	Very High	Very High
Pubtrans_Dependent	Moderate	Low
Pubtrans_heavilyDependent	Low	Low
No_Pubtrans	Very Low	Low
No_CommunicationSources	Very High	High
Protective_Services	Very Low	Low
Percent_BroadbandAccess	Low	Low
pm10	Very Low	Very Low
pm25	Very High	Very High
o3	Moderate	Moderate
so2	Low	Low
nox	Very High	Very High
co	Moderate	Moderate
PCT_IRRIGATED_ACRES	Low	Low
pct_nematode_acres	Low	Low
pct_manure_acres	Moderate	Moderate
pct_disease_acres	Moderate	Moderate
pct_defoliate_acres	Low	Moderate

(continued)

Indicator	Risk Level (Rural)	Risk Level (Places)
pct_harvested_acres	High	High
pct_au	Low	Moderate
fungicide	Very High	Very High
herbicide	Very High	Very High
insecticide	Very High	Very High
std_coal_prim_pop	Moderate	Moderate
std_metal_prim_pop	Low	Low
std_nonmetal_prim_pop	Low	Moderate
std_sandandgravel_prim_pop	Very Low	Very Low
std_stone_prim_pop	High	High
Radon	Moderate	Moderate
Facilities_Rate	Very Low	Very Low
Pct_BS	Moderate	High
Pct_Unemp_total	Moderate	Moderate
Pct_Fam_Pov	Very High	Very High
Per_TotPopSS	Very Low	Low
Per_PSWithSW	Moderate	Moderate
D303_Percent	Moderate	Moderate
ALLNPDESpersKM	Low	Moderate
CaAve	Low	Low
Kave	Very Low	Very Low
NO3Ave	Very Low	Very Low
ClAve	High	High
SO4Ave	Moderate	Moderate
HgAve	Very High	Very High
AvgOfD3_ave	Very Low	Very Low
W_As	Very Low	Very Low
W_Ba	Very Low	Very Low
W_Cd	Very Low	Very Low
W_Cr	Very Low	Very Low
W_CN	Very Low	Very Low

(continued)

Indicator	Risk Level (Rural)	Risk Level (Places)
W_FL	Moderate	Moderate
W_HG	Low	Low
W_NO3	Low	Low
W_NO2	Low	Low
W_SE	Very Low	Low
W_SB	Very Low	Very Low
W_ENDRIN	Very Low	Very Low
W_METHOXYCHLOR	Very Low	Very Low
W_DALAPON	Very Low	Very Low
W_DEHA	Very Low	Very Low
W_SIMAZINE	Low	Low
W_DEHP	Very Low	Low
W_PICLORAM	Very Low	Very Low
W_DINOSEB	Very Low	Low
W_ATRAZINE	Low	Low
W_24D	Very Low	Very Low
W_BENZOAP	Low	Low
W_PCP	Very Low	Very Low
W_PCB	Very Low	Very Low
W_DBCP	Very Low	Very Low
W_EDB	Very Low	Low
W_XYLENES	Low	Low
W_CHLORDANE	Very Low	Very Low
W_DCM	Very Low	Very Low
County_GEOID_ref	Low	NA