12-1-2022

Nexuscapes: A Landscape Approach for a Transdisciplinary Water-Energy-Food Nexus Decision-Making Process

Fortino Acosta

NEXUSCAPES: A LANDSCAPE APPROACH FOR A TRANSDISCIPLINARY WATER-ENERGY-FOOD NEXUS DECISION-MAKING PROCESS

By

Fortino Acosta

Bachelor of Science - Industrial Engineering
Universidad Iberoamericana
2004

Master of Arts – Landscape Architecture
The University of Sheffield
2010

A dissertation submitted in partial fulfillment
of the requirements for the

Doctor of Philosophy – Civil and Environmental Engineering

Department of Civil and Environmental Engineering and Construction
Howard R. Hughes College of Engineering
The Graduate College

University of Nevada, Las Vegas
December 2022

Dissertation Approval

The Graduate College
The University of Nevada, Las Vegas

October 26, 2022

This dissertation prepared by

Fortino Acosta

entitled

Nexuscapes: A Landscape Approach for a Transdisciplinary Water-Energy-Food Nexus Decision-Making Process

is approved in partial fulfillment of the requirements for the degree of

Doctor of Philosophy – Civil and Environmental Engineering
Department of Civil and Environmental Engineering and Construction

Sajjad Ahmad, Ph.D.
Examination Committee Co-Chair

Steffen Lehmann, Ph.D.
Examination Committee Co-Chair

Haroon Stephen, Ph.D.
Examination Committee Member

Erica Marti, Ph.D.
Examination Committee Member

Dak Kopec, Ph.D.
Examination Committee Member

Susanna Newbury, Ph.D.
Graduate College Faculty Representative

Alyssa Crittenden, Ph.D.
Vice Provost for Graduate Education &
Dean of the Graduate College

Abstract

This study develops a reliable transdisciplinary framework for complex ecological and social systems by characterizing, mapping, typifying, assessing, and testing enhanced water-energy-food nexus scenarios under critical time constraints, specialized skills, or sensitive data accessibility. Detached management of limited essential resources like fresh water, reliable energy from renewable sources, and nutritious food can jeopardize regional economies and governance. Using a novel landscape approach, this study recommends a decision-making framework focused on the circular economy that induces collaboration among diverse sectors and brings strategic coordination, specificity, and magnitude to the proposed solutions.

The study elaborates on a decision-making tool that integrates Kate Raworth's Doughnut Economics model (Raworth, 2022) and a landscape character assessment framework to address strategic sustainable solutions in the United States. A case study analysis was performed using the Southern Nevada region.

The four research objectives of the study are 1) to compile the Doughnut Economics indicators to recognize the current sustainability setting; 2) to build up a Landscape Characterization model by characterizing, mapping, and typifying biophysical dimensions and cultural aspects of the urban region; 3) to analyze water-energy-food (WEF) setbacks, synergies, future challenges, and to identify strategic WEF solutions 4) To provide a desirable scenario by using those water-energy-food strategies in a backcasting dynamic system model. The methods selected show a progressive system of thinking that can be enhanced by the work and knowledge of professionals of any discipline or sector, contributing to an integrative approach to complex problems.

Keywords: Integrated landscape approach, landscape characterization, urban regions, water-energy-food nexus, doughnut economics, sustainability, climate crisis, water management, renewable energy, food insecurity, decision-making, backcasting scenarios, system dynamics, science communication.

Acknowledgments

This study is dedicated to all the amazing people who believed in me. A special thanks to my mom, who taught me to live plentifully, even in resilient modes. To my dad (†), who introduced me to enjoy the natural and artificial sides of the Mojave Desert. Also, to my sisters, Lucero and Elisse, who have supported me throughout my life. To the rest of my family, who brought happiness when I needed it most. Furthermore, to my friends who added humor and kindness to this interdisciplinary academic process, especially Richard Gonzalez, Francisco Martinez, Dafne Morgado, David Paz, Michelle Church, and Saif Jackson.

I want to thank and acknowledge my research committee members: Dr. Steffen Lehmann, who invited me to this Southwestern adventure; I desire to recognize his exceptional support, knowledge, enthusiasm, and for inspiring me to work with him closely and with our talented students; I am indebted to Dr. Sajjad Ahmad who assisted me in navigating through many trials; Dr. Dak Kopec, who inspired enjoyment whenever we worked together; Dr. Susanna Newbury, who is a magnificent landscape reader and was able to grasp the benefits of this framework in depth; Dr. Erica Marti. by being an active vehicle to materialize sustainability practices in Southern Nevada; Dr. Stephen Haroon, who worked as a tutor on many aspects related to this work, and to Prof. Dany Ortega, who kept my landscape design passion alive.

My warmest thanks to the UNLV Student Sustainability Council and Rebel Roots Garden Club for all your hard work and experiences and for keeping the community garden alive, my favorite spot on campus. Likewise, to Sunrise Hospital staff, who saved my life twice, and Georgetown Hospital for following up while I was working on this project.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

BTU: British thermal unit

CTY: County

DE: Doughnuts Economics

GHG: Greenhouse gas emission

GOVT: Government

GPCD: Gallons per capita per day

IPCC: Intergovernmental Panel on Climate Change

LC: Landscape Characterization

LCA: Landscape Characterization Assessment

MWh: Megawatt hour

OECD: Organization for Economic Co-operation and Development

SDGs: Sustainable development goals

WEF: Water-Energy-Food Nexus

UN: United Nations

UNDP: United Nations Development Program

Chapter 1. Introduction

1.1 General introduction

The climate crisis, loss of biodiversity, ecological degradation, increasing demand for finite natural resources, social unrest, out-of-control consumerism, and other complex urban pathologies are limiting our knowledge capacities, budget, and time availability to make the right decision in urban planning at the speed and reliability required at the present moment (Andrews-Speed, 2015; Leck et al., 2015; McHarg, 1969; Pezzoli et al., 2009; Yue et al., 2021). It results in decisions typically taken without the demand for natural, human, or capital resources. The intertwining of resource dependencies within a natural ecosystem is the keystone to human civilization and secure livelihoods. Nowadays, every sector is evaluating and developing initiatives to cope with this challenge. This silos trend has continued over the last several decades, delivering short-sighted solutions that can eventually lead to scenarios that will be impossible to reverse. This study addresses the possibility of an integrated governance and nexus thinking.

This research aims to combine the Doughnut Economics' (DE) visual framework for sustainable development by Kate Raworth (2017) and landscape characterization (LC) integrative approach as a framework to explore potential, specific and strategic solutions to address the water-energy-food (WEF) nexus challenges under local conditions and in a cross-disciplinary background. A backcasting scenario dynamic system model will critically evaluate various possible strategies. By using a broader socio-ecological context on a regional scale, this transdisciplinary model will allow informed and engaged collaboration with multiple stakeholders at different stages, shaping sustainable solutions for water security, low-carbon energy networks, and food safety. This is achieved by understanding the magnitude of the challenge and the specific and dynamic spatial possibilities of the urban region on a local and global scale (Endo et al., 2020; Ghodsvali et al., 2019; Pezzoli et al., 2009; Potschin & Haines-Young, 2013a; Proctor et al., 2021). This holistic place-based nexus thinking conceives WEF interconnections more broadly, beyond a self-contained governmental department. The model can integrate lifestyles, cultural identity, perceptions, urban-rural socioeconomic equity, environmental justice, innovative technologies, and governance structures (Andrews-Speed, 2015). Hence, an integrated landscape approach can be a reliable linkage between cultural systems and inhabitants' well-being within their resources planning, decision-making, and management (Morrison et al., 2018; Potschin et al., 2013; Vos et al., 1999).

1.2. Structural outline of the thesis

The study is divided into six chapters, each building on the previous one.

Chapter one introduces the research's background. It also defines the study's research questions, aims, objectives, significance, and limitations.

In chapter two, the research conducts a state-of-art WEF nexus review to understand the integrative approaches better. This chapter concludes with an integrative methodology.

Chapter three introduces the Doughnut Economics model adapted for Nevada, including a brief description of the profile of the Southern Nevada urban region. An examination of relevant literature then describes the problems reported during the last ten years, WEF setbacks, and future challenges for the region.

Chapter four conducts a Southern Nevada landscape characterization, including the description of each landscape unit. This part of the exploration illustrates WEF trade-offs, setbacks, and future challenges using visual data that describes the landscape units at the end of the chapter.

In chapter five, the research identifies strategic solutions, their trade-offs, and synergies in using the previous models. Next, the author tested the combined framework through a backcasting method using system dynamics. The analysis produced desirable 2030 and 2050 regional scenarios and time targets.

In chapter six, the research expounds on results, conclusions, future work, and recommendations.

1.3. Background

Unsustainable urbanization and rising resource consumption have brought varied strategies to more efficiently management by intertwining natural resource domains during the last decades (Ghodsvali et al., 2019). Meanwhile, some WEF strategies helped achieve secure resource access and supply, generating significant trade-offs simultaneously (Leck et al., 2015). Interconnected complex systems consist of many variables, and simultaneous interactions can occur. These include a dynamic and mutable environment with direct and indirect feedback loops and non-linear behaviors that cannot be simplified (Cilliers, 2016). WEF nexus requires complex systems' strategies to manage this existing interconnectedness as the knowledge is currently fragmented. This research uses the urban region context with the WEF nexus complex system. Urban regions are complex open systems with an exclusive but simultaneously fluctuating pattern of interactions that connect with other urban regions at the perimeter and global level. Policies, sociocultural behaviors, and environmental conditions define the variables described and organized in the model presented in this research. The proposal of using socio-environmental boundaries of an urban region is a generalized self-conceptualization by the people about the places they live. The concept of the city as a nucleus means that decisions are taken based on knowledge, and this knowledge is primarily generated in urban centers. The urban region boundary works as a nervous system with a dependent and often imbalanced interconnectedness of diverse economic, natural resources, values, and lores.

Secure access to WEF resources continues to present challenges to many urban regions and cities (Medina-Santana et al., 2020). The demand for these interconnected resources exceeds the capabilities of anyone region. However, one needs to consider the global supply chains and the potential regional assets that can be offered in exchange (Joint Programming Initiative Urban Europe, 2018). Cities consume 60-80% of natural resources and produce 60-75% of greenhouse gas emissions (GHGs), half of which are accompanied by significant biodiversity loss and water stress related to resource extraction and processing (European Union, 2020; The Ecological Sequestration Trust, 2016; J. Williams, 2019). Future demand for energy-related materials and resources such as biomass, fuels, and minerals is expected to double by 2060, with an estimated 70% increase in waste generation by 2050 (European Union, 2020); Meanwhile, one-third of all global food production (1.3 billion tons of food for human consumption) is wasted from farm to fork (Borrelli et al., 2018). Overall, the WEF demand with increasing water, energy, and food consumption is expected to increase by 30-50% by 2050 (Radmehr et al., 2021). This increasing pressure will also affect freshwater provision, reliable energy sources, and nutritive food availability (Masson-Delmotte, 2021; Muthu, 2021; van den Heuvel et al., 2020).

Numerous experts agree that WEF nexus approaches are suitable to address extreme environmental hazards operating multiple policies, plans, and programs must better address vulnerability and build resilience (Itayi et al., 2021; Potschin & Haines-Young, 2013b; UNISDR, 2015). An effective decision-making nexus framework to elucidate rural-urban linkages, reduce resource interdependencies, and multifaceted uncertainty is required to tackle this multidimensional problem (Cilliers, 2016; Hoolohan et al., 2019; Lehmann, 2019a). The Sustainability Development Goals indicators, developed by the United Nations Development Program (UNDP, published in 2015), can lead to a well-balanced resource management plan in combination with other critical socioeconomic, and environmental assessment tools such as Doughnut Economics (DE) designed by Raworth (Muthu, 2021; Raworth, 2017).

This research study proposes a circular economy model to create novel scenarios using Doughnut Economics (DE) indicators. The cross-domain positive impact will define these enhanced scenarios (Ellen McArthur Foundation, 2013; Foran, 2015). This model aims to conceive and rethink the economy within two boundaries: a social foundation and an ecological ceiling, by twelve social and eight environmental indicators. DE shows in a single image the scarcities and overshoots of a city, an urban region, a country, or the planet (Raworth, 2017).

The second framework uses Landscape Characterization Assessment (LCA), which utilizes qualitative research methods to classify and describe landscape character types and areas. For this research, the term “landscape” is based on the definition of the European Landscape Convention: “Landscape as a land area perceived by people whose character is the result of the action and interaction of natural and human factors” (Council of Europe Landscape Convention, 2000; Primdahl & Kristensen, 2016; Warnock & Griffiths, 2015). Other landscape definitions such as objective geospatial and visual land features analysis can inform the perceived landscape. The integrative landscape approach works as a common language that fosters dialogue for a more precise understanding of our “region taxonomy” and the different driving forces shaping it.

LCA also includes users' perceptions and value of the experienced landscape (Tudor, 2014). Different and unique patterns include diverse natural and cultural drivers of change within the selected territory. The critical aspect of LCA is that it identifies and communicates what makes a landscape distinctive (Morrison et al., 2018; Swanwick, 2002; Tudor, 2014). The LCA framework helps to integrate an ecological assessment with plausible watershed models, energy potential infrastructure, food security strategies, climate change information, dynamic, biodiversity, and wildlife systems, cultural heritage aspects, and interconnectivity within, and with other urban regions. This study therefore upgrades and extends a recent decision-making tool currently used primarily in the United Kingdom planning system and the European Union in a novel way (Swanwick, 2002).

An urban region landscape approach addresses socio-economic and environmental boundaries following the mixed-method research trend. In North America, socio-ecological boundary considers regions inside each state that generally have a cohesive performance and tight stakeholder interactions (Frank & Marsden, 2016). For example, there are two principal regions in Nevada: Southern Nevada and Northern Nevada. Southern Nevada consists of four counties, with the epicenter of population growth in Las Vegas. Northern Nevada consists of twelve counties, with the epicenter in the Reno-Carson City urban corridor. Regionalization has blurred delimitations which can change depending on the agency, department, or organization and might not align with watersheds or ecosystems (Huckleberry et al., 2019). A landscape approach looks for internal stakeholders' collaboration, cooperating with partners from other regions with direct influences, interchanging assets with other regions across the country. Decision-making requires to occur through these dynamic interconnections (Hancock, 2010).

The research study focuses on the Southern Nevada region as a case study, allowing the collection of local data for a better understanding of the subject and reducing potential bias constructed by the landscape disconnection on a smaller scale.

This study applies system dynamics for backcasting scenarios. Backcasting refers to a design process for system innovations using desirable future visions (Quist et al., 2006). Meanwhile, the DE model aims to visualize sustainable goals, and LCA aids in identifying spatial solutions; a backcasting approach determines the dimensions and complexity of the challenge, bringing attention and narrative toward an enhanced future. In addition, visual and open-source frameworks in natural resources planning and management can support the certainty and transparency of those sectors and visualize different scenarios. A transdisciplinary framework built by an integrated DE, LCA, and backcasting systemic model called "Nexuscapes" engages more policymakers, citizens, and broader organizations to be informed and to understand their role and impact in regional WEF networks, resulting in more collaborative, regenerative, and distributive projects in the environmental agenda (Foran, 2015). Therefore, this method invites cross-disciplinary stakeholders or sectors to discuss the stages and steps required to achieve an ideal scenario. Chapters four and five of this study result in ideal enhanced scenarios after testing and combining different WEF nexus proposed solutions.

1.4. Research problem

A significant global risk that undermines social stability and economic prosperity is related to the upcoming security of WEF resources (World Economic Forum, 2011). Previous WEF nexus models have identified some components that configure the complex context of these three resources: These implied largely populated areas under environmental degradation by anthropogenic activities and accelerated by the climate crisis; a growing demand for compromised access to clean, fresh water, reliable energy, and nutritious food; and interstate or international trades that operate under strictly regulated markets (Bazilian et al., 2011). In a narrower scope, interdependencies, silo thinking planning, and a selective and unrepresented range of stakeholders raise the system's complexity (Brears, 2018). Past WEF nexus studies have used quantitative and qualitative mixed methods, including general comprehensive review articles, specialized reviews, reports, interlinkages assessment, summaries, trade-offs and synergies descriptions, place-specific analyses, and the review of case studies (Endo et al., 2020). Recently, systematic approaches and participatory processes have been developed to enhance cross-sectoral collaboration (Muthu, 2021). Current models integrate a mixed method to link these resources to other crucial variables like health, ecosystem services, social participation, circular economy, and urban planning (Hancock, 2010; Lehmann, 2019a).

The general problem is how to organize the three domains spatially and strategically, and how the citizens can appropriately integrate those critical regenerative and distributive projects without undesired socio-ecological side effects for the region in a hasty time and with knowledge gaps about other vital resources in a circular economy framework.

Past quantitative approaches to solve this challenge have utilized multi-dimensional data. They have also oversimplified the context and other variables that are at play. The number and quality of interdisciplinary qualitative approaches have recently increased (Mohtar & Daher, 2010), providing a broader context without reducing the importance of any sector or stakeholders. However, qualitative methods demand more time and can only succeed when presenting effective solutions with the scale and urgency required. Both approaches can be complementary but need a framework to provide a synergetic impulse to complex environmental systems.

1.5. Nexuscapes: WEF Nexus as an enabler of complex system thinking

In this study, the term Nexuscapes is the first ever used in this research to refer to WEF nexus models using a landscape approach. This method addresses WEF nexus challenges using an integrated place-based framework. Nexus models can learn from a landscape approach:

1. To become multi-scale and multifunctional, which allows top-down and bottom-up governance (Primdahl et al., 2016).

2. Under uncertainty trade-offs, the model integrates precautionary principles in Raworth's indicators and landscape characterization assessment that seek to understand the "big picture."

3. WEF challenges and solutions can be understood using landscape approach tools such as site analysis, input-output analysis, conceptual design, possible iterative variations, maps, and scenario visualizations (Foran, 2015). In addition, waterscapes, energyscapes, and foodscapes can make meaningful connections for enhanced decision-making processes and communication.

4. Decisions are embedded in a more extensive broader context.

5. To allow for new quantitative, qualitative, and visual methods from different fields to build a reliable model.

As previously described, the WEF nexus is a set of interdependent resources that are strategic to humankind, where the non-linear performance of the whole is affected by its components and context. Consequently, WEF nexus, as well as landscapes, are considered complex systems. Nexuscapes aims to identify the magnitude and specificity of WEF analysis by giving a structural place-based method that can be replicated and enhanced across multiple scales, stakeholders, and decision-makers from different backgrounds.

WEF nexus and landscapes have a dynamic, complex system performance that cannot be simplified. Both self-contained systems operate with limited information, cross-domain impacts, ambiguous sources, and biases, while reinforcing and balancing feedback mechanisms (Amadei, 2019; Foran, 2015). Decisions made using WEF nexus models or a view through the lens of landscape scope aim to establish a consent socio-ecological equilibrium by continuous improvement throughout different periods. (Cilliers, 2016). Furthermore, WEF nexus, as well as landscape decisions, can be tracked spatially. Patterns or land uses within a spatial and temporal context express resource-management practices and other economic and cultural driving forces (Leck et al., 2015). By interpreting these driving forces of landscape change, the research study contributes to a systematic analysis of real problems.

1.6. Research aims

Given the lack of integrative and strategic methods regarding water-energy-food nexus complex systems, the research aims to elaborate a combined Doughnut Economics theory and Landscape Character Assessment to recognize the magnitude of the challenge and the spatial specificity of the decision-making. This novel framework will be tested using a backcasting scenario system dynamics model to address integrative resource planning and management processes for different regions in the United States.

1.7. Research objectives

The main objectives of the research are:

1) To develop a Doughnut Economics model for the state of Nevada, examining Southern Nevada's social and environmental levels.

2) To build a Landscape Characterization model by mapping, characterizing, and typifying Southern Nevada's biophysical dimension and cultural aspects.

3) To identify and analyze WEF setbacks, future challenges, and strategic solutions in those regions, mapping the landscape units that are affected, influenced, or suitable to address.

4) To develop a desirable scenario for those enhanced WEF solutions, identify projects, policies, and programs that will construct that future scenario to our present, using Doughnut Economics and Landscape Characterization combined in a system dynamic model.

1.8. Research questions

In consequence, the study will define the following three research questions:

RQ1. What is Nevada's social and environmental progress, and how does this outcome relate to WEF analysis?

RQ2. How effective is the Landscape Characterization method in assessing the WEF nexus driving forces and trade-offs in a particular region?

RQ3. How can Landscape Characterization Assessment and Doughnuts Economics integrate the WEF nexus solutions using a backcasting system dynamics model?

1.9. Research significance

This study is significant because it expands the contribution to interdisciplinary research and open innovation practice, specifically in the case of WEF nexus knowledge, by establishing a dynamic and comprehensive spatial framework that can evolve and be enhanced, encompassing different approaches or data actualizations.

Furthermore, this applied research focuses on the interdependence of multiple means and methods. This innovative combined framework aims to ease the communication among stakeholders to develop integrative and articulated WEF strategies that recognize ecological boundaries, socioeconomic thriving, and other well-being benefits (Andrews-Speed, 2015; Potschin & Haines-Young, 2013a). The place-based approach offers integrative WEF strategies that must be distributive, equitable, and regenerative (McHarg, 1969). It also contributes to distributive solutions that save operations and maintenance costs (Sarni, 2015); as a cross-disciplinary approach, it supplies equitable solutions to resolve community concerns. Meanwhile, the aim is to find regenerative solutions to preserve the ecosystem and restore neglected landscapes. These conditions are embedded in the combined framework preventing underestimations and unforeseen trade-offs with other variables related to sustainability.

1.10. Knowledge gap

Recent findings recognize the WEF nexus models as an intellectual-based exercise requiring extensive data that are challenging to use by policymakers or the community (Amadei, 2019; Proctor et al., 2021). Accurate and up-to-date specialized data required to build a practical and comprehensive WEF framework are limited by skill and data scarcity, confidentiality, or time-consuming. The institutional capacity and common regulatory framework continue to be fragmented, impacting the daily quality of communication, implementation procedures, and coordination among the different domains (Future Earth, 2021; J. Williams, 2019).

For a spatially explicit WEF approach, the environmental, technological, socioeconomic, and policy explorations require a comprehensive combined framework that includes different methods (Amadei, 2019; Martinez-Hernandez et al., 2017; Mroue et al., 2019). In this case, quantitative, and visual qualitative methods aim to answer questions regarding the aspects that have yet to be studied thoroughly (Amadei, 2019). Meaningful nexus thinking requires more attention to the WEF place-based interactions and consequences with the affected ecosystems and the provisioning, regulating, cultural, and supporting interdependent services they provide at multiple spatial scales (Lehmann, 2019a; van den Heuvel et al., 2020). Models require a socio-ecological boundary to respond to the magnitude and specificity of dynamic WEF outcomes (European Union, 2020; Ghodsvali et al., 2019; Liu, 2016).

Likewise, scientific communication is a significant knowledge gap that continues in science and government interlocution (M. Giampietro et al., 2014; Morrison et al., 2018). Appropriate language, scientific recommendations, and timing are underestimated. Project managers and policy-makers decisions do not only rely on reliable data but also on perceptions, interests, and personal dogmas that affect an objective balance among stakeholders. These frequent mismatches and lack of homogeneous assessment tools bring about poor policies and short-scale resource management (Cumming et al., 2006; Mroue et al., 2019). A historically evidence-informed and operative transdisciplinary framework is required to compensate for the silo-thinking narrative among the established sectors (Foran, 2015; Pahl-Wostl, 2019).

1.11. Study limitations

The combined place-based framework sets clear guidelines and constraints; however, it cannot predict solutions or scenarios. These frameworks require a “reader” that can ensemble and interpret the available solutions, ideas, or projects to reflect their interactions (Potschin & Haines-Young, 2013a). The predictions are not particularly acute as any other complex system model; however, the frameworks, enriched by people from different fields, provide an open innovation method that can help us understand the effects of future decisions. On the other hand, there is a risk of relativizing frameworks if the operators miss critical opportunities for ‘the bigger picture” and use them trivially. Also, context and historical meanings can change throughout time, limiting or exacerbating innovative, radical solutions.

This research lacks a fieldwork assessment that can improve and verify landscape unit definitions.

Another limitation of this study is that it needs future participatory research methods to assess backcasting scenarios' effectiveness or bring intersectoral policy discussions (Wichelns, 2017). Future research will need to be conducted to enhance these interdisciplinary methods with participatory approaches (van den Heuvel et al., 2020).

Finally, the Doughnut Economics model can require more work to generalize and compare identical indicators. For example, while one state is more interested in water availability, another is more interested in water quality. Weighted values can change among regions as well.

Chapter 2. Literature review on integrated WEF nexus methods

2.1. Summary of chapter 2

Critical sectors such as water, energy, and food are at the heart of human well-being. The water-energy-food nexus examines the processes used for each system by assessing the interlinkages, uncertainties, trade-offs, synergies, and benefits among these vital resources. WEF strategies, such as reducing demands and increasing supplies, storage, or transport, must be accompanied by new actions to the climate crisis. 'Silos' policies try to perpetuate the status quo, expanding the detachment between place and policies. Place and institutional governance require merging existing models or designing new transdisciplinary frameworks. Urban regional scale is a promising risk management for place-based models. The proposed WEF Nexuscapes decision-making tools contain a Doughnut Economics framework and a Landscape Character assessment. The DE model is an initial common understanding stage where cross-disciplinary stakeholders and decision-makers can comprehend the magnitude of WEF challenges. LC uses a geographic information system to communicate the land’s spatial carrying capacity or limitations on a regional scale. At the end of the chapter, Nexuscapes’ general methodology is included.

2.2 Introduction

This research study conducted an in-depth literature review to identify the key concepts building upon the current WEF nexus knowledge gap.

Scientists recognize that human-induced climate change generates one of the most challenging times facing our civilization, particularly populations that are already vulnerable, especially those who live in low-resource settings (Chen et al., 2020). Events like higher temperatures, extreme weather, increases in coastal flooding, ocean circulation changes, disruptions of ecosystem services, and biodiversity loss are increasingly threatening people's health and well-being. Widespread, and rapid ecosystem changes will further disrupt the biosphere, magnifying present health challenges and causing new ones (Masson-Delmotte, 2021; U.S. Global Change Program, 2018). Additionally, non-climate stressors, such as land-use changes, migration, and population growth, can exacerbate vulnerability (U.S. Global Change Program, 2018). These drastic weather patterns challenge the most trustworthy organizations and economic systems our civilization depends on. Most economies are based on high resource consumption and ecosystems degraded by undistinguished externalities. Hence, these multifaceted gaps of knowledge or awareness of the landscape and its driving forces, like different sectors of the economy, politics, and technology, contribute to the hesitancy of our times and will continue to be relevant in the future (Ghodsvali et al., 2019; Muratovski, 2016).

The Intergovernmental Panel on Climate Change (IPCC) scientists have assigned to our generation a specific, measurable, and timebound target to limit global warming to 1.5°C. The latest research indicates that the planet has already warmed between 1.1°C and 1.2°C. Pathways limiting global warming to 1.5°C (2.7 °F) would require rapid expansion of sustainable energy sources and resilient urban infrastructure (Masson-Delmotte, 2021). For this reason, policymakers need an effective decision-making model to facilitate and accelerate our transition to a decarbonized economy and simultaneously regenerate ecosystems. This enhanced capacity to adapt to the possible impacts as a complementary strategy can also integrate significant changes in land use, disaster response, risk mitigation, transportation plans, and economic and financial systems (U.S. Global Change Program, 2018).

Some of the critical sectors affected by the current climate crisis are water, energy, and food. WEF nexus is an approach to complex systems that focus on the intersections and potential synergies between these sectors commonly perceived apart by authorities, industry, academy, and people (Ghodsvali et al., 2019; Joint Programming Initiative Urban Europe, 2018). The integrated WEF framework introduces a part of a broader ecologically-informed planning platform that helps to identify biodiversity and ecosystem services spatially, prioritizing specific areas of interest where the WEF domains interact and interplay within the urban region and their more sustainable future scenarios.

2.3. WEF nexus concept

The water-energy-food nexus examines the processes used for each system by assessing the interlinkages, uncertainties, trade-offs, synergies, and benefits among these vital resources (Howarth & Monasterolo, 2016; Muratovski, 2016). WEF nexus thinking integrates socio-ecological systems, providing scarce resource management, technological innovations, and governance solutions (Allouche, 2019; Scanlon et al., 2017). WEF strategies such as reducing demands and increasing supplies, storage, or transport strategies, must be accompanied by new actions to the climate crisis like livability, decarbonization, and resilience (Lehmann, 2019b; Scanlon et al., 2017). This defiant transformation must answer social and environmental justice claims for a long-lasting resolution (Future Earth, 2021).

2.4. WEF history

Allouche et al. contribute to a clear origin of the nexus approach. Since the 1930s, multi-purpose and technocratic large water infrastructure designs such as river dams and irrigation districts have been based on this incipient integrated principle. By the late 1940s, the academy expressed a need to reintegrate resource research, planning, and management departments (Allouche, 2019). During the 1960s, many researchers and writers referred to our impact on the ecosystems and the non-registered environmental externalities, concluding that ecological problems are best addressed in a system's context (Wichelns, 2017). Some of the texts referred to by Wichelns are Silent Spring by Rachel Carson, Ecology by E.P. Odum, The Population Bomb by Paul Ehrlich, The Tragedy of the Commons by Garrett Hardin, Diet for a Small Planet by Frances Moore Lappé, and The Limits to Growth by Meadows et al.

In 1983, United Nations University used the concept of nexus for a program oriented to addressing food-energy nexus challenges in developing countries. Another two similar programs was followed in Brazil (1984) at a Food-Energy Nexus and Ecosystems conference and in India (1986) for a symposium on the same topic (Allouche, 2019). In 1994, Dr. Peter H. Gleick addressed the need for informed policy and decision-making regarding potential conflicts between energy and freshwater connections. The World Economic Forum, the Organization for Economic Co-operation and Development (OECD), and private industries relaunched the concept after the 2007 oil and natural gas shock and 2008 financial crisis. Climate crisis and resource security uncertainties brought interest in a more coordinated program to achieve more effective, inclusive, and plural policy responses, primarily in the social and environmental justice agenda. During the Bonn 2011 conference, the nexus approach upscaled to the global level. Ultimately, OECD provides three guidelines for this interdependent approach: increase and preserve ecosystem services, create more with less, and accelerate inclusive solutions to cut poverty.

The United Nations Sustainable Development Goals (2015) and The Paris Agreement (2016) integrative approach are underpinned by a cross-sectoral and quantitative systematic approach (Allouche, 2019; Amadei, 2019; Ghodsvali et al., 2019). Meanwhile, the US National Intelligence Council recognizes WEF Nexus as one of four global megatrends in its Global Trends 2030 report (Venghaus et al., 2019).

2.5. WEF nexus as a decision-making tool

The WEF nexus model was created to provide an interdisciplinary solution to resource scarcity, storage, and transport through data collection, interdependencies modeling, cross-collaboration, and governance improvement (Allouche, 2019; Scanlon et al., 2017). To this extent, the WEF nexus grounded at the decision-making level is a tool designed to illuminate the best paths through an ocean of unpredictable trade-offs that are exacerbated by drivers of change, like climate crisis, as a multiplier of stress that is affecting our ecosystems beyond our thinking (Andrews-Speed, 2015). WEF decision-support tools should be instrumented in a transdisciplinary framework that can be enhanced by diverse knowledge sources and engaged stakeholders, decision-makers, and the community (Albrecht et al., 2018; Lehmann, 2019b).

For the decision tool designed in this research, precautionary principle and drivers of change are also suitable for sustainable decisions. The precautionary principle is broadly used in environmental practices when extensive knowledge is unavailable. Drivers of change are those spatial and temporal processes that produce patterns in our daily activities, such as urbanization, agriculture, farming, mining, and other operational economies that alter existing ecosystems' services (Hancock, 2010).

Even though water and energy are inputs, and food is an output of the system, the three-way analysis is required to thrive as a civilization (Wichelns, 2017). The idea of not taking nexus decisions or continuing to make decisions in silos could threaten our access to these resources, impacting entire regions internationally (Scanlon et al., 2017).

2.6. WEF security

The concept of human security started in World War I, specifically in the International Labor Organization founding document; during the 1980s, global vulnerabilities were discussed academically, and it was promoted in the 1990s when the Pakistani economist Mahbub ul Haq, working at the United Nations (UN), announced it as the development aid main goal (Andrews-Speed, 2015). Nowadays, human security is considered a right in which well-being has to prevail for each independent of the government or economic model established (The Ecological Sequestration Trust, 2016).

Human security relates to water, energy, and food directly. Water security means access to clean and affordable potable water and the preservation of freshwater reserves; energy security is an uninterrupted and reliable low greenhouse emissions energy supply, enough to satisfy demands at a reasonable cost; Food security depends on affordable access to healthy food by a reliable and safe farm to fork supply chain (Lehmann, 2019b; Muthu, 2021).

However, access to WEF resources continues to be a significant problem worldwide. Bieber adduces that one-fifth of the world's population deals with some level of scarcity (Bieber et al., 2018). In 2020, 1.6 billion people did not have safe drinking water at home, 2.8 billion people lacked secure sanitation services (UNICEF, 2021), an estimated 759 million people lacked reliable electricity, and about 800 million people faced hunger, and around 660 million people may still face hunger and lack of access to electricity in 2030 (Beh Lih Yi, 2021; FAO, 2021; Scanlon et al., 2017). Parallelly, since 1960, an area of 720,000 km2, more than twice that of Germany, has changed its land cover every year, deteriorating ecosystem services by triggering ecosystem degradation and biodiversity loss (Winkler et al., 2021).

Human security is interdependent on biodiversity security. Water and land resources management have a solid connection to the ecosystems and the services required for proper security (Bieber et al., 2018). WEF security needs a broader scope to incorporate climate change, biodiversity, and ecosystem services into play (Bazilian et al., 2011).

2.7. WEF interdependencies

WEF linkages and interdependencies, either directly or indirectly, can alter regions positively or negatively (Ghodsvali et al., 2019). It is also affected by some pressures like population growth, demand for higher standards of life, natural resources scarcity, climate crisis, ecosystem degradation, and biodiversity loss (Lin et al., 2019). All global goods should be solved locally to mitigate socio-ecological risks that can manifest in price rise, famine, environmental inequities, migration, or even bellicose conflicts (Martinez-Hernandez et al., 2017).

Scanlon points out that by 2030, water demand is expected to increase by 40%, and energy and food by 50% to 2010 levels. The corresponding usage of water for energy production is 15%, and 70% for water-intensive food production, while 3% to 11% of electricity is required for water supply and 6% to 30% for food production (Scanlon et al., 2017). However, one-fourth of the food produced is wasted at postharvest, processing, and consumer stages (Medina-Santana et al., 2020).

The following WEF interconnections are based on the findings in this literature review (Allouche, 2019; Brears, 2018; Future Earth, 2021; Howarth & Monasterolo, 2016; Lehmann, 2019a; Muthu, 2021; Sarni, 2015; Scanlon et al., 2017; Swatuk et al., 2018):

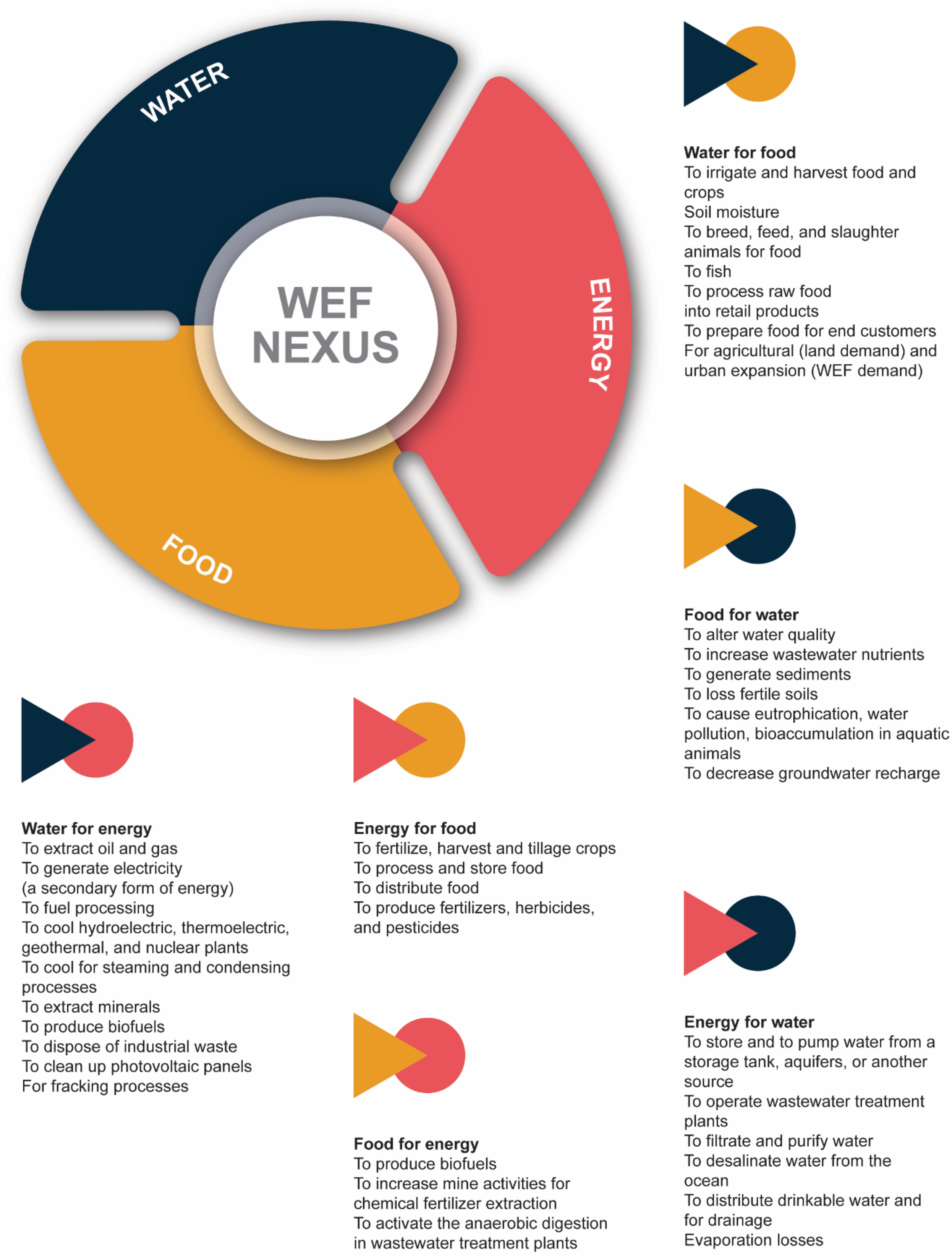


Figure 1. Water-energy-food nexus trade-offs and synergies.

In an extended version of WEF nexus, Ian McHarg, in his book Design with Nature, highlights ecosystem functions as a kind of energy, where life and matter are in cycles, or it assumes the role of a reserve (McHarg, 1969). Wildlife is a flux of energy connecting with water and food resources that integrates well into a more holistic approach. It is, therefore, embedded as supporting ecosystem services in this research.

2.8. WEF nexus approaches

After a systemic review of 245 sources related to nexus, Albrecht et al. conclude that less than one-third of methods used for WEF nexus approaches are irreplicable; resource interactions are not fully explained; nearly three-quarters use quantitative methods; approximately one-fourth come from a social science method; only 10% applied on qualitative methods alone, and less than one-fifth uses both quantitative and qualitative approaches (Albrecht et al., 2018).

Nexus continues to be a top-down approach. Some methods remain in a reactive silo-thinking and a cause-effect process between availability and access (Allouche, 2019). The interconnections are sometimes linear, oversimplified, and limit future and context consideration. Externalities and community values are highly avoided by previous nexus work. Water-centric dialogues can minimize and coerce other variables, including climate crisis; WEF nexus models should understand historical and social premises to ease the finding and understanding of the problem arguments (Allouche, 2019).

The most frequent methods are quantifying environmental footprints, optimization tools, and systematic scenario-based simulation (Lin et al., 2019).

In the last three years, a new trend of qualitative methods gained recognition through the WEF nexus can be analyzed. These models are ecosystem perspective, waste management, learning process, and institutional and stakeholder trust perspectives (Proctor et al., 2021).

2.9. WEF integrative approaches

This research focuses on WEF integrative approaches, security, and accomplishing sustainability goals (SDGs). Integrated water management, life-cycle assessment, and sustainable principles support most of the WEF nexus approaches (Proctor et al., 2021). Martinez-Hernandez et al. enlist different WEF modeling frameworks, such as GLOBIOM based on global land uses; WEF Nexus Tools 2.0 is based on an input-output systematic approach for food self-sufficiency level and its connection to GHG emissions. Another model is MuSIASEM, which uses a systematic approach based on fund indicators, GHG emissions, and land use. The third model is CLEWS, which focuses on climate, land, energy, and water regional assessment. The Quantitative assessment framework is determined by technologies and systematic interactions using Wassily Leontief matrices. The Data envelopment analysis model (DEA) is based on input-output efficiency. Finally, PRIMA is related to GHG emissions, land use analysis, and costs (Amadei, 2019; Martinez-Hernandez et al., 2017). Other frameworks used in the last three years include the holistic qualitative approach, focusing on natural and social sciences like learning-oriented living labs where stakeholders from different disciplines co-produce the research-problem framing process and the design (Allouche, 2019). The urban metabolism trade-off analysis, which assesses the linkage among supply, operation, demand, and final sink on an urban scale (Chen et al., 2020); and the critical social sciences qualitative approach, which focuses on the winners and losers from particular events influenced by WEF components in specific places (Albrecht et al., 2018).

Urban regions require more effective management to prevent uncertain and interconnected future hazards (U.S. Global Change Program, 2018). 'Silos' policies try to perpetuate the status quo, increasing the detachment between space and policies. Place and institutional disconnection is widely recognized in previous WEF nexus publications, examining integration on existing models or attempting to design new transdisciplinary frameworks (Holt et al., 2016; Morrison et al., 2018; RSPB, 2009). A transdisciplinary place-based model through an ecosystem perspective uses ecosystem services as indicators to develop a common language integrating WEF nexus linkages and contrasting different regional sustainability concepts, standards, and practices (Pahl-Wostl, 2019; Proctor et al., 2021). Proctor suggests this concept is comparable to Dr. Raworth's Doughnut Economics socioecological boundaries model. The transdisciplinary WEF nexus aims to facilitate potential sustainable innovations by converging and legitimate thinking that requires multiple stakeholders, decision-makers collaboration, and consensus (Allouche, 2019; Ghodsvali et al., 2019).

2.10. WEF nexus findings

Humanity faces a complex challenge of limited and inadequate natural resources management increased by silos thinking practices (Andrews-Speed, 2015). WEF nexus qualitative and quantitative mixed frameworks are required to understand specific WEF interactions and imbalances (Albrecht et al., 2018; Chen et al., 2020; Wichelns, 2017).

The understanding of transdisciplinary frameworks helped define the proposed framework for this study. The first learning outcome is that quantitative and qualitative could be at different stages and not blended in an atypical silver bullet methodology (Hoolohan et al., 2018). The second is that the latest WEF nexus is expected to solve GHG emissions, land use, and socio-ecological challenges. Moreover, the third is that the transdisciplinary nexus should be inclusive preventing community sectors' marginalization and being receptive to different sources of knowledge (Ghodsvali et al., 2019). Meanwhile, the last learning outcome is that place-based models improve the specificity of realistic solutions.

2.11. Nexuscapes methods

The WEF decision-making tools contain a DE framework and a LC assessment. The DE model is an initial common understanding stage (Muratovski, 2016) where cross-disciplinary stakeholders and decision-makers can comprehend the magnitude of WEF challenges. LC uses a geographic information system to communicate the spatial carrying capacity or limitations that restrict the implementation of WEF strategic solutions on a regional scale. At the same time, LC examines how people collectively experience and build up or preserve their lands (Muratovski, 2016). The DE model captures a moment of that reality described in LC. Both frameworks collect data presenting complex relationships about sustainability in a more meaningful and holistic form (Muratovski, 2016). The testing phase generates a 2050 projection for enhanced scenarios using a system dynamics model that can improve with more information and evidence.

The methods consist of the following:

RQ1. What is Nevada's social and environmental progress, and how does this outcome relate to WEF analysis?

Input:

Twelve social and nine environmental indicators published by existing peer-reviewed data, government reports, or international organizations for Nevada.

Time frame:

The latest and more complete information has been published in the last five years.

Process:

Step 1: Identify the most reliable and updated indicators based on the Doughnut Economics dimensions.

Step 2: Identify the sustainable target for each indicator.

Step 3: Visualize those indicators in a Doughnut Economics model.

Step 4: Create a generic matrix showing positive, null, and negative interconnections.

Step 5: Identify and analyze WEF setbacks and future challenges in Southern Nevada.

Output:

1. Nevada's Doughnut Economics model.

2. Generic Doughnut Economics interconnections matrix.

3. WEF pressures and challenges magnitude for the state.

4. Southern Nevada’s WEF overview.

Tools: Adobe Creative Cloud, Excel.

RQ2. How effective is the Landscape Characterization method in assessing the WEF nexus driving forces and trade-offs in a particular region?

Input:

Maps for the urban region: Topography, geomorphology, soils, hydrology (surface, springs, and groundwater), ecoregions, land cover, land patterns, mines, landfills, wildlife habitat, built environment, county divisions, native people lands.

Time frame:

The latest and more complete information published in the last ten years.

Process (Based on Chen et al., 2020):

Step 1: The study will collect primary qualitative and quantitative spatial, historical and visual data through a literature review. Followed by the description, characterization, and mapping (1:50,000 scale) of the environmental qualities as topography, geology, geomorphology, soils composition, hydrology, vegetation cover, and social dimensions, such as land uses, settlements, and other built environmental patterns, aesthetic qualities, cultural context, historical background, and distinctive features.

Step 2: Natural conditions and social and cultural features are analyzed to define main boundaries and create a landscape character map.

Step 3: Afterward, the analysis will identify and typify new landscape description units along with a definition of driving forces derived from consistent natural and cultural patterns and key distinct attributes of the landscape (Warnock & Griffiths, 2015). Additionally, each landscape unit includes a synthetic ecosystem services analysis, social-environmental identification, and pattern interpretation (Kim & Pauleit, 2007).

Step 4: Create a WEF map using a WEF nexus in Southern Nevada overview for a WEF driving forces and trade-offs spatial analysis.

Output:

1. Regional landscape character units map using landscape cover and land use (1:50,000 scale) (PDF and SHP version).

2. Description of each landscape character unit, including identification code, brief description, landscape type, location map, area, potential partnerships, landscape composition, driving forces of landscape change, pictures showing relevant natural or cultural codes, ecosystem services analysis, axonometric pattern, plan and elevation (PDF).

3. A Southern Nevada's WEF driving force and trade-offs map (PDF).

Tools:

QGIS Analysis, Open maps, Excel, and Adobe Creative Cloud.

RQ3. How can Landscape Characterization Assessment and Doughnuts Economics integrate the WEF nexus solutions using a backcasting system dynamics model?

Input:

Nevada Doughnut Economics model, Southern Nevada WEF pressures and challenges analysis, WEF strategies compilation, and Southern Nevada landscape characterization.

Process:

Step 1: Identify ten WEF strategies for the region that can amend those WEF pressures and challenges.

Step 2: To generate a general matrix using WEF strategies and suitable landscape units and their spatial capability.

Step 3: To produce a relationship matrix to show WEF strategies' spatial compatibility.

Step 4: To generate a matrix of these ten WEF strategies with the Economic Doughnuts indicator and understand their positive, null, and negative relationships.

Step 5: To create a WEF nexus dynamics system based on Doughnuts Economics indicator, Landscape Characterization assessment, population growth, and ten WEF strategies;

Step 6: To find an enhanced WEF nexus scenario by testing different WEF strategies combinations in a harmonious balance according to landscape suitability;

Step 7: To use backcasting scenario to show a timeline of how we can achieve this scenario in a critical path, and

Step 8: To generate three maps and artworks to visualize how that enhanced scenario looks in the future.

Output:

1. WEF strategies spatial compatibility matrix (PDF).

2. WEF strategies / Economic Doughnut matrix (PDF).

3. WEF strategies / Landscape characterization suitability assessment matrix (PDF).

4. Nexuscapes dynamics system based on Doughnuts Economics indicator, Landscape Characterization assessment, population growth, and WEF strategies (Dynamic model).

5. An enhanced WEF nexus scenario and a critical path using backcasting method (PDF).

6. Three maps and artworks show an enhanced WEF nexus scenario (TIFF).

Tools:

QGIS Analysis, Adobe Creative Cloud, and Stella Architects.

The material generated for research questions 1 and 2 can be the foundation for further qualitative and quantitative approaches. In addition, learning experiences, expert workshops, interviews, and many other methods could use the DE and LC mixed framework, enhancing and increasing the tool's robustness. For this study, and to answer research question 3, the study uses system dynamics to generate backcasting scenarios in future research. Developing a desirable scenario for those WEF solutions identifies projects, policies, and programs that will construct that future scenario to the present time.

Chapter 3. Doughnut economics framework

3.1 Summary of chapter 3

Doughnut Economics is a visual tool that expresses the social and ecological dimensions nexus designed by Dr. Raworth in 2012. It aims to rethink the 21st-century economic mindset to meet social needs within a safe environmental ceiling. The Development Economics (DE) framework is based on the Sustainable Development Goals (SDGs) adopted by the UN in 2016. The SDGs are achieved only through the interconnection of the seventeen individual goals, but these links need to be better defined for integrated strategic decision-making. A deeper description of WEF Southern Nevada illustrates the relevance of a cross-disciplinary decision-making tool that could identify interconnectivity among diverse but essential sustainability indicators. According to the WEF parameters, the urban region surpasses the planet's ceiling in water use, greenhouse gas emitted by non-renewable energy sources, and falling short in food security. The research brings a circular economic model to an independent American state-level context.

3.2 Introduction

Doughnut Economics is a visual tool that expresses the social and ecological dimensions nexus, aiming to rethink the 21st-century economic mindset to meet social needs within a safe environmental ceiling (Raworth, 2022). The model was first published in 2012 by Dr. Raworth while working at Oxfam. Since then, the holistic scope and visual simplicity model used to express complex system thinking has been recognized internationally at a shifting age where traditional economic models are under scrutiny, and more social organizations are oriented to thrive rather than to pursue an unrealistic and treacherous endless growth (Raworth, 2022; Wiggering, 2014).

This integrative framework consists of two concentric rings: an inner social foundation ring with twelve social indicators and an outer planetary ceiling ring with nine environmental indicators. With its scientific grounding, it has turned into a transdisciplinary model used to reimagine a converging sustainable future (Raworth, 2022). In a single graphic, DE users can easily distinguish if citizens are short in crucial human needs or exceeding the planetary boundaries in a particular area or context. The social foundation includes food, health, education, income, sanitation, energy, networks, housing, gender equality, social equity, political voice, and peace and justice access. Meanwhile, the ecological indicators to keep Earth's life-supporting systems include climate crisis, ocean acidification, chemical pollution, nitrogen and phosphorus loading, freshwater withdrawals, land conversion, biodiversity loss, air pollution, and ozone layer depletion (Raworth, 2017). These indicators consist of one or more weighted variables that depend on the model's authors, working as a socio-ecological compass that aids us in devising the big picture, where everyone could contribute to having a healthier and more sustainable living (Raworth, 2022) (Figure 2).

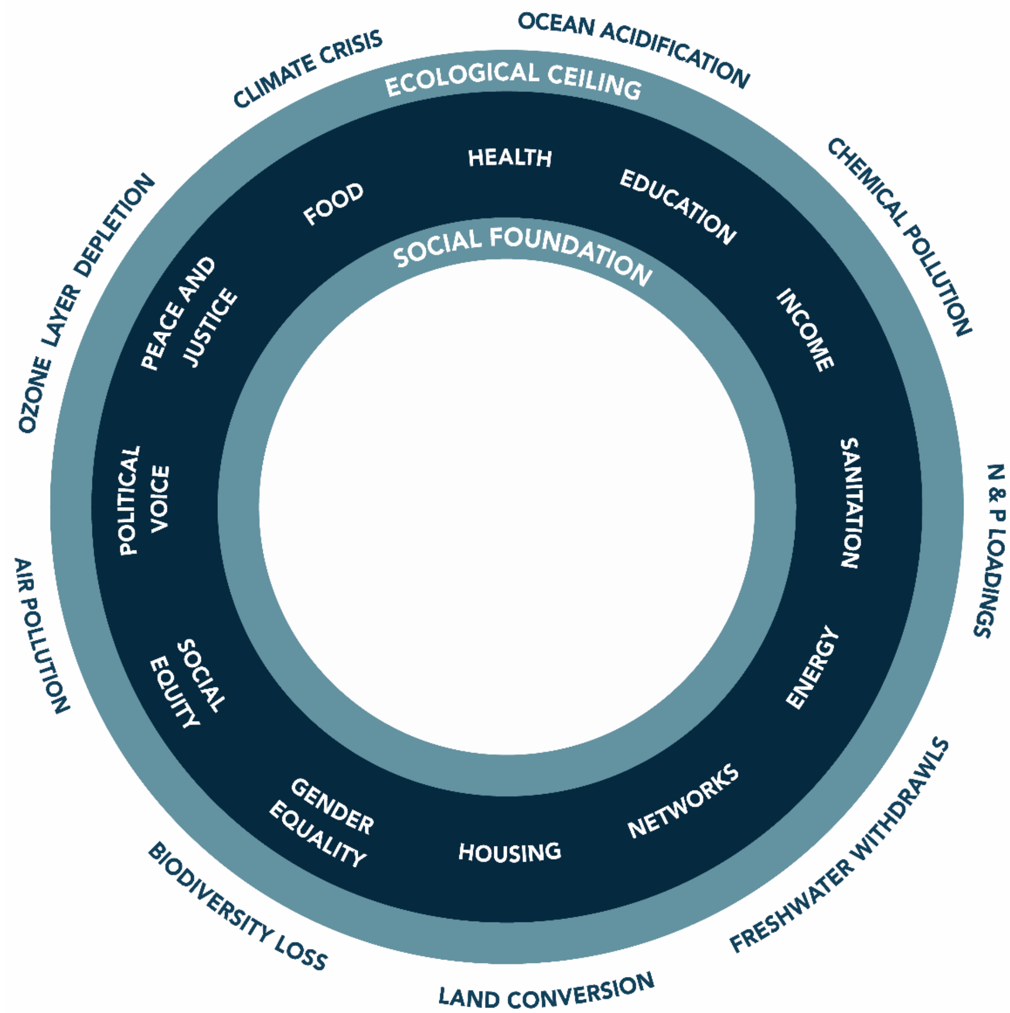


Figure 2. Optimal Doughnut Economics scenario without social scarcities or negative externalities to the environment.

The DE model utilizes a simplified strategic perspective based on the Sustainable Development Goals (SDGs) adopted by the UN in 2016 for its 2030 Sustainable Development Agenda (Pahl-Wostl, 2019). The SDGs are achieved only through the interconnection of the seventeen individual goals, but these links need to be more well-defined and distinguished for integrated strategic decision-making (Pahl-Wostl, 2019). For example, WEF demand for these resources increases, posing severe risks and tradeoffs to other humanity sectors and living systems

(Ghodsvali et al., 2019). Parallelly, the relationship between climate crisis, ecosystem degradation, and negative impact on people's well-being is more evident every day (Muthu, 2021). International Council for Science depicted key aspects of these SDGs unidirectional, bidirectional, or indirect dependencies: Context, governance, technology, and time planning (Ghodsvali et al., 2019). Adequate cross-disciplinarity increases integration in the decision and actions taken dealing with SDGs goals (Ghodsvali et al., 2019; Stoy et al., 2018).

Another tactic used in recent WEF nexus models is the inclusion of the preservation and regeneration of ecosystem services and its positive influence on the implementation of the SDGs (van den Heuvel et al., 2020). The DE model embedded these two considerations.

A second model that influenced DE framework is the circular economy systematic approach. Resourceful use of raw materials and zero waste practices is a revival of the limits of growth that defines the environmental ceiling (Allouche, 2019). Natural capital preservation, resource yield optimization, and minimizing negative externalities decouple resource consumption from economic growth (Lehmann, 2019b). Cities require a systematic approach to innovate in a circular economy. Cities must stimulate their natural and cultural resources by collaborating on sustainable supply chains and decarbonizing the economy (European Union, 2020). The Green Urbanism Wheel by Dr. Lehmann is based on an urban approach using the circular economy to bring together spatial context-dependency solutions associated with energy, water, biodiversity, socio-cultural features, urban planning, and transportation sustainable strategies (Ghodsvali et al., 2019; Lehmann, 2019b). Along with achieving several other ecological targets, sustainable WEF management within biophysical limits is one of the most significant tasks in achieving sustainable development (Swatuk et al., 2018). WEF nexus, like DE, SDGs, and Green Urbanism

Wheel, is a framework to rethink viable and intertwined strategies encompassing all biophysical processes and human aspirations (Huckleberry & Potts, 2019; McHarg, 1969).

On that account, the DE model is an accurate socio-ecological picture of a particular time that grasps the assets but also the risks and nexus pressures that provide a convening space for stakeholders to complement the WEF nexus knowledge and to make shared strategic decisions required to achieve significant progress without leaving any stakeholder behind (Allouche, 2019; Lehmann, 2019b; Raworth, 2022). Nonetheless, one of the main refusals for this method is the loss of a centralized and controlled narrative. Narrative decentralization raises undisputable environmental justice demands regarding who gains or losses from sectorial decisions taken in the WEF nexus (Foran, 2015). Ultimately, the WEF nexus significantly redefines old economic models of prosperity, development, and unlimited growth (Muthu, 2021; Venghaus et al., 2019).

This research explores the Nevada case study as a practical approach to understanding the model in a U.S. context. A deeper description of WEF Southern Nevada illustrates the relevance of a cross-disciplinary decision-making tool that could identify interconnectivity among different but essential sustainability indicators.

3.3. Hypothesis

What is Nevada's social and environmental progress, and how does this outcome relate to WEF analysis?

3.4. Methods

For this research, data collection is conducted to build up the DE model in Nevada. Even though the focus is on Southern Nevada, reliable regional data is arduous to obtain since it depends on the data accessibility for each county that constitutes the region. Nevertheless, the selection of this state demonstrates the flexibility of the model to adapt to different contexts and WEF nexus circumstances.

Step 1: Identify the most reliable and updated indicators based on the Doughnut Economics dimensions.

Step 2: Identify the sustainable target for each indicator.

Step 3: Visualize those indicators in a Doughnut Economics model.

Step 4: Create a generic matrix showing positive, null, and negative interconnections.

Step 5: Identify and analyze WEF setbacks and future challenges in Southern Nevada.

3.5. Results

Introduction to Nevada

Nevada is the seventh-largest state in the country, with 110,572 square miles; 286,380 sq. kilometers). The Bureau of Land Management, a federal entity, owns nearly 85% of the territory. The state's name originates from the Spanish colonizers, meaning "snow-covered mountain range" (Nevada State, 21 C.E.).

The Paiute, Shoshone, Quoeech, Washoe, Hualapai, and other Southwestern Native American groups had inhabited Nevada for centuries before European and American colonization (Hulse, 2010). In the 1700s, horses were introduced to Southwest tribes, bringing commercial opportunities and deadly diseases (Taylor, 2002). After the Mexican-American war (1846-1848), Mexico ceded the present-day U.S. states of California, Nevada, Utah, and part of Arizona, New Mexico, Colorado, and Wyoming to the United States (Bradshaw & Frisbie, 1983). In the 1850s, the discovery of gold and silver mines brought Mexican American migrants and immigrants to populate these lands massively. The state became the 36th state in 1864 during the Civil War (Nevada State, 21 C.E.). 1869 was the first state to ratify the 15th Amendment, recognizing African American men's vote (Nevada State, 21 C.E.). Meanwhile, the Central Pacific Railroad crossed Nevada in 1868 (Taylor, 2002). As the most relevant infrastructure project in the American Southwest, Hoover Dam was completed in 1935 and provides water to 40 million people nowadays (Lustgarten, 2021).

Nevada has 3,104,614 people, over 90% in urban space and 9.34% in rural lands. Race and ethnicity in the state consist of White alone 61.6%; Black alone 12.4%; Hispanic 18.7%; Asian alone 6%; American Indian and Alaska Native alone 1.1%; Native Hawaiian and Other Pacific Islander alone 0.2%; Some other race alone 8.4%; two or more races 10.2%. The population grew 15% in the previous ten years (Nevada State, 21 C.E.). The population grew 15% in the last ten years (Nevada State, 21 C.E.). Nevada has a median age of 38.4, about the same as the nation (38.5). 22% of the population is under 22, 61% are between 18 to 64 years, and 16% are 65 and over (U.S. Census Bureau, 2021).

The mining, gambling, and tourism industries are the state's most well-known economies; they represent 4.72% and 15.67% of Nevada's Gross Domestic Product (GDP), respectively. On the other hand, the financial economics, insurance, and real estate industry represent almost 30% of the state GDP. Meanwhile, professional business services are 17.27%, and the government is 15.9% (Bureau of Economic Analysis, 2021). The 2008 Financial Crisis 2008-2009 and the

2020-2022 COVID-19 pandemic have shown economic volatility and rapid resilience to respond to these international challenges.

To construct Nevada's Doughnut Economics, the researchers used the following sustainability parameters and references:

Nevada's social dimension

The social dimension in Nevada's doughnut economics uses four general categories for each indicator: unsustainable, marginally sustainable, moderately sustainable, and highly sustainable, established in this study. These categories aid in visualizing the sustainability ranking independently of the details and parameters used for each indicator. The following parameters and values for Nevada used are (Table 1):

1. Food Indicator

This parameter comprises three indicators whose values will have an equal-weighted effect. The three selected indicators are self-sufficiency (34%), children's nutrition levels (33%), and food productivity (33%).

Prevalence of moderate or severe food insecurity in the population (Self-sufficiency) indicator: The category is based on the published worldwide values. The prevalence of moderate or severe food insecurity values in the country is between 68.3% and 7.8%, with an average of 30%. Values under 5% are considered on a sustainable track (FAO, 2021). According to Governor Sisolak, 12% of Nevada citizens experience food insecurity (Sisolak, 2021).

Food sufficiency, children ages 0-17 whose households can always afford nutritious meals indicator: access to sufficient food is critical for children's development (United Health

Foundation, 2022). The category is based on accomplishing the universal coverage required. In 2022, the lowest value in the U.S. is Mississippi (58%), and the highest is Massachusetts (80%). The average value in the country is 69.8%, and Nevada is under the national average of 64.5% (United Health Foundation, 2022). Therefore, the range of categories uses these values for the study.

The proportion of income per acre used for agriculture (Productivity): A limited amount of farming activities are required to keep water and land resources in Nevada. Currently, the average crop profit in Nevada is $129 per acre. However, increasing more sustainable and profitable crops without increasing water or land demands could improve rural communities' livelihoods. The range of categories is based on an estimated $8,561 annual return on berries production by one acre (Center for Crop Diversification, 2014), with accumulative inflation of 21% (Webster, 2022), above $10,300 per acre. The region has five or more native berries that can be produced for consumption (Taylor, 2002). Another farm alternative for some crops is water-smart hydroponics; the profitability exceeds berries production with an average revenue between $10 to $25 per square foot (Treftz & Omaye, 2016).

2. Health Indicator

Even though the health indicator is multifactorial, the research considers preventive healthcare and improving survival by using the number of infant deaths and life expectancy on an equal base to determine it.

The number of infant deaths (before age 1) per 1,000 live births indicators: the category range is based on the lowest national levels. Massachusetts, with a 3.9% value, the highest level;

Mississippi, with 8.6%; and Nevada, with 5.8%, is above the national average rate of 5.7% (United Health Foundation, 2022).

The life expectancy category uses the average 70-80 age range worldwide to determine it. Nevada's average life expectancy is 78 years, similar to the national average and above the world's population's average life expectancy of 72 years. Gender, genetics, hygiene, diet and exercise, access to quality healthcare, lifestyle, recreational opportunities, and crime rates influence this indicator (World Population Review, 2022a).

3. Education Indicator

This indicator is composed of equal proportion by the percentage of the population able to read and write among persons aged 15 and older and the percentage of students who graduated within a regular time.

The percentage of the population who can read and write among persons aged 15 and older is an indicator of literacy. The categories are based on U.S. literacy ranges. California has the lowest position, with 76.90%. Meanwhile, the highest rank is in New Hampshire, with 94.20%. Nevada is closer to the lower ranking with 83.9% (World Population Review, 2022b).

The second indicator, the percentage of students who graduated within a regular time, relates to higher education achievements. The categories are based on the U.S. percentage of high school students graduating with a regular high school diploma within four years of starting ninth grade. The lowest in the ranking is New Mexico (71.1%), and the highest is Iowa, with 91%. Nevada has 80.9%, below the national level (84.6%). Educational attainment is associated with constructive citizens and well-being (United Health Foundation, 2022).

4. Income Indicator

It is composed of equal proportion by the percentage of the population under the poverty line and the unemployment rate through the percentage of citizens without a job who are available for work and have been actively looking for a job in the prior four weeks.

12.5% of Nevada's citizens are under the poverty line. The categories are based on U.S. percentages between 20% and 7% (Spotlight on Poverty & Opportunity, 2022).

The unemployment rate in Nevada is 4.2%, which is above the national average level of 3.7%. (The Prosperity Now Scorecard, 2022).

5. Sanitation Indicator

Nevada's population with access to safe sewage systems is 99.55% (Capone et al., 2020). In 2020, 54% of the global population (4.2 billion people) will use a safely managed sanitation service (World Health Foundation, 2022). The categories selected are higher than the average to prevent severe diseases and critical ecological impacts.

6. Energy Indicator

The measure is composed of equal proportions by the percentage of the population with access to electricity and the percentage of energy from renewable sources.

Access to electricity in the U.S. is fully covered; however, other countries have less than 20% coverage (World Bank, 2020). World ranges conform to the categories used.

The renewable energy indicator is based on electricity production and does not include fuel consumption for private and public transportation, including airplanes. Nevada's renewable energy is 30.7%, with a strategic goal of 50% of its electricity from renewable resources by 2030

(Nevada Energy, 22 C.E.). The categories are based on 0 to 100% coverage from renewable resources.

7. Networks Indicator

Accessibility to a reliable network is related to internet coverture and speed. For example, Nevada’s internet speed is 104.1 Megabits per second (Mbps), which is already reasonable (Wheelwright, 2021). The category used the world’s internet speed standards.

8. Housing Indicator

The indicator is composed of an equal proportion of homeless people per 10,000 individuals and a percentage of occupied housing units with at least one of the following problems: lack of complete kitchen facilities, lack of plumbing facilities, overcrowding, or severely cost-burdened occupants in a 5-year estimate (United Health Foundation, 2021c).

Lack of housing is composed of multiple factors: house affordability, low income, health inequalities, drug abuse, domestic violence, and racial disparities, among others. The national average is 17.58 homeless people per 10,000 individuals. Nevada has 22.4 homeless people per 10,000 individuals. Category ranges correspond to the national average value (National Alliance to End Homelessness, 2021).

Severe housing problems threaten well-being. In Nevada, 19.6% of every occupied house has at least one of the following problems: lack of complete kitchen facilities, plumbing facilities, overcrowding, or severely cost-burdened occupants. Category ranges correspond to the average U.S. value of 17.3% (United Health Foundation, 2021c).

9. Gender Equality Indicator

Higher education and income are critical indicators of gender equality. The national average is 35.7% (United Health Foundation, 2021a). The percentage of women ages 25-44 with a college degree in Nevada is 24.9%, the lowest value in the country. The category's ranges use this U.S. average value.

The gender pay gap uses women's median annual earnings as a percentage of men's median annual earnings for full-time, year-round civilian workers ages 16 and older as an indicator. Nevada's value is 85.6%, above the nation's average value of 81% (United Health Foundation, 2021b). The category's ranges use this U.S. average value.

10. Social Equity Indicator

Nevada's income inequality value is 45%, close to the U.S. average value of 48%. Gini Index ranges are between 0 to 1. The closer the value to 0, the community is equal. Meanwhile, values closer to 1 mean an unequal income distribution (World Population Review, 2021b).

11. Political Voice Indicator

The U.S. Prosperity Index Report includes a sector about governance. It measures political accountability, the rule of law, and government integrity, enabling more community involvement in the political system. Nevada occupies 37th place in the state ranking (c, 2021).

12. Peace and Justice Indicator

It is composed of equal proportion by National Center for Access to Justice's Justice Index and by homicide rate per 100,000 individuals.

The Justice Index measures attorney access, support for self-represented litigants, language access, and disability access. The category uses a 0 to 100 scale. Nevada's score is 20.4. The highest is D.C., with 64.80, and the lowest score is South Dakota, with a score of 11.36 (National Center for Access to Justice, 2021).

The homicide rate uses a scale of 0 to 10. Scores above ten are considered critical. The homicide rate in Nevada is 7.3 per 100,000 people. The homicide national rate is 7.5 per 100,000, and the highest is in Louisiana, with 19.9 per 100,000 people.

Table 1. Nevada's social dimension.

	Sector	Indicator	Units	Weight	Unsustainable	Marginally sustainable	Moderately sustainable	Highly sustainable	Nevada	References
1	Food	Prevalence of moderate or severe food insecurity in the population (Self-sufficiency)	Percentage of population	34%	> 30	30 – 14	14 – 5	< 5	12.0	Nevada's indicator: (Sisolak, 2021) Categories: (Based on FAO et al., 2021)
		Food sufficiency, children ages 0-17 whose households could always afford nutritious meals	Percentage of population	33%	< 70	70 – 80	80-95	> 95	64.5	Nevada's indicator and categories: (United Health Foundation, 2022)
		Proportion of income per acre used for agriculture (Productivity)	US$/acres	33%	< 300	300 - 5 k	5 k - 9 k	> 9 k	129	Nevada's indicator: (Nevada Department of Agriculture, 2021) Categories: (Center for Crop Diversification; Tretz & Omaye, 2016)
2	Health	Number of infant deaths (before age 1) per 1,000 live births	per 1,000 live births	50%	> 7	7-6	6 – 4	< 4	5.8	Nevada's indicator and categories: (United Health Foundation, 2022)
		Life expectancy	years	50%	< 70	70 – 75	75 – 80	> 80	78	Nevada's indicator and categories: (World Population Review, 2022a)
3	Education	Literacy	Percentage of the population able to both read and write among persons aged 15 and older	50%	< 75	75 – 85	85-95	> 95	83.9	Nevada's indicator and categories: (World Population Review, 2022b)
		High School Graduation	Percentage of students who graduated within a regular time	50%	< 80	80 – 85	85 – 90	> 90	80.9	Nevada's indicator and categories: (United Health Foundation, 2021a)

4	Income	Poverty rate, population under the poverty line	Percentage of people under the poverty line	50%	> 20	20 – 12	12 – 5	< 5	12.5	Nevada's indicator and categories: (Spotlight on Poverty & Opportunity, 2022)
		Unemployment rate	Percentage of citizens without a job, are available for work, and have been actively looking for a job in the prior four weeks.	50%	> 5	5 – 4	4 – 3	< 3	4.2	Nevada's indicator and categories: (The Prosperity Now Scorecard, 2022)
5	Sanitation	Population with access to safe sewage systems	Percentage of population	100%	< 80	80 – 89	89 – 95	> 95	99.55	Nevada's indicator: (Capone et al., 2020) Categories: (World Health Foundation, 2022)
6	Energy	Proportion of the population with access to electricity (Accessibility)	Percentage of population	50%	< 20	20 – 50	50 – 95	> 95	100	Nevada's indicator and categories: (World Bank, 2020)
		Energy from renewable sources	Percentage of electricity generation	50%	< 20	20 – 50	50 – 95	> 95	30.7	Nevada's indicator and categories: (Nevada Energy, 22 C.E.)
7	Networks	Average download internet speed	Mbps	100%	< 25	25 – 60	60 – 100	> 100	104.1	Nevada's indicator and categories: (Wheelwright, 2021)
8	Housing	Homelessness	People homeless per 10,000	50%	> 30	30 - 15	15 – 2	< 2	22.4	Nevada's indicator and categories: (National Alliance to End Homelessness, 2021)
		Severe housing problems	Percentage of occupied housing units with at least one of the following problems: lack of complete kitchen facilities, lack of plumbing facilities, overcrowding, or severely cost-burdened occupants (5-year estimate)	50%	> 20	20 - 12	11 – 6	< 5	19.6	Nevada's indicator and categories: (United Health Foundation, 2021c)
9	Gender Equality	College graduate - women	Percentage of women ages 25-44 with a college degree	50%	< 28	28 - 45	45- 60	> 60	24.9	Nevada's indicator and categories: (United Health Foundation, 2021a)

		Gender pay gap	Women's median annual earnings as a percentage of men's median annual earnings for full-time, year-round civilian workers ages 16 and older	50%	< 75	75 - 85	85 – 95	> 95	85.6	Nevada's indicator and categories: (United Health Foundation, 2021b)
10	Social Equity	Income inequality (Gini Index)	Percentage of income inequality	100%	> 60	60 - 40	40 – 20	< 20	45	Nevada's indicator and categories: (World Population Review, 2021b)
11	Political Voice	Governance	State ranking based on political accountability, the rule of law, and government integrity	100%	> 40	40 - 25	25 – 10	< 10	37	Nevada's indicator and categories: (Legatum Institute Foundation, 2021)
12	Peace and Justice	Justice access	Justice Index	50%	< 40	40-60	60 - 80	> 80	20.4	Nevada's indicator and categories: (National Center for Access to Justice, 2021)
		Homicide rate	per 100,000	50%	> 10	10 - 5	5 - 2	< 2	7.3	Nevada's indicator and categories: (Centers for Disease, 2021)

Nevada's environmental dimension

Like the social dimension in Nevada's doughnut economics, the environmental dimension uses four general categories for each indicator: unsustainable, marginally sustainable, moderately sustainable, and highly sustainable.

The following environmental parameters and values for Nevada used are (Table 2):

13. Climate Crisis Indicator

Total state carbon dioxide emissions are from direct fuel use across all sectors, including residential, commercial, industrial, and transportation (U.S. Energy Information Administration, 2021). The category is based on a safer limiting global warming to 1.5 degrees Celsius above pre-industrial levels, which means that every person on Earth would need to emit an average of just 2.3 metric tons of energy-related carbon dioxide per year by 2030 (Oxfam, 2021). The U.S. average is 15.7 metric tons of energy-related carbon dioxide per capita per year. Meanwhile, Nevada is 13.5 metric tons of energy-related carbon dioxide per capita per year. The U.S.'s lowest values are New York state with 8.7, and the District of Columbia with 4 (U.S. Energy Information Administration, 2021).

14. Ocean Acidification Indicator

Even though Nevada contributes to the Colorado river delta's revival or deterioration, the state's contribution remains unclear.

15. Chemical Pollution Indicator

The Toxics Release Inventory tracks toxic chemical releases and pollution prevention activities reported by industrial and federal facilities. The category’s units are a total of releases per square mile. Nevada’s total releases are 4,204 lb./ square mile, the highest score in the U.S. (U.S. Environmental Protection Agency, 2021).

16. Nitrogen and Phosphorus Loading Indicator

The indicator comprises an equal proportion of impaired lakes and reservoirs by nitrogen and phosphorus loadings. Impaired water bodies are those that do not achieve water quality standards (U.S. Environmental Protection Agency, 2017).

The Bureau of Water Quality Planning assessed 383,486 acres of lakes and reservoirs in the last three years in Nevada. The total water impairment in lakes and reservoirs by nitrogen sources is 0.43% (1,684 acres or 6.81 km2). Meanwhile, phosphorus sources are 16.32% (62,572 acres or

252.52 km^2 (Nevada Division of Environmental Protection & Bureau of Water Quality Planning, 2022). The category provides a quartile ranking using the number of acres. The lowest and most unsustainable value is based on the current 28% or 106,391 acres of lakes and reservoirs with critical conditions to support aquatic (Nevada Division of Environmental Protection & Bureau of Water Quality Planning, 2022).

17. Freshwater Withdrawals Indicator

Freshwater withdrawals ranking uses U.S. Census Bureau scores in domestic water use in gallons per capita per day (U. S. Environmental Protection Agency, 2022). The national level is 82 gallons per capita per day. Meanwhile, water demand in Nevada is 126 gallons per capita per day (Office of Disease Prevention and Health Promotion, 2022).

18. Land Conversion Indicator

Natural lands with minimal human alteration are critical for wildlife and biodiversity preservation. The state's natural land cover percentage is 93.8% (Nevada Division of Forestry, 2020). The category uses the lowest range of 30% as the minimal protected land for strategic wildlife preservation (Thompson, 2022).

19. Biodiversity Loss Indicator

Species designated as threatened or endangered enlisted for Nevada are 46, the same as the national average score in a single state (U.S. Fish & Wildlife Service, 2021). The category is aligned with the Post-2020 Global Biodiversity Framework coordinated by the International Union for Conservation of Nature (IUCN). This global biodiversity framework aims to halt biodiversity loss by 2030 and achieve recovery and restoration by 2050 (IUCN, 2022).

20. Air Pollution Indicator

The Air Quality Index (AQI) measures four major air pollutants regulated by the Clean Air Act: ground-level ozone, particle pollution, carbon monoxide, and sulfur dioxide. Nevada has a score of 42.1 units. The category uses AQI ranking. Air values over 150 are considered unhealthy (World Population Review, 2021a).

21. Ozone Layer Depletion Indicator

An ozone-depleting substance (ODS) for the state of Nevada is not available. The late score for the country is 714 tons (Ritchie & Roser, 2018). According to Nevada's population, and considering that most Americans consume similar equipment and materials with ODS, such as refrigerators, air conditioners, foam contained in buildings, fire protection systems, and fire extinguishers, the state consumes 6.72 tons, approximately (U.S. Environmental Protection Agency, 2018). The Nevada Statewide Greenhouse Gas Emissions Inventory and Projections, 1990-2040, report 1.536 tons of ODS substitutes (Nevada Division of Environmental Protection, 2020). The category uses cross-multiplication to calculate Nevada's rankings based on the national score on the consumption of ozone-depleting substances map created by the United Nations Environment Program (Ritchie & Roser, 2018).

Table 2. Nevada's environmental dimension.

	Sector	Indicator	Units	Ponderation	Unsustainable	Marginally sustainable	Moderately sustainable	Highly sustainable	Nevada	References
13	Climate crisis	Per capita energy-related carbon dioxide emissions	Metric tons of energy-related carbon dioxide per person per year	100%	> 9	9 – 6	6- 2.3	< 2.3	13.5	Nevada's indicator: (U.S. Energy Information Administration, 2021) Category: (Oxfam, 2021)
14	Ocean acidification	Average aragonite saturation state	Carbon ion concentration	100%	-	-	-	-	NA	NA
15	Chemical pollution	Toxics Release Inventory	lb./ square mile	100%	> 800	799 - 401	400 - 41	< 40	4204	Nevada's indicator and categories: (U.S. Environmental Protection Agency, 2021)
16	Nitrogen and Phosphorus Loading	Percentage of assessed lakes and reservoirs impaired by nitrogen sources	Percentage of 383,486 acres of assessed lakes and reservoirs	50%	> 28	28 – 21	21 - 14	< 14	0.43	Nevada's indicator and categories: (Nevada Division of Environmental Protection & Bureau of Water Quality Planning, 2022)
		Percentage of assessed lakes and reservoirs impaired by phosphorus sources	Percentage of 383,486 acres of assessed lakes and reservoirs	50%	> 28	28-21	21-14	< 14	16.32	Nevada's indicator and categories: (Nevada Division of Environmental Protection & Bureau of Water Quality Planning, 2022)
17	Freshwater withdrawals	Water demand	Gallons per capita per day	100%	> 125	125 – 100	100 - 75	< 75	126	Nevada's indicator: (Office of Disease Prevention and Health Promotion, 2022) Categories: (U.S. Environmental Protection Agency, 2022)
18	Land conversion	Area of natural land with low human alteration	Percentage of natural land cover	100%	< 30	30 – 50	50 - 70	> 70	93.8	Nevada's indicator: (Nevada Division of Forestry, 2020) Categories: (Thompson, A, 2022)
19	Biodiversity loss	Threatened or endangered species	Number of threatened or endangered species	100%	> 76	75 – 51	50 - 25	<25	46	Nevada's indicator: (U.S. Fish & Wildlife Service, 2021) Categories: (IUCN, 2022)

20	Air pollution	Air Quality Index	Index calculated for four major air pollutants regulated by the Clean Air Act: ground-level ozone, particle pollution, carbon monoxide, and sulfur dioxide.	100%	> 150	150 – 100	100 - 50	< 50	42.1	Nevada's indicator and categories: (World Population Review, 2021a)
21	Ozone layer depletion	Ozone-depleting substances	Ozone-depleting substances in tons	100%	> 14.11	14.11– 9.4	9.4 – 4.7	< 4.7	6.72	Nevada's indicator and categories: (Ritchie & Roser, 2018)

For a better visualization of Nevada's socio-ecological indicators, the following diagrams are included (Figure 3):

1.A. FOOD
Percentage of population with a prevalence of moderate or severe food insecurity (Sisolak, 2021)
Range (>30-5)
TARGET < 5
(Based on FAO et al., 2021)

1.B. FOOD
Percentage of children ages 0-17 whose household could always afford nutritious meals
Range (<70-95)
TARGET > 95
(United Health Foundation, 2022)

1.C. FOOD
Average US$ /acre income used for agriculture
(Nevada Department of Agriculture, 2021)
Range (<300-9000)
TARGET > 9000
(Center for Crop Diversification; Tretz & Omaye, 2016)

2.A. HEALTH
Number of infant deaths (before age 1) per 1,000 live births
Range (>7-4)
TARGET < 4
(United Health Foundation, 2022)

2.B. HEALTH
Life expectancy in years
Range (<70-80)
TARGET > 80
(World Population Review, 2022a)

3.A. EDUCATION
Percentage of population able to both read and write among persons age 15 and older
Range (<75-95)
TARGET > 95
(World Population Review, 2022b)

3.B. EDUCATION
Percentage of students graduated within a regular time
Range (<80-90)
TARGET > 90
(United Health Foundation, 2021a)

4.A. INCOME
Percentage of population under poverty line
Range (>20-5)
TARGET < 5
(Spotlight on Poverty & Opportunity, 2022)

4.B. INCOME
Percentage of citizens without job, are available for work and have been actively looking for a job in the prior four weeks
Range (>5-3)
TARGET < 3
(The Prosperity Now Scorecard, 2022)

5. SANITATION
Percentage of population with access to safe sewage systems
(Capone et al., 2020)
Range (<80-95)
TARGET > 95
(World Health Foundation, 2022)

6.A. ENERGY
Percentage of the population with access to electricity
Range (<20-95)
TARGET > 95
(World Bank, 2020)

6.B. ENERGY
Percentage of energy from renewable sources
Range (<20-95)
TARGET > 95
(Nevada Energy, 22 C.E.)

7. NETWORKS
Average download internet speed in Mbps
Range (<25-100)
TARGET > 100
(Wheelwright, 2021)

8.A. HOUSING
Number of homeless per 10,000
Range (>30-2)
TARGET < 2
(National Alliance to End Homelessness, 2021)

8.B. HOUSING
Percentage of occupied housing units with at least one of the following problems: lack of complete kitchen facilities, plumbing facilities, overcrowding or severely cost-burdened occupants
Range (>20-5) **TARGET < 5**
(United Health Foundation, 2021c)

9.A. GENDER EQUALITY
Percentage of women ages 25-44 with a college degree
Range (<28-60)
TARGET > 60
(United Health Foundation, 2021a)

9.B. GENDER EQUALITY
Women's median annual earnings as a percentage of men's median annual earnings for full-time, year-round civilian workers ages 16 and older
Range (<75-95)
TARGET > 95
(United Health Foundation, 2021b)

10. SOCIAL EQUITY
Gini index
Percentage of income inequality
Range (>60-20)
TARGET < 20
(World Population Review, 2021b)

11. POLITICAL VOICE
State ranking based in political accountability, rule of law, and government integrity
Range (>40-10)
TARGET < 10
(Legatum Institute Foundation, 2021)

12.A. PEACE AND JUSTICE
Justice Index
Range (<40-80)
TARGET > 80
(National Center for Access to Justice, 2021)

12.B. PEACE AND JUSTICE
Homicide rate per 100,000
Range (>10-2)
TARGET < 2
(Centers for Disease, 2021)

13. CLIMATE CRISIS
Megatons per capita energy-related carbon dioxide emissions yearly
Range (>9-2.3)
TARGET < 2.3
(U.S. Energy Information Administration, 2021; Oxfam, 2021)

14. OCEAN ACIDIFICATION

15. CHEMICAL POLLUTION
lb/ square mile
Toxics Release Inventory
Range (>800-40)
TARGET < 40
Nevada's indicator and categories: (U.S. Environmental Protection Agency, 2021)

16.A. NITROGEN LOADING
Percentage of assessed lakes and reservoirs impaired by nitrogen sources
Range (>28-14)
TARGET < 14
(Nevada Division of Environmental Protection & Bureau of Water Quality Planning, 2022)

16.B. PHOSPHORUS LOADING
Percentage of assessed lakes and reservoirs impaired by phosphorus sources
Range (>28-14)
TARGET < 14
(Nevada Division of Environmental Protection & Bureau of Water Quality Planning, 2022)

17. FRESHWATER WITHDRAWALS
Gallons per capita per day (GPCD)
Water demand
(Office of Disease Prevention and Health Promotion, 2022)
Range (>125-75)
TARGET < 75
(U.S. Environmental Protection Agency, 2022)

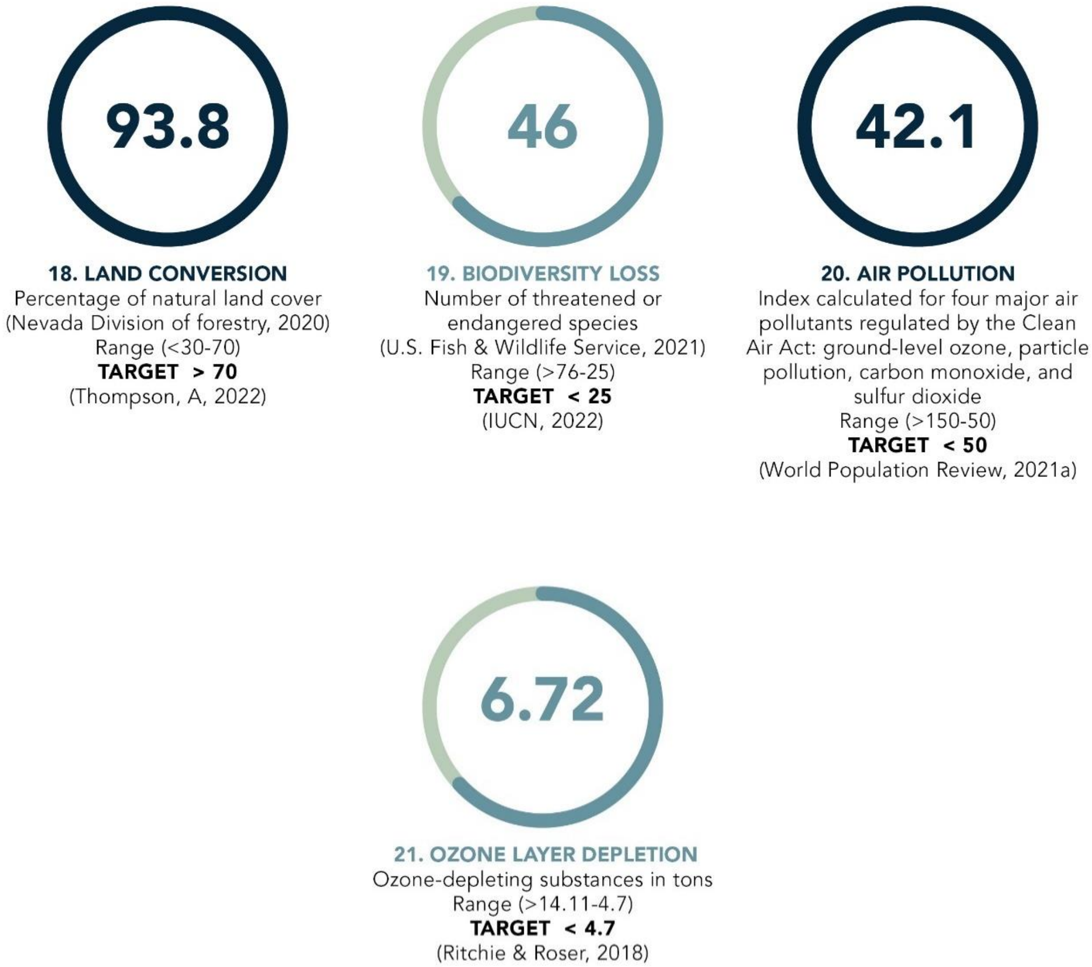


Figure 3. Nevada's socio-ecological indicators used for DE modeling.

Nevada's Doughnut Economics model (Figure 4) uses social indicators to visualize the social foundation shortfalls at the center of the graphic. The ecological ceiling overshoots spread out of the doughnut.

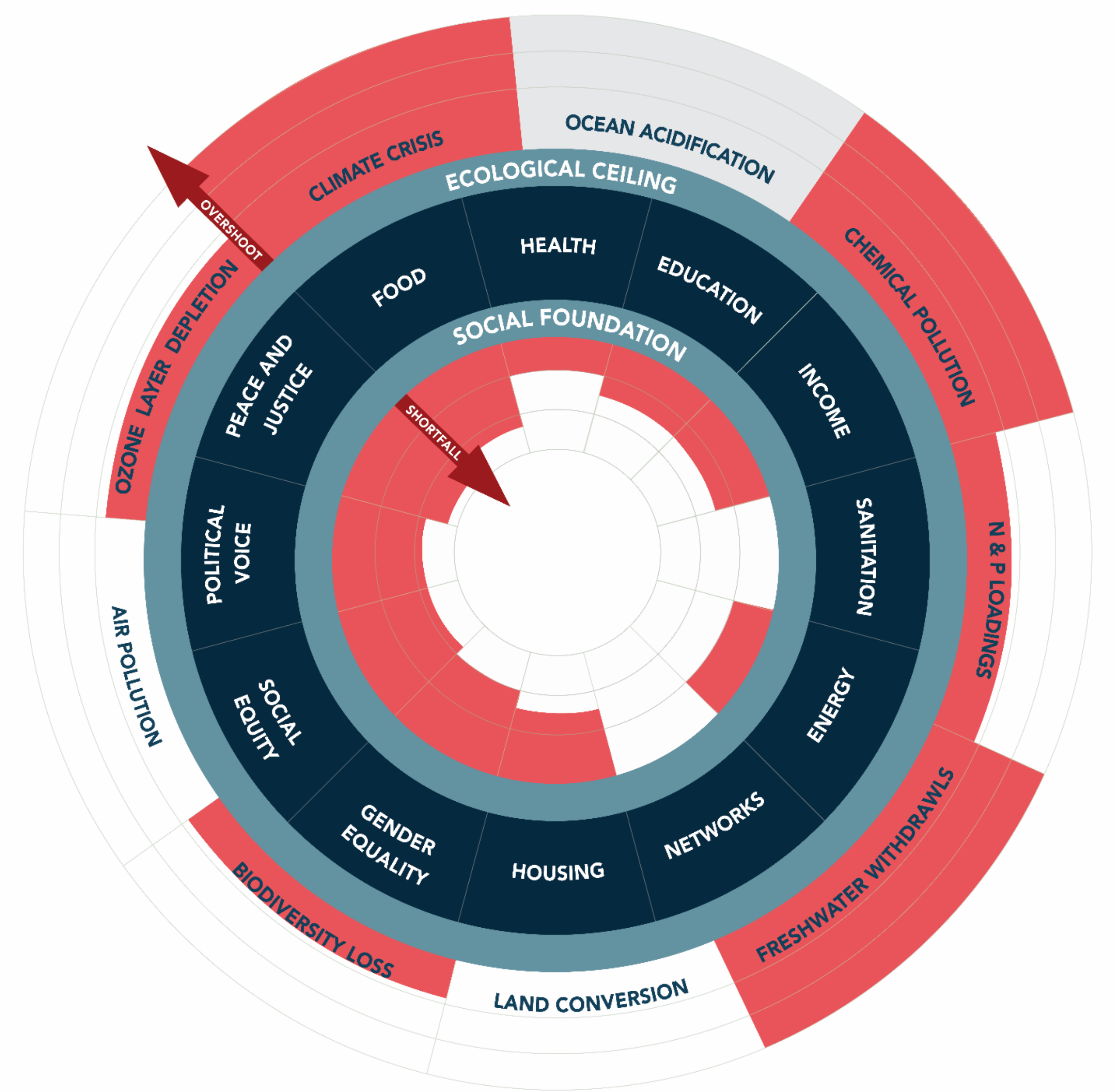


Figure 4. Nevada's Doughnuts Economics model. Unsustainable ecological ceiling overshoots and social foundation shortfalls are in red.

To define strategic policies, projects, and programs, the model must consider possible trade-offs and synergies among the indicators. These interrelationships with benefits or disbenefits are only evident in some cases, or they can differ depending on the strategic plan. These kinds of indirect or unclear relationships should be analyzed in more detail.

The latest IPCC's Climate Change report (H.-O. Pörtner et al., 2022) shows a table regarding the positive or negative relationships between climate responses and strategic adaptation options and their relation to sustainable development goals. In the same way, DE indicators must show the type of relationships for an integrated decision-making framework and managing externalities (Ghodsvali et al., 2019).

The following table (Table 3) is based on this IPCC relational database, and the subsequent critical connections published most recently:

Food: A general perspective of food accessibility and production has mixed benefits and disbenefits according to health, income, energy generation, gender equality, and social equity. It shows a potential ecological trade-off if not managed carefully, especially with water quality and fertilizers, herbicides, and pesticide runoff, triggering ocean acidification. An unclear positive or negative balance remains with other ecological indicators. For example, this strategy's implementation, specificity, and magnitude can modify food contribution or capture greenhouse emissions (Liu, 2016; Masson-Delmotte, 2021).

Health: In general, better education, high income, and access to sanitation facilities, energy, reliable internet, and housing increase health levels in the population (Dow-Fleisner et al., 2022; Raghupathi & Raghupathi, 2020). Similarly, gender equality, social equity, and a state of peace positively affect health (Milner et al., 2021). There is also a strong link between human well-being and environmental conditions, including the regulation of diseases (Hancock, 2010). Land conversion has a mixed interrelation with health.

Education: An increase in education increases the opportunities to fulfill most social needs, including political voice and lower insecurity (Raghupathi & Raghupathi, 2020). However, in general, access to education is concentrated in urban areas. These circumstances can cause an unclear interrelation between greenhouse emissions, land conversion, and biodiversity loss (Beamer & Steinbaum, 2019).

Income: Access to higher income can improve most social needs, such as governance. Meanwhile, higher income might induce higher consumption of resources, increasing greenhouse emissions, freshwater demand, land conversion, biodiversity loss, air pollution, and use of ozone-depleting substances. Parallelly, the risks of poverty increase with the deterioration of environmental conditions (Hancock, 2010).

Sanitation: Wastewater treatment has a high energy demand; however, it positively correlates with ocean acidification prevention and decreased freshwater withdrawal by reusing treated water in different sectors (Parkinson et al., 2019). A mixed interrelation exists between social equity, greenhouse emissions, chemical pollution, land conversion, biodiversity loss, and air pollution.

Energy: This parameter shows potential tradeoffs with other ecological indicators if not managed carefully, especially with water treatment and distribution, land conversion for urban and farming uses, food production, and distribution (Liu, 2016; Masson-Delmotte, 2021; Mroue et al., 2019). Internet access and social inequality improve with better access to reliable energy. Tradeoffs with greenhouse emissions, land conversion, air pollution, and the use of ozone-depleting substances depend on the characteristics of the strategy.

Networks: A positive relationship exists with housing. Other social benefits remain unclear, including social equity (U.N. Economic Development, 2019). Greenhouse emissions related to new logistics systems are under debate.

Housing: Homeownership and house affordability benefit social equality (Foster & Kleit, 2015). Building new housing considering ecological functions in previously impacted land, such as brownfields, might have minimal environmental tradeoffs (Washbourne et al., 2020).

Gender Equality: Improving gender equality also expands social equity, contributes to enhanced governance, and reduces acts of violence (Cho, 2016; Huber, 2019; Jamil et al., 2022)

Social Equity: This indicator interrelates positively with governance and peacefulness (Cho, 2016; Huber, 2019).

Political Voice: Citizens' participatory governance is critical for a peace agreement and mitigating future conflicts (Elfversson, 2016).

Peace and Justice: Higher health, education, income, gender equality, social equity, and political voice raise peace and justice levels (Ghazalian & Hammoud, 2021). However, access to the internet relationship with this indicator remains unclear.

Climate Crisis: Greenhouse emissions effects climate and precipitation patterns, affecting water supply systems, energy and food operations, biodiversity loss, and human health and wellbeing (Garfin et al., 2018; Liu, 2016). Chemical fertilizers produce more greenhouse gases in the atmosphere (U.S. Environmental Protection Agency, 2022). Climate alterations can trigger the use of refrigerants, air conditioning, and other devices with ozone-depleting substances (Chiodo & Polvani, 2022).

Ocean Acidification: Air pollution, land pollution infiltration, ocean littering, and agricultural product runoff are responsible for ocean acidification, and marine biodiversity decline, adding more pressure on land resources for food production (Landrigan et al., 2020).

Chemical Pollution: Industrial pollution, including farms and hazardous pharmaceutical waste, can damage large areas of ecosystems that people depend on (Carrington, 2022). Chemical pollution has different forms, from plastic to mercury, threatening human well-being, freshwater reservoirs, and biodiversity.

Nitrogen and Phosphorus Loading: Nutrient over-enrichment leads to eutrophication and hypoxia in water bodies, including marine ecosystems, affecting biodiversity (National Research Council & Environment, 2000). Fertilizers' export and mining practices contribute to air pollution.

Freshwater Withdrawals: The parameter shows a potential trade-off with other ecological indicators if not managed carefully, especially with land conversion, biodiversity loss, and ocean acidification (Masson-Delmotte, 2021). Also, this factor is sensitive to energy and food production (Dale et al., 2011; Liu, 2016).

Land Conversion: Operational WEF landscapes conflict with ecosystem functions, including hydrological alteration, deforestation, and diminishing ecological integrity (Liu, 2016).

Biodiversity Loss: Biological interactions can affect human health, food production, and ecosystem services that people rely on (Liu, 2016).

Air Pollution: Better air quality improves health. It prevents obesity, and diabetes, reduces stress and asthma attacks, enhancing cardiovascular systems, among other benefits (Kabisch et al., 2017).

Ozone Layer Depletion: Vulnerability and health problems arise when ozone-depleting substances are released, contributing to air pollution (Chiodo & Polvani, 2022).

Trade-offs with benefits or disadvantages occur among the indicators. Some of these trade-offs have mixed or unclear results. The indirect relationship in some indicators remains unclear, so no significant data exists to confirm a specific relationship.

Table 3. Doughnut Economic relationship table.

	FO	HE	ED	IN	SA	EN	NE	HO	GE	SE	PV	PJ	CC	OA	CH	NP	FW	LC	BL	AP	OD
FO																					
HE	·																				
ED	/	1																			
IN	·	1	1																		
SA	/	1	1	1																	
EN	·	1	1	1	-1																
NE	/	·	1	1	/	1															
HO	/	1	1	1	1	-1	1														
GE	·	1	1	1	/	/	·	·													
SE	·	1	1	1	·	1	·	1	1												
PV	/	/	1	·	/	/	·	/	1	1											
PJ	/	1	1	1	/	/	·	/	1	1	1										
CC	·	-1	·	·	·	·	·	·	/	/	/	/									
OA	-1	-1	/	/	1	/	/	/	/	/	/	/	-1								
CH	·	-1	/	/	·	-1	/	/	/	/	/	/	-1	-1							
NP	-1	-1	/	/	/	·	/	/	/	/	/	/	-1	-1	-1						
FW	-1	-1	/	·	1	-1	/	/	/	/	/	/	·	-1	-1	-1					
LC	·	·	·	·	·	-1	/	·	/	/	/	/	-1	-1	-1	-1	-1				
BL	·	-1	·	·	·	-1	/	·	/	/	/	/	-1	-1	-1	-1	-1	-1			
AP	·	-1	/	·	·	·	/	·	/	/	/	/	-1	-1	-1	-1	/	-1	·		
OD	·	-1	/	·	/	·	/	·	/	/	/	/	-1	/	-1	/	/	-1	/	-1	

Type of interrelation:

1	With benefits	·	Mixed or not clear
-1	With disadvantages	/	Insufficient evidence

Positive and negative relationships amid DE indicators (based on H.-O. Pörtner et al., 2022). FO: Food, HE: Health, ED: Education, IN: Income, SA: Sanitation, EN: Energy, NE: Networks, HO: Housing, GE: Gender Equality, SE: Social Equality, PV: Political Voice, PJ: Peace and Justice, CC: Climate Crisis, OA: Ocean Acidification, CH: Chemical Pollution, NP: Nitrogen and Phosphorus Loading, FW: Freshwater Withdrawals, LC: Land Conversion, BL: Biodiversity Loss, AI: Air Pollution, OD: Ozone Layer Depletion.

This research study will describe in more detail Southern Nevada WEF indicators. For this place-based research, WEF nexus indicators are formulated around resource availability, accessibility, and utilization (Muthu, 2021). The doughnut economics model shows the magnitude of the challenge. The following overview identifies the direct and indirect causes of the problems by considering the region's historical and cultural specificities (Zhang et al., 2021).

3.6. Understanding the WEF nexus in Southern Nevada

Located in the southern part of Nevada, the region corresponds to 36.6% of the state territory (U.S. Census Bureau, 2021), around 40,486 square miles (104,858 square kilometers), in a similar size range as Guatemala, Iceland, and South Korea (Worldometer, 2022) conformed by Clark, Esmeralda, Lincoln and Nye counties. Southern Nevada is a plateau with lower-elevations dunes and several rocky mountain ranges, generally oriented north-south. The lowest point is 479 feet (147 m) above sea level in the Colorado River in Clark County (Western Regional Climate Center, 2022), and the highest point is Boundary Peak in Esmeralda County, with an elevation of 13,140 feet (4005 m) above sea level (U. S. Geological Survey, 2022)

The region is an ecosystem transition between the Basin Desert and the Mojave Desert, one of the hottest areas on Earth (de Leon & Schwartz, 2020). The annual precipitation ranges from 3.5 inches at lower elevations to nearly 10 inches in the mountains (National Park Service, 2022). It is the habitat for the bighorn sheep, mountain lion, desert tortoise, and for some plants such as the Joshua trees that lived for more than 150 years and Creosote bush, with some organisms dated to nearly 12,000 years ago and continues living, being among the oldest living organisms in the planet (The Nature Conservancy, 2022). The Great Basin Desert is a semi-arid ecosystem created by the Sierra Nevada Mountains of eastern California with annual precipitation of 10 inches or less (National Park Service, 2021). It is the habitat for the yellow-bellied marmot, beaver, pygmy rabbit, and bighorn sheep. Birds that live here are: Kilideer, long-billed curlew, golden eagle, Northern harrier, common raven, American kestrel, red-tailed hawk, mourning dove, horned lark, woodhouse's scrub jay, black-billed magpie, Western kingbird, barn swallow, loggerhead shrike, song sparrow, black-throated sparrow, Cassin's finch, European starling, red-winged blackbird, and Western meadowlark (National Park Service, 2021). Among the endangered species are the Great Basin bristlecone pine, cougar, Palmer’s chipmunk, desert tortoise, Bendire’s thrasher, Amargosa toad, relict leopard frog, nineteen species of fishes, and twelve other species (Earth’s Endangered Creatures, 2022).

The first people in the region were the Washoe, the Northern and Southern Paiute, and the Western Shoshone. It was until the middle of the XIX century that small Mormon groups started to settle (Nevada State, 21 C.E.). According to the latest census, 28,255 people consider themselves American Indian alone (U.S. Census Bureau, 2021). Currently, the population is 2,324,740. Clark county (2.26 million), Nye County (51,591), Lincoln (4,499), and Esmeralda County (969) represent 74% of the population in the state (U.S. Census Bureau, 2021). The larger cities are in Las Vegas Valley, including Las Vegas, Henderson, North Las Vegas, and Boulder City. The Las Vegas metropolitan area is one of the fastest growing in the country. Clark county's growth in population is expected by 2035 to be 3,018,000 people, and by 2050 around 3,296,000 (Center for Business and Economic Research, 2021). Southern Nevada will be home to another one million people in three decades, an increment of around 42%. These people will demand houses, jobs, infrastructure, and services, adding more pressure to the existing scenario.

Under the current climate crisis and environmental vulnerability denial, health risks in the region are rising as heat-associated strokes, illnesses caused by poor air quality, detrimental mental well-being by forced migration, and vulnerable conditions (Lehmann, 2019b; U.S. Global Change Program, 2018).

Southern Nevada's Water Overview

Around 70 percent of Colorado Basin water supplies are for agriculture and farming; 60 percent is forage and pasture (Brears, 2018b). The basin also provides water to nearly 40 million people (Congressional Research Service, 2021). The basin operates by the Colorado River Compact of 1922, allocating 7.5 million acre-feet annually for the upper basin, including Colorado, New Mexico, Utah, and Wyoming. Another 7.5 million acre-feet annually for the lower basin encompassing Arizona, Southern Nevada, and Southern California, and 1.5 million acre-feet to Mexico under a 1944 treaty (Figure 5). In 2017, the treaty was updated to add flexibility to hold water in U.S. reservoirs for water scarcity emergencies and ecological alleviation in the Colorado River delta (Congressional Research Service, 2021). Additionally, the Indian water rights settlements offer the possibility to use more than 3.2 million acre-feet in the lower and upper basins after being restricted over the last centuries (Garfin et al., 2018; The Water & Tribes Initiative, 2021).

Figure 5. Colorado River Compact and water rights allocation
(Background picture source: Hoover Dam by Michael Kemper, 2009).

The Intergovernmental Panel on Climate Change (IPCCC) provides the following implications and potential future risks related to climate change: projected hotter temperatures, between 2.7 and 4.4 °C by 2075, will increase the probabilities of decadal to multidecadal droughts and will contribute to aridification, a long-term process to a drier environment, reducing the supply of water from snowmelt in the basin's northern areas, and by evapotranspiration in existing superficial waterbodies by 8-13 percent (Brears, 2018; Garfin et al., 2018).

In Southern Nevada, the Hoover, David, and Parker Dams provide water storage and electricity to the lower basin. Lake Mead, formed by the Hoover Dam, is the largest reservoir in the country; however, the existing mega-drought dating, high evapotranspiration rate, and continued water consumption by agriculture and cities since 2000 have put stress on the water supply in the Colorado basin, modifying local regulating ecosystem services (Congressional Research Service, 2021; Garfin et al., 2018; Masson-Delmotte, 2021). Moreover, hydroelectric power ends at Hoover's water level of fewer than 1050 ft, affecting a snowball effect on other local sectors (Huckleberry & Potts, 2019). Last year, a first-ever critical shortage condition was declared, which reduced the water supply in Arizona, Nevada, and Mexico (Congressional Research Service, 2021). Reservoirs' over-reliance and high evapotranspiration rates increase the region's vulnerability (di Baldassarre et al., 2018).

The Southern Nevada Doughnut Economics model includes two water-related indicators: access to sanitation and freshwater withdrawals. Around 90.9% of the region's population has access to safe sewage systems (Rural Health Information Hub, 2021). The target for a higher sustainable level is to cover over 95% of this sector (95,315 additional people). For the second indicator, the potable water demand is 220 gallons per capita per day at the present day. Las Vegas Valley has advanced wastewater treatment management and water-saving programs like xeriscape practices, but these are insufficient. The target for a higher sustainable level is under 92 gallons per capita per day. Under these circumstances, the Basin requires a more flexible and updated water management agenda, like aquifer recharge using wastewater, nature-based solutions for evapotranspiration, and runoff reduction to address the current unbalanced condition. (Radmehr et al., 2021; U.S. Global Change Program, 2018).

Southern Nevada's Energy Overview

The IPCC recommends that regional hydroelectric plants can decrease their operation due to water scarcity (Garfin et al., 2018). Wildfire frequency could increase by 25%, disrupting electrical transmission, potentially putting wind and solar powerplants at risk in the future and transforming existing forests from carbon sinkers to net carbon emitters, reducing their provisioning and regulating services (Garfin et al., 2018; U.S. Global Change Program, 2018).

A positive reality for Southern Nevadans is that 100% of the population has access to electricity. Currently, 28% (125.2 trillion BTU per year) of that electricity generation is from renewable sources; 4% of this renewable electricity is produced in Hoover Dam, with a capacity of over 2000 MW (Brears, 2018). Nonetheless, the state consumes 315.6 trillion BTU per year of natural gas, 137.1 trillion BTU per year of motor gasoline, 79.2 trillion BTU per year of jet fuel, 76.3 trillion BTU per year of distillate fuel oil, and 37.2 trillion BTU per year of coal (U.S. Energy Information Administration, 2021a). Therefore, a highly sustainable standard is to be over 95% of electricity generation from renewables, representing an increment of 2,060,000 MWh (U.S. Energy Information Administration, 2021a) in clean electricity to the present-day demand, which can increase next to population growth (9 MWh for every 10,000 people) and 3.8 MWh/year for every new electric vehicle, approximately or it can be maintained or reduced by strategic energy efficiency policies (U.S. Drive, 2019) (Figure 6).

At the regional scale, energy challenges include grid and energy distribution and the conflict with biodiversity connectivity (Garfin et al., 2018). Matching energy demand and storage continues.

Geothermal, photovoltaic, and wind farms offer increased electricity reliability (U.S. Global Change Program, 2018). However, sufficient water-smart biofuels from regional renewable sources in an arid region can be challenging.

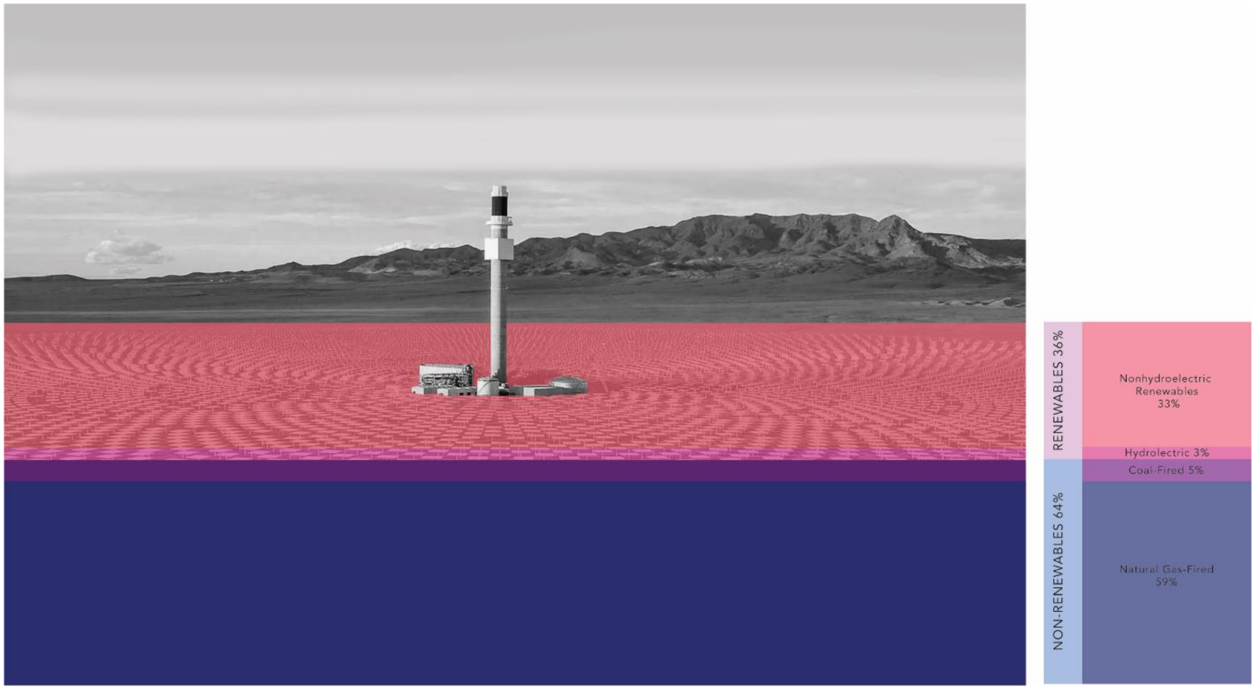


Figure 6. Nevada’s renewable and non-renewable energy sources in 2022
(Background picture source: Crescent Dunes Solar Energy Project, 2022).

Southern Nevada’s Food Overview

Water scarcity causes food vulnerability in the region. The dependence on food importation also means reliance on energy pricing. The climate crisis adds a worsening scenario: 32.2 to 41.3 percent of agricultural welfare can decrease if the region has a 10 percent reduction in precipitation and if the global temperature increases from 1.5 °C to 2.5 °C, respectively (Brears, 2018).

Investing in renewables, increasing productivity, and recycling resources can reduce risks in the food system (World Economic Forum, 2022). Water is the limiting factor; energy can counteract some trade (Huckleberry & Potts, 2019). For example, more energy-intensive solutions such as advanced water treatment systems, desalination plants, and hydroponic farming can be considered (Figure 7).

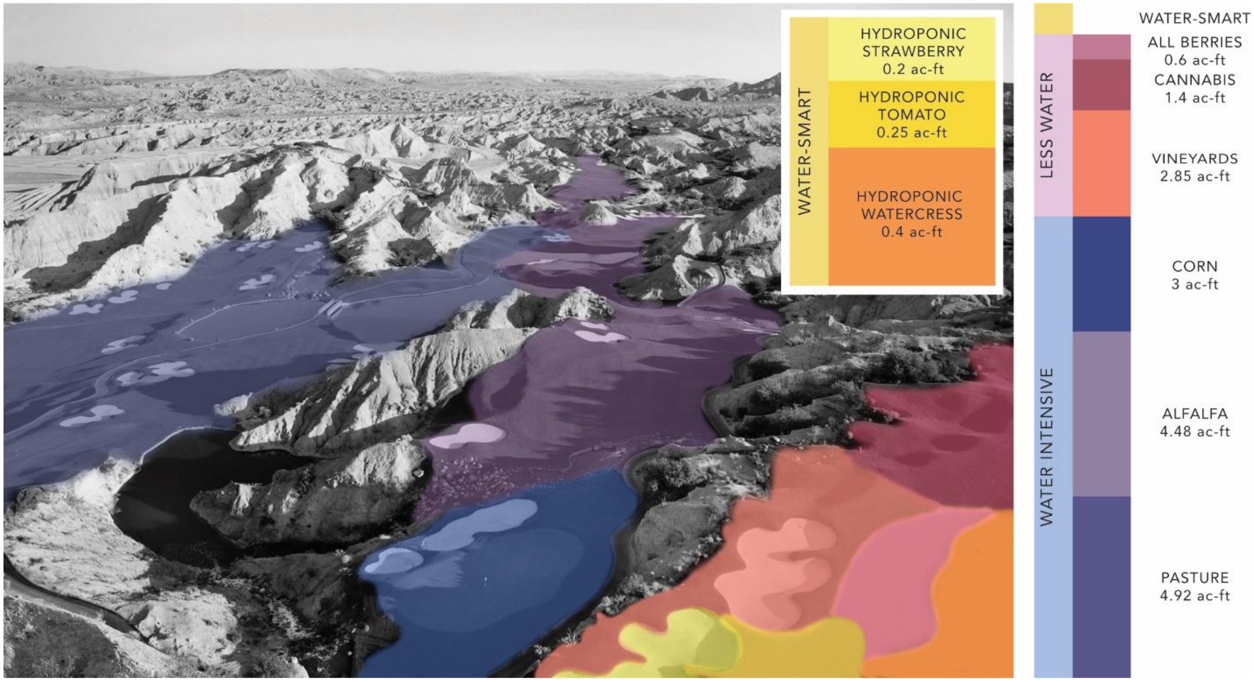


Figure 7. Nevada's existing and potential water footprint in one acre of farm (Dara et al., 2016; Johnson & Cody, 2015; Lowe & Gereffi, 2008; Nederhoff & Stanghellini, 2010; Pera, 2021; Background picture source: Mesquite by Wolf Creek, 2020).

At the same time, recognizing traditional food knowledge in using native edible plants could enhance food security strategies in the future. Drier weather caused by higher temperatures can jeopardize tribes' health considerably. Native people's well-being relies on local species and natural systems for their livelihoods and cultural heritage (Garfin et al., 2018; U.S. Global Change Program, 2018). Some traditional edible native plants are bitterroot (*Lewisia rediviva*), blazing star seeds (*Mentzelia laevicaulis*), buffaloberries (*Shepherdia argentea*), acorn (*Quercus Kelloggii*), wild asparagus (*Epilobium angustifolium*), bentgrass seeds (*Agrostis alba*), nutgrass tubers (*Cyperus rotundus*), mariposa lily bulbs (*Calochortus invenustus*), Green ephedra seeds (*Ephedraceae Nevadensis*), garlic (*Allium falcifolium*), gooseberry (*Ribes roezlii*), screwbean mesquite (*Prosopis pubescens*), honey mesquite seeds (*Prospois glandulose*), mustard seeds (*Cruciferae* spp.), onion (*Allium acuminatum*), pinion nuts (*Pinus monophyla*), sego lily bulbs

(*Calochortus nuttallii*), tiger lily (*Lilium columbianum*), Indian ricegrass (*Oryzopsis hymenoides*), wild rose hips *(Rosa nutkana*), wild rye (*Echinochloa cinereus*), sand potato (*Ammobroma sonorae*), rabbitbrush knots (*Chrysothamnus nauseosus*), whitebark raspberry (*Rubus leucodermis*), bushy knotweed (*Polygonum ramosissimum*), tule roots (*Scirpus acutus*), Indian turnip (*Psoralea* spp.), watercress (*Nasturtium officinale*), Saskatoon serviceberry (*Amelanchier alnifolia*), wild spinach (*Chenopodium album*), wild strawberry (*Fragaria virginiana*), sunflower (*Helianthus annus*), wintergreen leaves (*Gaultheria humifusa*), yampah or wild carrot (*Perideridia gairdneri*). For medicinal uses agave (*Agave parryi*), iris roots (*Iris missouriensis*), juniper berries (*Juniper* spp.), elderberry (*Sambucus racemosa*), green ephedra stems (*Ephedraceae Nevadensis*), lupine (*Lupine polyphyllus*), big sagebrush leaves (*Artemisia tridentata*), tobacco root (*Valeriana edulis*), and willow (*Salix lasiandra*) (Taylor, 2002).

Currently, in Southern Nevada, approximately 12% of the population (280,000 people) are in moderate to severe food insecurity situations (Sisolak, 2021). This data indicates that food insecurity affects people living in urban areas, specifically Las Vegas Valley. Therefore, the target for a higher sustainable level is under 5% of the population (116,000 people).

The second indicator relates to children under seventeen whose households could always afford nutritious meals. However, only 64.7% of this sector is covered, with around 346,000 children (United Health Foundation, 2022). The target for a higher sustainable level is to cover over 95% of this sector (507,955 children).

The third indicator responds to agricultural productivity. This indicator can be controversial, but the region requires specific food supply security and can offer qualitative jobs in this industry. The most common Southern Nevada farming products are forage-hay, alfalfa, corn, cattle, egg production, sheep, and lambs, with an average return of 129 dollars per acre (Nevada

Department of Agriculture, 2021). The water footprint of these products is high compared to more diverse water-smart crops with higher profitability (Sustainable Agriculture Research and Education, 2004). Besides the drought crisis in the region, alfalfa growth in Lower Colorado is exported as fodder for livestock to other countries (Huckleberry & Potts, 2019). Simultaneously, Indigenous traditional foods are affected by drought, increasing heat stress, water shortages, wildfire conditions, industries related to mining, energy such as nuclear testing and waste management, and intensive monoculture farming (Andrews-Speed, 2015; U.S. Global Change Program, 2018).

WEF strategies must be upscaled and amplified at a higher speed to avoid negative impacts such as higher economic costs, volatile costs, more ecosystem damage, displacement, and environmental justice degradation (Andrews-Speed, 2015; Dale et al., 2011; Masson-Delmotte, 2021; U.S. Global Change Program, 2018).18).

3.7. Conclusions

Nevada's Doughnut economics model reframes social and environmental indicators in an integrated diagram that responds to sustainable levels. The process of building it is flexible, but it requires certain levels of specialized data. Data for indicators such as biodiversity loss, chemical pollution, ozone layer depletion, political voice, and network are more daunting at a regional or county level. Most of the selection of these indicators relies on official reports published periodically, contributing to showing how the model evolves. The state's significant social and environmental challenges are food insecurity, limited access to justice, political apathy and opacity, social inequality combined with over-exceeded greenhouse gas emissions, chemical pollution, and unsustainable freshwater withdrawals. Additionally, the Doughnuts Economics relationship table includes existing and potential synergies and trade-offs among indicators contributing to further systematic analysis.

The model also shows the magnitude of the WEF nexus challenge by showing that the state is surpassing the planet's ceiling in water use and greenhouse gas emitted by energy sources and falling short in food security. Therefore, future WEF decision-making requires more creativity and considering this model for more integrated strategies.

A closer look at WEF variables in the Southern Nevada region shows that the most influential water consumer in the region is the conventional agricultural sector. In addition, the inflexible Colorado River Compact and the fastest climate change are contributing to a negative impact on the three sectors (Huckleberry & Potts, 2019). Therefore, a strategic water policy must address food producers and consumers more innovatively.

Meanwhile, the current energy strategy of achieving 50 percent renewables in 2030, and net-zero emissions by 2050, even with a fast-growth population rate, is a positive commitment to reducing greenhouse gas emissions. However, this objective does not consider transport emissions, including aerial vehicles' jet fuel. Therefore, energy strategies must complement its renewable energy infrastructure program with sustainable building, new housing codes, and a significant transport decarbonization investment.

The region also suffers from food insecurity and nutritious food inaccessibility. As a result, the food sector requires more local and territorial work to reach every individual. Meanwhile, food production must be revamped, introducing diversification, and converting existing farmlands into more water-efficient crops without increasing the use of new lands.

Some limitations in this study include the difficulty of defining specific parameters and setting weights if they are compound indicators. Undepicted ranking categories use average values. Updated and reliable data is difficult to collect for indicators such as ozone depletion and chemical and nutrient pollution. The doughnut economics model was designed to be built through participatory governance; however, it can be calibrated by consensus in the future. Even though the model is self-explanatory, it requires "readers" to analyze existing and potential synergies and tradeoffs. The relationship tables contribute to this critical analysis.

The research contributes to bringing a circular economic model to an American and state-level context that can easily be replicated. In addition, the Doughnuts Economics relationship table showing positive, null, and negative interconnections contributes to systemizing integrated models in the future.

The doughnut economics model does not give answers but depends on the people's skills and knowledge in its construction. A transdisciplinary team would enhance the results from the model for future work, ending up the silos-thinking management. In addition, spatial analysis and ecosystem carriage capability could add specificity to the model and enhance the decision-making progress. After this recommendation, this research study proposes a landscape approach for better clarity required in the WEF decision-making framework.

Chapter 4. Landscape characterization

4.1. Summary of chapter 4

Major sustainability interlinkages occur between urban and rural communities. Cities are high consumers of the world's energy and are the primary source of carbon emissions. Urbanized lands disrupt hydrological cycles, the productivity of the soils, and even the local climate. In many cities worldwide, water, energy, and food are outside the city boundaries. Coping with the current environmental crisis through urbanized regions' perspective not only responds to the ecosystem functions and protection but also to social well-being and sustainable economic prosperity. A landscape approach includes a socio-ecological analysis, a study of the driving forces of landscape change, and a simulation-based design framework. This research conceptualizes the landscape as a physical and as a perceived space. A place-based landscape approach to WEF Nexus as Landscape Characterization Assessment can contribute to refining the strategies by understanding the existing pressures in a particular region. The research study uses Southern Nevada as a case study. This urban region scale identifies a local lexicon that could encourage stakeholders from different disciplines to contribute and help calibrate the framework.

4.2. Introduction

Major sustainability interlinkages occur between urban and rural communities. Cities are the most efficient human habitat, which makes the creation of investment and specialized services possible (Lehmann, 2019b). Interconnected human settlements bring possible conditions to explore collectively or as individuals in the innovation of economies, prosperity, and selfrealization. Parallel to urban centers, the countryside is full of cultural and natural heritage. Together, their logistic network encompasses larger-scale productivity, wildlife habitat in intermingled spatial and temporal arrangements of ecosystem services, and effective institutions (Andrews-Speed, 2015). Interdisciplinary urbanized region planning can help identify critical risks in advance (U.S. Global Change Program, 2018).

As far as we know, cities use 78% of the world's energy and produce over 60% of carbon emissions (The Ecological Sequestration Trust, 2016); urbanized lands disrupt hydrological cycles, the productivity of the soils, and even the local climate (Lehmann, 2019a). However, besides these adverse aspects, cities can influence and collaborate with other cities, regions, and the interregional and international levels. Therefore, cities' presence and open dialog with other sectors have the necessary conditions to move forward to a low-carbon circular economy and to combine their integrated decision-making processes on multiple scales with their regional landscapes (Frank & Marsden, 2016).

Vos and Meekes suggest that transdisciplinary landscape planning could foster the integration of disarticulated silos of planning and natural resource decision-making at several temporal and spatial scales (Vos & Meekes, 1999). Social and ecological dimensions of the landscape can be identified and categorized in ecosystem services (Morrison et al., 2018). For example, Kim and Pauleit use a combined landscape character and ecological assessment to improve land-use policies for an urbanized region in the South (Kim & Pauleit, 2007). Effectively, a socio-ecological framework bridges human and ecological scale and boundaries on place-based frameworks, which are a potential transboundary medium (Morrison et al., 2018), recognizing the connection between the city and its operational and natural surroundings into a manageable landscape unit.

4.3. Urban region scope

Landscapes embed local, regional, and global complex systems. A multiple-scale landscape planning is a framework that provides more effective and informed decisions that might not finish at the edge of the built environment or a political boundary. In many cities worldwide, water, energy, and food are outside the city boundaries, even out of the region and country. Prosperous urban centers depend on operational landscapes as a source of fresh water, energy, food, and other services (Brenner, 2014). Generally, WEF nexus projects based on a water approach are more common on a basin scale, the energy-based strategies are on a state or country scale, and the food-based approach is multiscale, from urban farming to extensive farmlands. The broader landscape perspective considers the metropolitan and regional levels as administrative districts where wealth, wildlife, and cultural and natural contexts are involved in uneasy tradeoffs and harmonious synergies (Swatuk et al., 2018; The Ecological Sequestration Trust, 2016).

Frank A. & Marsden T. suggest a reconnection between different fields with advanced regional planning promoting discourses equally on sociocultural and ecological perspectives (Frank & Marsden, 2016). Coping with the current environmental crisis through urbanized regions' perspectives not only responds to the ecosystem functions and protection but also to social well-being and sustainable economic prosperity. This framework might limit activities spatially, but at the same time, it includes a scope about what land uses, infrastructures, and policies are working and those that are not in a socio-ecological network. Ecologically informed landscape character assessment visualizes spatial possibilities for humans and wildlife in a dynamic climate change scenario for a specific urbanized region.

For this research study, the urbanized region is defined according to the following three characteristics: First, the region must have a unique socio-environmental cohesive or semi-cohesive influence area, in this case, an administrative state boundary. Second, it must have an urban nucleus that can operate more sophisticated demands like higher education, specialized medical services, and jobs required nowadays in a globalized world. Third, no living creature is left behind, and the urban region is comprehensive, avoiding overlooking smaller components.

It is necessary to bring knowledge integration into play to achieve these qualities. The world's economy is becoming increasingly knowledge-intensive. For this research, the definition of knowledge is the act of organizing information coherently to make better decisions. Consequently, urban region planning must decide what information to embed that could be strategic to operate. This need will drive further technological, societal, and organizational change (Burbridge, 2017). Participatory approaches, including local and indigenous experiences, can accelerate the transition to a decarbonized society. Furthermore, integrative approaches aim to tailor policies to specific stakeholders and contexts. Conjointly, strengthened regional organizations enable better conditions for strategic decision-making for a more sustainable future (Masson-Delmotte, 2021).

Policymakers, urban planners, landscape architects, engineers, and other stakeholders must understand the urbanized region's biodiversity, especially its connectivity through nuclear areas and remnants of the ecosystem. The ecosystem approach aims inform decision-making through ecosystem services and socio-ecological linkages (Morrison et al., 2018). Biodiversity and healthy ecosystem services are the best resources for a sustainable future with more synergetic effects in the region.

4.4. WEF nexus place-based models

Numerous WEF models and existing WEF decision-making frameworks do not integrate ecosystems adequately, limiting their results by degrading or overlooking sensitive landscapes for nature and the community (Borrelli & Mela, 2018; Pezzoli et al., 2009). A landscape approach does not leave anyone or anything "out of the picture." A future pressure or conflict can arise if a sensitive natural or cultural component is excluded. A landscape approach includes a socio-ecological analysis, a study of the driving forces of landscape change, integrative systematic planning, and a simulation-based design framework for a more sustainable resource management (Bürgi et al., 2017). Other models, such as integrated water resource management, differ in that they do not prioritize one or other WEF components but understand their socio-ecological dimensions and the complex interrelations among them (Venghaus et al., 2019).

For this research, the WEF nexus analyzes and characterizes landscape dimensions to better understand landscape drivers of change, revealing a spatial portion of WEF interconnectivity (Chen et al., 2020; Leck et al., 2015). Therefore, the proposed WEF decisions consider the local spatial and temporal context as many other variables depend on other regions, the sum of them, or more global management. Moreover, a precautionary principle implementation reduces uncertainty, mitigating human and environmental health pressures (deFur and Kazuba; Jordan and O'Riordan in Swatuk et al., 2018). However, U.S. Global Change Program scientists recognize that land-use decisions are changing from short-term economic benefits to increasingly influenced global market driving forces (U.S. Global Change Program, 2018).

In the same way, the mindset of understanding the dynamic links between WEF sectors and the landscape could open the path toward more bottom-up governance rather than the common top-down approach (Amadei, 2019; Primdahl & Kristensen, 2016). A landscape approach lies at the heart of the WEF nexus by visualizing, developing place-based solutions, and assessing the impact produced by the demand for these resources and their diverse ramifications for lifestyles, livelihoods, cultural values, rural-urban linkages, technologies, social networks, and governance (Hoolohan et al., 2018; Stoy et al., 2018) using an integrative and collaborative tool across sectors and scales, called landscape character assessment.

4.5. Landscape character assessment definition

Landscape character assessment (LCA) is a leading landscape assessment tool in the United Kingdom and the European Union planning schemes (Swanwick, 2002). Different and unique patterns include diverse natural and cultural drivers of change in the territory (Warnock & Griffiths, 2015). The critical aspect of LCA is 1) to identify these drivers through systematic analysis, 2) to communicate distinctive landscape character for varied stakeholders, and 3) to recognize the landscape features that people value (Morrison et al., 2018; Swanwick, 2002; Tudor, 2014). This approach is mainly used for conserving cultural landscapes with a relevant past or visual impact assessment in several countries worldwide. However, the landscape approach could upgrade as a decision-making tool by integrating this framework with other studies, such as ecological assessment, watershed models, climate change forecasts, dynamic wildlife systems, cultural heritage aspects, ecosystem services, and interconnectivity with the context and other regions (Kim & Pauleit, 2007).

Ian McHarg introduces in his book ‘Design with Nature’ the overlaying spatial analysis used today for geographic information systems from a landscape planning perspective, including LCA (McHarg, 1969; von Haaren et al., 2019).

Potteiger and Purinton consider landscape an instrument to open a dialogue between people and nature. Landscape materials, spatial experiences, and processes make unique places after a long time. At the same time, the landscape is the medium that unifies the context with stories, peoples' experiences, cultural learnings, historical passages, systems of belief, critical awareness, and the origin of scientific data, working as a middle ground for diverse stakeholders with multiple points of view. Natural and cultural surface patterns evoke real and perceptible stories, "printed energy" of persistent driving forces that interpret interrelated dimensions and diverse versions. New landscape representation depicts a new way to rethink the place and its interplay of natural processes and cultural meanings. Using the landscape to open discourse can be risky for some actors or bring ideologically distorted facts. Some of these detractions can be existing fears of the actor who holds a landscape's determinant narrative. In other cases, the landscape approach can be improved, revealing evolving processes of information, identities, and meanings, unmasking invisible socio-environmental processes as the first step before social collectivity solves it (Potteiger, 1998).

This research conceptualizes the landscape as a physical and as a perceived space. Physical space is composed of mountains, hills, flatlands, rivers, wetlands, vegetation covers, soil types, crops, housing, roads, dams, and other relevant natural components and infrastructure, along with a perceived landscape related to place attachment, social construction, and cultural values (Bürgi et al., 2017).

A landscape character is the ensemble of attributes that make a specific landscape unique by a distinct, recognizable, and consistent pattern (Warnock & Griffiths, 2015). In addition, natural and cultural factors influence landscape progress and composition, introducing a robust and relevant local vocabulary to describe it. Under this scope, LCA is composed of different landscape units. A *landscape unit* is a spatial framework characterized by unique nature and socio-cultural assemblage obtained through geospatial analysis of the information available independently on the format or the different scales used in the study area (Kim & Pauleit, 2007). Each landscape unit can be developed over time by adding more details, pictures, historical documents, scientific research, community agreements, and other layers of information (Warnock & Griffiths, 2015a). For this research, landscape unit delineation will use an intermediate scale of 1:50,000, an intermediate scale suggested by many practitioners (Warnock & Griffiths, 2015).

Integrating a broader landscape perspective on facing WEF nexus challenges can be effective in obtaining awareness of WEF impacts on the landscape's components. The composition of the natural and human landscapes offers a particular landscape character, and how society uses the land affects the ability of ecosystems to provide essential goods and services (U.S. Global Change Program, 2018). Previous studies found that more than 70 percent of the vocabulary used in transdisciplinary WEF models uses the local lexicon for enhanced collaboration among different sectors (Ghodsvali et al., 2019). In addition, the visual characterization and the use of a socio-cultural imaginary can facilitate the decision-making process across different stakeholders, increasing the possibility of a synergetic framework. (Morrison et al., 2018; Primdahl & Kristensen, 2016).

4.6. Hypothesis

How effective is the Landscape Characterization method in assessing the WEF nexus driving forces and trade-offs in a particular region?

4.7. Methods

This research uses data collection through maps and literature available in the last ten years to build up the Southern Nevada Landscape Characterization. The maps consulted include topography, geomorphology, soils, hydrology (surface, springs, and groundwater), ecoregions, land cover, land patterns, mines, landfills, wildlife habitat, built environment, county divisions, and native peoples' lands. The methods use one of the latest landscape characterization analysis processes published (Chen et al., 2020):

Step 1: The study will collect primary qualitative and quantitative spatial, historical and visual data through a literature review followed by the description, characterization, and mapping (1:50,000 scale) of the environmental qualities such as topography, geology, geomorphology, soils composition, hydrology, vegetation cover, and social dimensions, such as land uses, settlements, and other built environmental patterns, aesthetic qualities, cultural context, historical background, and distinctive features.

Step 2: An analysis of the natural conditions and social and cultural features will define main boundaries based on land covers and land uses, creating a landscape character map. The research includes an ecosystem services analysis by gathering and interpreting information on maps, analyzing geospatial data using landscape units, and creating ecosystem services and landscape unit matrix.

Step 3: Afterward, the analysis will identify and typify new landscape description units along with a definition of driving forces derived from consistent natural and cultural patterns and key distinct attributes of the landscape (Warnock & Griffiths, 2015). Additionally, each landscape unit includes a synthetic ecosystem services analysis, social-environmental identification, and pattern interpretation (Kim & Pauleit, 2007).

Step 4: To create WEF maps using WEF Nexus in Southern Nevada overview for a WEF driving forces and trade-offs spatial analysis.

4.8. Results

The research uses a geographic coordinated system WGS 84/ Zone UTM 11 N and a scale of 1:50,000 for analysis and building up the landscape character map.

The primary source of information used for the landscape character assessment is land cover and land use data, obtained through visual analysis of the following maps (Table 4):

Table 4. Spatial data used for Southern Nevada's landscape characterization.

Dimension	Layer	Spatial Data	Reference
Environmental	Digital Elevation Model	Raster	Environmental Protection Agency, 2016
	Geologic Map of Nevada	Raster	Environmental Protection Agency, 2016
	STASGO soils	Vector	Environmental Protection Agency, 2016
	Basins State Eng. Admin. Boundaries	Vector	Nevada Division of Water Resources, 2022
	Water Springs	Vector	Environmental Protection Agency, 2016
	Streams	Vector	Environmental Protection Agency, 2016
	Water bodies	Vector	Environmental Protection Agency, 2016
	Land Cover	Vector	Environmental Protection Agency, 2016
	Nevada Vegetation Project Index	Raster	Nevada Division of Natural Heritage, 2008
	Ecoregions	Raster	Environmental Protection Agency, 2003
	National Conservation Lands	Vector	Bureau of Land Management Nevada, 2021
Social	State outline	Vector	Igismap, 2022
	County-level	Vector	Igismap, 2022
	Highways lines	Vector	Igismap, 2022
	Native Land Digital	Vector	Native Land Digital, 2021
	Cities and towns	Vector	Environmental Protection Agency, 2016
	Active mines and energy producers	Vector	Creative Commons, 2021
	Open Street Map	Vector	Creative Commons, 2022

Each of the natural patterns (landform, waterbodies, and vegetation covers) and human features (built-up areas, administrative borders, and farming patterns) considers delineating the study area into distinct character areas. Areas of similar character components were grouped in landscape character types. The study uses land use, land cover, and topography as the main criteria for delineating the landscape character units and types to create the landscape character map. For Southern Nevada, the research defined 26 different landscape units (Figure 8). The given names show a relevant component to identify them. The main boundaries for each landscape unit are defined as follows:

SN1. Las Vegas Valley: Road density, mountain range, and urban land.

SN2. Mesquite: Farms, urban lands, surface water, mountain range, and state border.

SN3. Pahrump: Farms, urban lands, and state border.

SN4. Laughlin: Urban lands, highway, and state border.

SN5. Meadow Valley Wash: Farmlands, superficial water, and mountain range.

SN6. Panaca Valley: Mountain range, county and state borders.

SN7. Amargosa: Vegetation cover, mountain range, and administrative state borders.

SN8. Lake Mead Wildlife: Superficial water, mountain range, and state border.

SN9. Tonopah Dunes: Flatlands, mountain range, administrative and county border.

SN10. Silver Peak Mountains: Mountain topography, county and state borders.

SN11. Grant Range: Mountain topography and county border.

SN12. Shingle Peak: Mountain topography and county border.

SN13. Delamar Valley: Flatlands and valley sands.

SN14. End of the Line: Flatlands surrounded by mountains and state border.

SN15. Mormon Mountains: Mountain topography.

SN16. Sheep Range: Mountain topography and administrative border.

SN17. Tecopa: Flatlands and state border.

SN18. Sloan: Mountain topography.

SN19. Desert National Wild Refuge: Administrative boundary.

SN20. Spring Mountains: Mountain topography.

SN21. Desert Tortoise: Flatlands, vegetation cover, and state border.

SN22. Railroad Valley: Dry lake bed and flatlands.

SN23. Snake range: Mountain topography and state border.

SN24. Basin and Range: Mountain topography, wildlife parks corridor, and state border.

SN25. Defense: Administrative boundary.

SN26. Toiyabe Range: Mountain range and basin system, and county border.

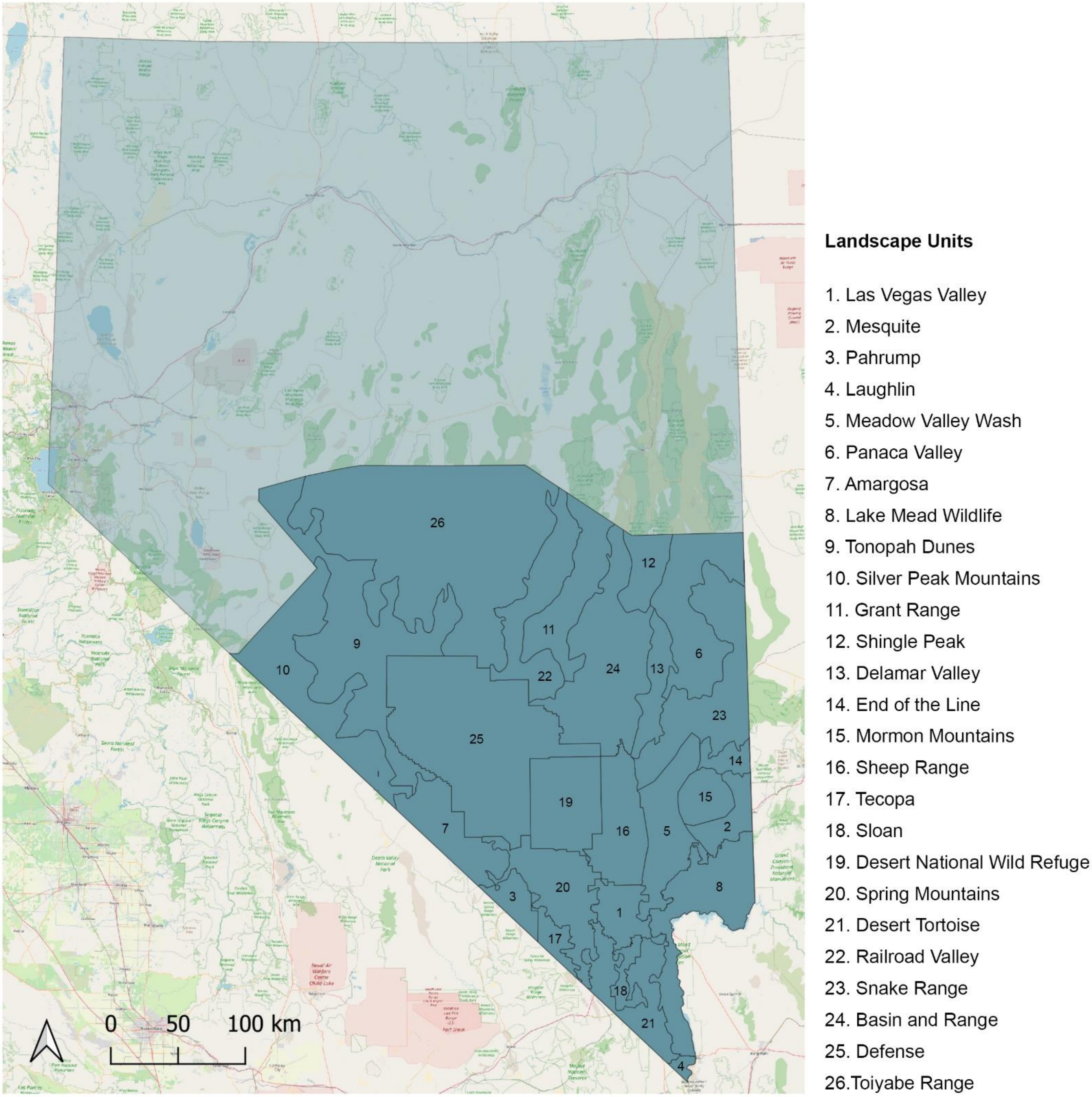


Figure 8. Southern Nevada's landscape units.

Each landscape character unit has a data sheet using a description and analysis of spatial information and other information collected from several sources such as published literature, official and community technical reports, and social media, integrating specialized science, people's knowledge, community creeds, and values (Swatuk et al., 2018). The data sheet includes a brief description, landscape composition, driving forces of landscape change, ecosystem services, location map, area, corresponding basin, potential partnerships, axonometric, a longitudinal section, and pictures to illustrate it.

The ecosystem services identification is a significant and innovative contribution to the landscape characterization approach. A place-based assessment of ecosystem services provides information about the interactions between people and the environment, sustainability development, and the ecology of landscapes (Potschin & Haines-Young, 2013b). Ecosystem services are humans' benefits from nature (Ronchi, 2018; von Haaren et al., 2019). A place-based assessment of ecosystem services tracks and localize problems and solutions in a specific context. For this research, the place is the region ensembled by biophysical and social dimensions.

Ecosystem services classification based on Haines-Young and Potschin's ecosystem services assessment on habitats (Potschin & Haines-Young, 2013b), Millennium Ecosystem Assessment (Tengberg et al., 2012), and Common International Classification of Ecosystem Services criteria selection by Garcia et al. (García et al., 2020). The score for each parameter depends on a significant extent and an evident recognition of this service in the assessed landscape unit. However, it does not calculate the impact on each of them. This preliminary ecosystem services assessment uses geoanalysis tools to identify them in the consulted maps and literature.

The research identifies the following ecosystem services divided into four themes:

Supporting services

Ecosystem services are required to preserve and maintain all other ecosystem services (von Haaren et al., 2019).

S1. Habitat for endangered species (Malaney et al., 2015; Nussear et al., 2009).

S2. Migratory bird routes (U.S. Environmental Protection Agency, 2003, 2016).

S3. Habitat for pollinators (Nevada Division of Natural Heritage, 2008; U.S. Environmental Protection Agency, 2003).

S4. Primary production of new organic matter by plants and other autotrophs (Nevada Division of Natural Heritage, 2008).

S5. Plant biomass for soil formation (U.S. Environmental Protection Agency, 2016).

Provisioning services

It relates directly or indirectly to land suitability for generating plant biomass and other useful resources for humans and wildlife (García et al., 2020).

P1. Surface water for drinking (U.S. Environmental Protection Agency, 2016).

P2. Water springs (U.S. Environmental Protection Agency, 2016).

P3. Cultivated lands for food supply (Creative Commons, 2022; U.S. Environmental Protection Agency, 2016b).

P4. Lands for fiber, timber, medicines, and other uses (Creative Commons, 2022; Nevada Department of Agriculture, 2021; U.S. Environmental Protection Agency, 2016b).

P5. Genetic resources in biodiversity (U.S. Environmental Protection Agency, 2016a)

Regulating services

The benefits of regulating ecosystem processes, including climate, water, and some human diseases regulations (von Haaren et al., 2019).

R1. Natural water catchments (Nevada Division of Natural Heritage, 2008; U.S. Environmental Protection Agency, 2016a).

R2. Vegetation cover for flood control (Nevada Division of Natural Heritage, 2008; U.S. Environmental Protection Agency, 2016a).

R3. Vegetation cover for erosion control (Nevada Division of Natural Heritage, 2008; U.S. Environmental Protection Agency, 2016b).

R4. Carbon capture and storage (Nevada Division of Natural Heritage, 2008).

R5. Landscape units without stationary or area sources of air pollution (Creative Commons, 2021; U.S. Environmental Protection Agency, 2016b).

Cultural services

They are related by a broad spectrum of cultures, knowledge systems, creeds, tangible and intangible heritage values, social exchanges, aesthetic appreciation, and recreational activities that improve health and well-being (García et al., 2020; Tengberg et al., 2012). Furthermore, the added care for nature and cultural features is fundamental for people, as they are attached to the landscape (Kopec & Bliss, 2020).

C1. Spiritual enrichment: Landscape units with sacred places, temples, and graveyards (Creative Commons, 2022; Taylor, 2002; U.S. Environmental Protection Agency, 2016b).

C2. Recreation: Landscape units with federal or state parks (Creative Commons, 2022; U.S. Environmental Protection Agency, 2016b).

C3. Aesthetic experiences: Landscape units with unique sensorial experiences (Creative Commons, 2022; U.S. Environmental Protection Agency, 2016b).

C4. Heritage: Landscape units with a memorable historical background or unique cultural feature or identity (Creative Commons, 2022; Taylor, 2002; U.S. Environmental Protection Agency, 2016b).

C5. Cognitive or emotional connection: Landscape units with a strong collective bond and sense of belonging (Creative Commons, 2022; U.S. Environmental Protection Agency, 2016b).

The relationship matrix of ecosystem services and landscape units (Table 5) represents the diversity of ecosystem services in a single landscape unit, not the quantification of the ecosystem services.

Table 5. Relationship table between ecosystem services and landscape units.

Code	Landscape Unit	S1	S2	S3	S4	S5	ST	P1	P2	P3	P4	P5	PT	R1	R2	R3	R4	R5	RT	C1	C2	C3	C4	C5	CT
SNV1	Las Vegas Valley		•				1	•	•				2						0	•		•	•	•	4
SNV2	Mesquite	•	•	•	•		4	•	•	•	•		4		•		•		2	•		•	•	•	4
SNV3	Pahrump			•			1	•	•	•	•		4						0	•			•	•	3
SNV4	Laughlin	•	•	•	•		4	•	•				2		•				1	•		•		•	3
SNV5	Meadow Valley Wash	•	•	•	•		4	•	•	•	•		4	•	•	•	•		4	•	•	•	•	•	5
SNV6	Panaca Valley	•	•	•	•		4	•	•	•	•		4				•	•	2	•	•	•	•	•	5
SNV7	Amargosa	•	•	•	•		4	•	•				2		•		•		2	•	•	•	•	•	5
SNV8	Lake Mead Wildlife	•	•	•	•		4	•	•				2	•	•				2		•	•	•	•	4
SNV9	Tonopah Dunes	•	•				2	•	•	•	•		4						0	•		•		•	3
SNV10	Silver Peak Mountains	•	•	•	•	•	5	•	•	•	•		4	•		•	•		3	•	•			•	3
SNV11	Grant Range	•	•	•	•	•	5		•		•	•	3	•	•	•	•	•	5		•	•		•	3
SNV12	Shingle Peak	•	•	•	•	•	5		•		•	•	3	•		•	•	•	4		•			•	2
SNV13	Delamar Valley	•	•	•	•		4	•	•				2			•	•	•	3			•	•	•	3
SNV14	End of the Line	•		•	•		3		•				1				•	•	2						0
SNV15	Mormon Mountains	•	•	•	•		4		•				1	•			•	•	3	•	•	•	•	•	5
SNV16	Sheep Range	•	•	•	•	•	5	•	•		•	•	4	•	•	•	•	•	5	•		•		•	3
SNV17	Tecopa	•		•	•		3		•				1			•	•	•	3						0
SNV18	Sloan	•	•	•	•		4		•				1			•	•	•	3	•	•	•	•	•	5
SNV19	Desert National Wild Refuge	•	•	•	•	•	5	•	•			•	3	•	•	•	•	•	5	•	•	•	•	•	5
SNV20	Spring Mountains	•	•	•	•	•	5	•	•			•	3	•	•	•	•		4	•	•	•	•	•	5
SNV21	Desert Tortoise	•	•	•	•		4	•	•				2			•	•		2	•		•		•	3
SNV22	Railroad Valley	•	•	•	•		4	•	•	•			3		•				1		•		•		2
SNV23	Snake Range	•	•	•	•	•	5	•	•		•	•	4	•	•	•	•	•	5	•	•	•		•	4
SNV24	Basin and Range	•	•	•	•		4	•	•			•	3	•	•	•	•		4	•	•	•	•	•	5
SNV25	Defense	•	•	•	•	•	5	•	•			•	3	•	•	•	•		4				•	•	2
SNV26	Toiyabe Range	•	•	•	•	•	5	•	•		•	•	4	•	•	•	•		4	•	•	•	•	•	5

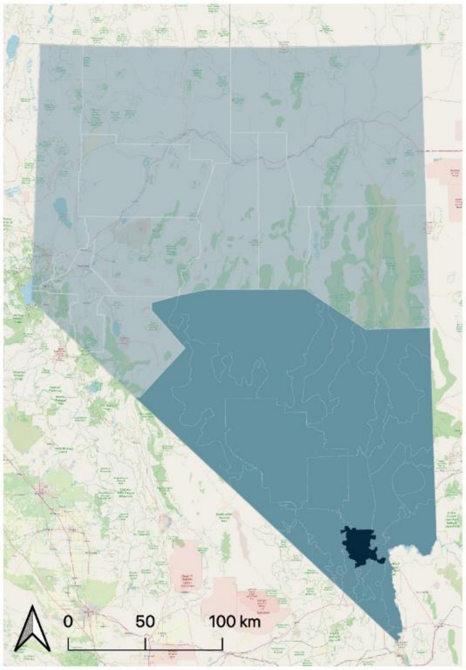
Southern Nevada relationship matrix between ecosystem services and landscape units. S1. Habitat for endangered species, S2. Migratory bird routes, S3. Habitat for pollinators, S4. Primary production of new organic matter by plants and other autotrophs, S5. Plant biomass for soil formation, ST. Total supporting ecosystem services, P1. Surface water for drinking, P2. Water springs, P3. Cultivated lands for food supply, P4. Lands for fiber, timber, medicines, and other uses, P5. Genetic resources in biodiversity, PT. Total provisioning ecosystem services, R1. Natural water catchments, R2. Vegetation cover for flood control, R3. Vegetation cover for erosion control, R4. Carbon capture and storage, R5. Landscape units without stationary or area sources of air pollution, RT. Total regulating ecosystem services, C1. Spiritual enrichment: Landscape units with sacred places, temples, graveyards, C2. Recreation: Landscape units with federal or state parks, C3. Aesthetic experiences: Landscape units with unique sensorial experiences, C4. Heritage: Landscape units with a memorable historical background or with a unique cultural feature or identity, C5. Cognitive or emotional connection: Landscape units with a strong collective bound and sense of belonging, CT. Total cultural ecosystem services.

After incorporating this information, the following 26 landscape character data sheets were prepared (Figures 9-34):

SN1. Las Vegas Valley

"Las Vegas" means "the meadows" due to water found in underground artesian wells.[1] Call it Entertainment Capital of World with 2.2M [2] people and around 42M visitors per year in pre-pandemic levels.[3] The McCarran International Airport is one of the ten busiest airport worldwide.[4] The city is mostly low density residential area.[5]

1. Motus (2021). 1905: How Las Vegas Was Founded and the Meaning of Its Name. History.Info.
2. Census (2021). Clark County, Nevada.
3. LVCVA Research Center (2022). Visitor Statistics.
4. Howarth, Bryan (2022). Las Vegas airport among busiest worldwide in 2021. Las Vegas Sun. Published on 04/14/2022.
5. Shreckengast, Brian (2017). How Dense is Las Vegas? Spare Foot Moving Guides. Published on 02/02/2017.



Landscape Type
Urban

Area
1,571.91 km^2
606.92 mi^2

Basin
Mojave

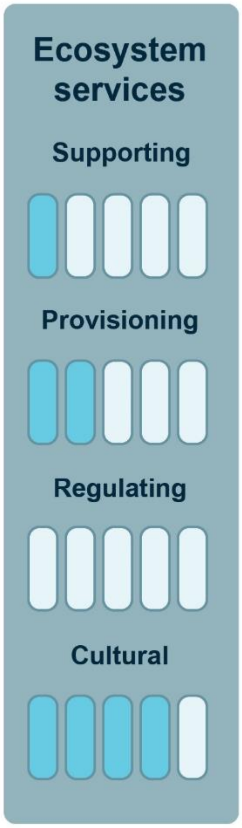
Partnerships
Federal govt. ,State govt.,Clark cty., City of Las Vegas, North Las Vegas, Boulder City, Henderson, Chemehuevi and S. Paiute people

Landscape Composition
Low density urban area. Small remnants of a highly disturbed in a cresote bush (*Larrea tridentata*)-dominated basin (Image: Maps3D.io).

Source: Apple.com/maps/

Driving forces of landscape change
- Urban and infrastructure development.

#LasVegas, #Vegas, #LV



Source: LasVegasWildlife

Source: Viva_lasvegas1

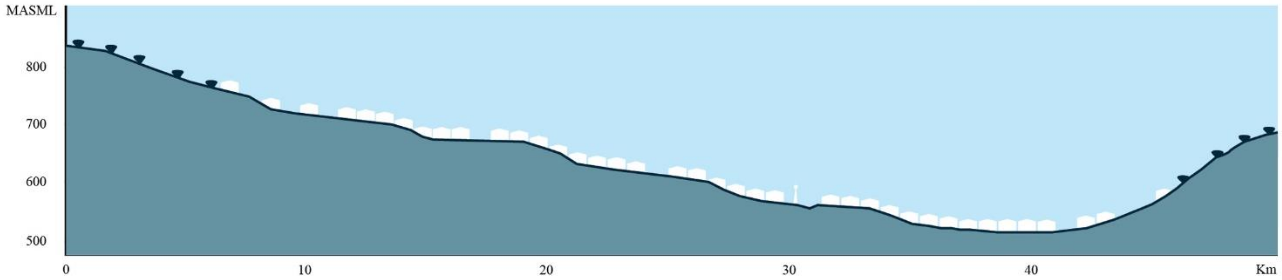
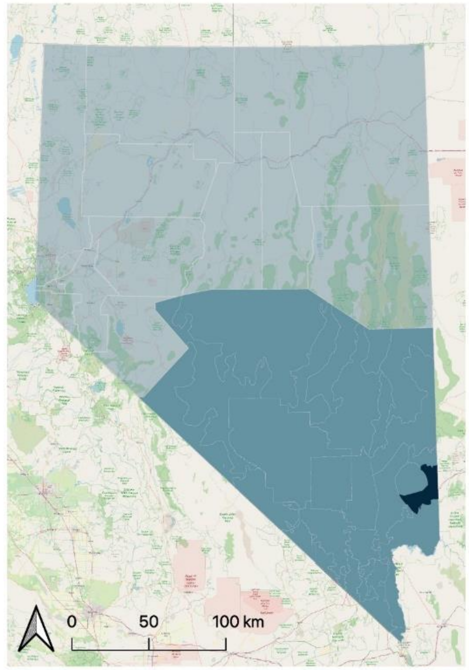


Figure 9. Las Vegas Valley Landscape Character Unit.

SN2. Mesquite

Mesquite city was founded in 1880 by Mormon settlers. Mesquite is home to an increasing retiree population, and several golf courses, and casino resorts. The farms cultivate pomegranates, figs, grapes, cotton, alfalfa, wheat and cane.[6] Low density residential area surrounded by hills and the Virgin river.

6. MesquiteNV (2021). Pioneering with Pride. Mesquite, Nevada.



Landscape Type
Suburb

Area
1303.64 km^2
503.34 mi^2

Basin
Mojave

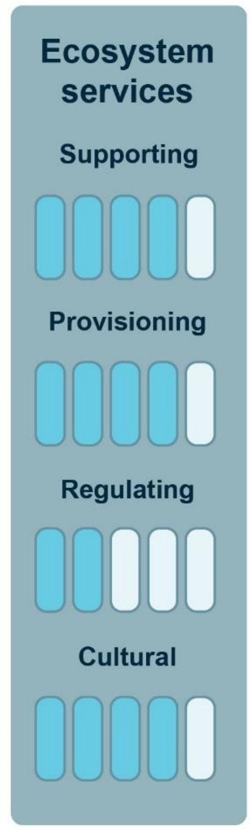
Partnerships
Federal govt.
State govt.
Clark cty., Lincoln cty., Mesquite city, Moape city, Southern Paiute people

Landscape Composition
Low density urban area. Intermediate disturbance in a cresote bush (*Larrea tridentata*) dominated basin with some gentle arid slopes (Image: Maps3D.io).

#Mesquite, #MesquiteNV

Source: Apple.com/maps/

Driving forces of landscape change
- Urban and infrastructure development.
- Agricultural expansion and intensification.



Source: Mesquitefreak

Source: Brianonar

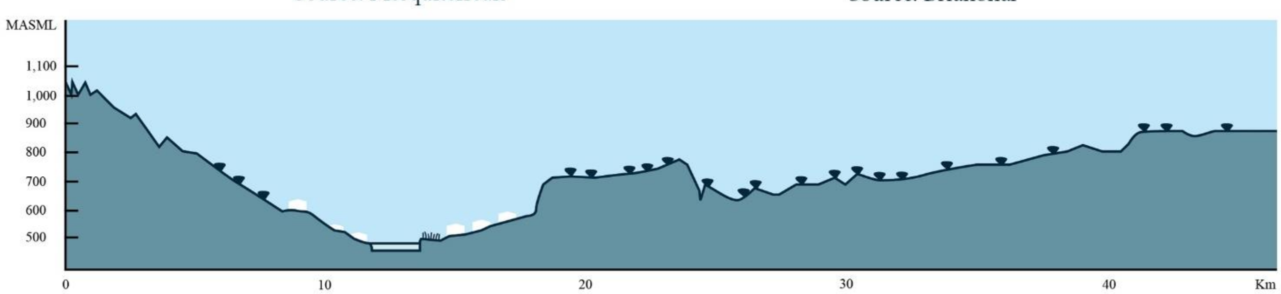
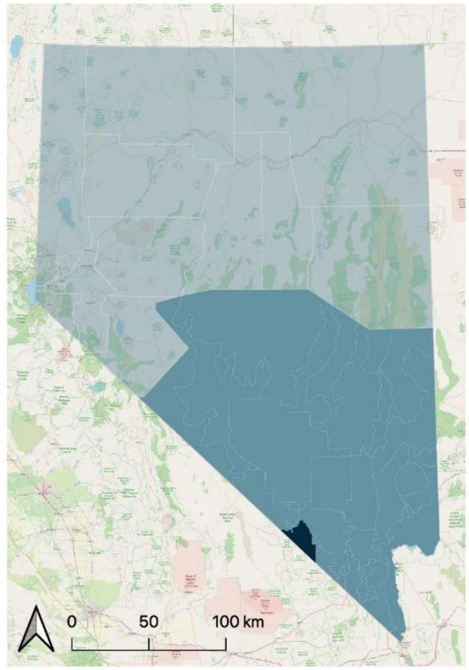


Figure 10. Mesquite Landscape Character Unit.

SN3. Pahrump

Originally, the valley was named it "Pah-Rimpi" or "Water Rock" due to the abundant artesian wells throughout the valley by The Southern Paiute people.[7] Low density residential area with high number of vacant lots.

7. Town of Pahrump (2020). Pahrump True Nevada. Pahrump, Nevada.



Landscape Type
Suburb

Area
966.66 km^2
373.23 mi^2

Basin
Mojave

Partnerships
Federal govt.
State govt.
Nye county, Clark cty., Pahrump city, Western Shoshone, Southern Paiute, Chemehuevi people

Landscape Composition
Low density urban area. Intermediate disturbance in Amargosa desert with some gentle arid slopes and Mojave playas (Image: Maps3D.io).

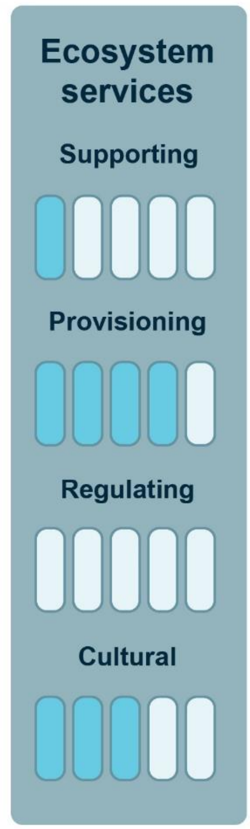
Source: Apple.com/maps/

Driving forces of landscape change
- Urban and infrastructure development.

#Pahrump, #PahrumpNevada

Source: Vannoyrochelle

Source: Michael Quine



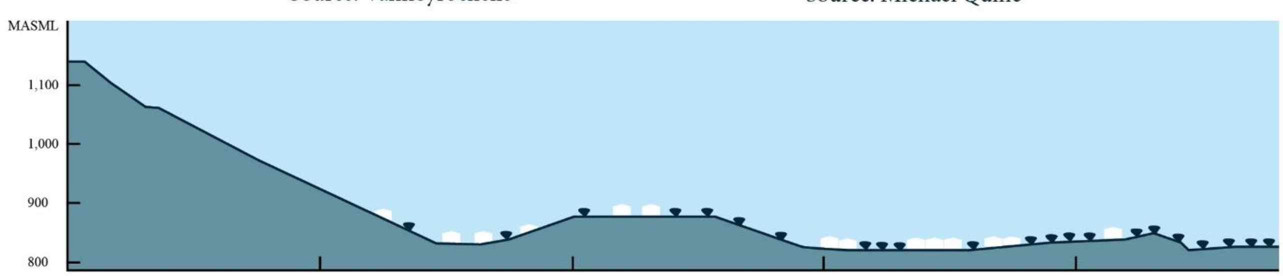
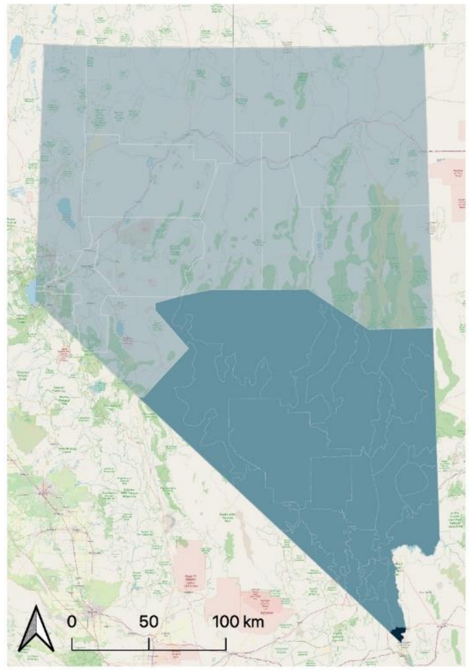


Figure 11. Pahrump Landscape Character Unit.

SN4. Laughlin

Flat desert with rocky hills, power stations, and small low density residential areas.

Landscape Composition
Low density urban area. Low disturbance in a cresote bush (*Larrea tridentata*) dominated basin (Image: Maps3D.io).



Source: Apple.com/maps/

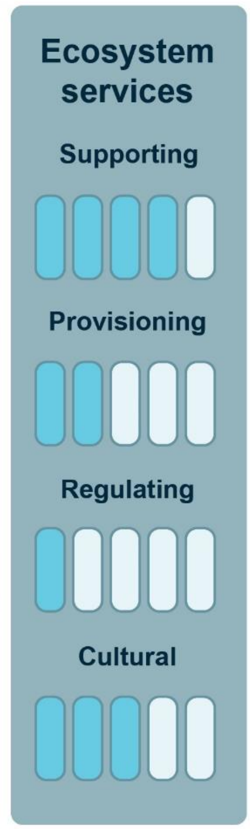
Driving forces of landscape change
- Urban and infrastructure development.

Landscape Type
Suburb

Area
205.44km^2
79.32 mi^2

Basin
Mojave

Partnerships
Federal govt.
State govt.
Nye county, Clark cty., Pahrump city, Western Shoshone, Southern Paiute, Chemehuevi people



#Laughlin #Laughlinnevada #laughlinnv

Source: Hijo_del_toro

Source: Greenskeeperorg

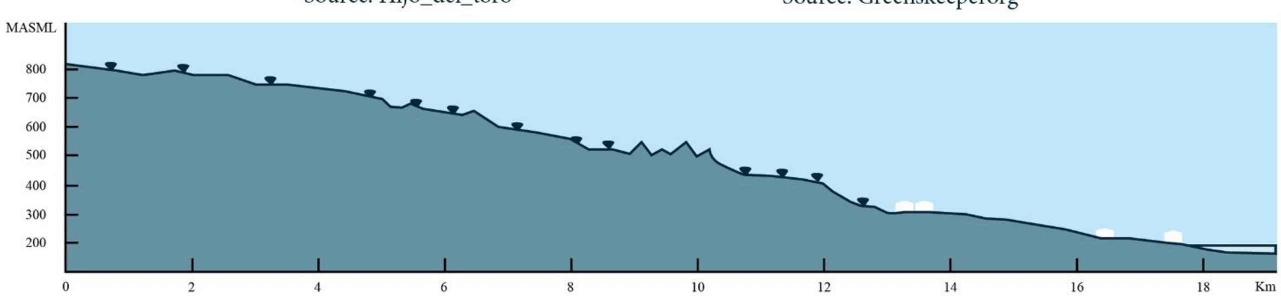
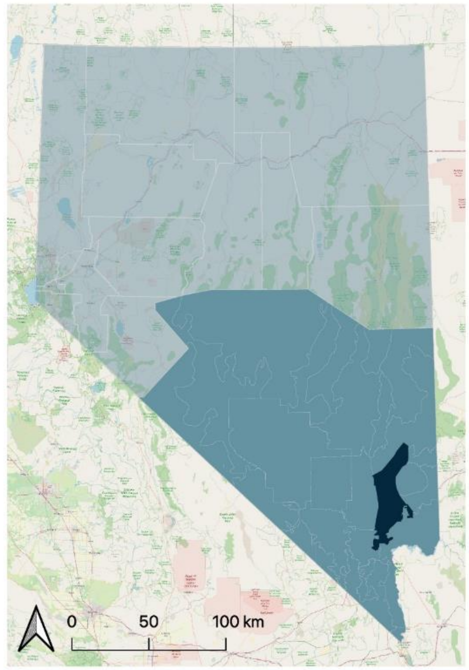


Figure 12. Laughlin Landscape Character Unit.

SN5. Meadow Valley Wash

Intertwined Union Pacific railroad and the Meadow Valley wash. A rural and low density residential areas are combined in Moapa Valley city.

Landscape Composition
Cresote bush (*Larrea tridentata*) dominated basin flat lands and gentle arid slopes with some disperse farmlands by the Meadow Valley Wash (Image: Maps3D.io).



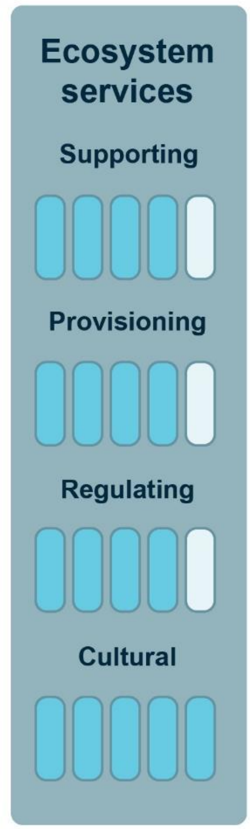
Source: Apple.com/maps/

Landscape Type
Rural/ Wild Natural

Area
3337.74 km^2
1,288.71 mi^2

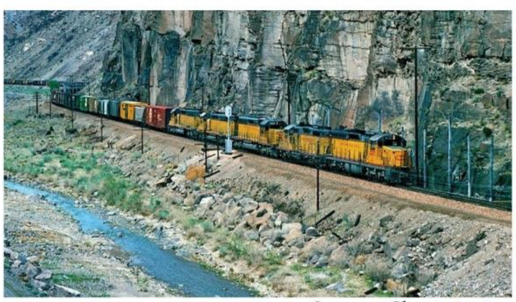
Basin
Mojave

Partnerships
Federal govt.
State govt. Clark cty., Lincoln cty., Moape Valley city, Western Shoshone, and Southern Paiute people



Driving forces of landscape change
- Nature and heritage conservation
- Agricultural expansion and intensification

#MeadowValley



Source: Classic.trains

Source: Ajsaintphotography

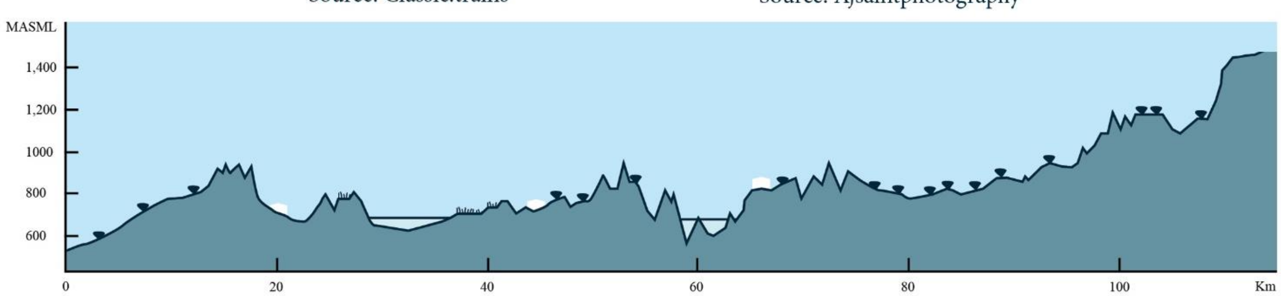
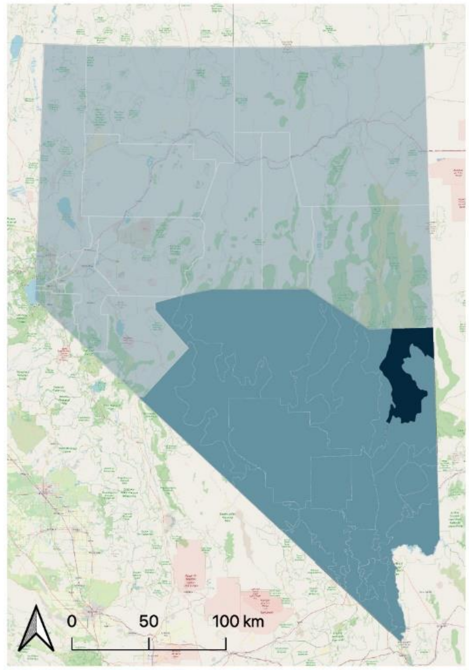


Figure 13. Meadow Valley Wash Landscape Character Unit.

SN6. Panaca Valley

Lowlands with isolated and rugged mountains including Fortification Range Wilderness.

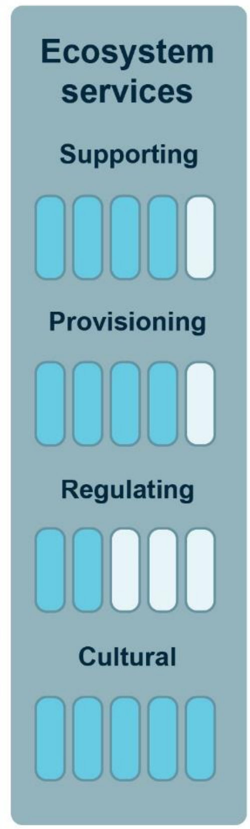


Landscape Type
Rural/ Wild Natural

Area
4,735.9 km^2
1,828.54 mi^2

Basin
Central Basin and Range

Partnerships
Federal govt., State govt., Lincoln county, Western Shoshone people, Southern Paiute people



Landscape Composition
Carbonate sagebrush (*Artemisia tridentata*) valleys conformed by pinyon juniper woodland (*Juniperus* spp.) zones, shadscale (*Atriplex confertifolia*) dominated saline basins, and a small number of disperse irrigation intensive farmlands (Image: Maps3D.io).

Source: Apple.com/maps/

Driving forces of landscape change
- Extraction of nonrenewable resources,
- Agricultural expansion and intensification

#Panacavalley, #PanacaNV

Source: Clairecodlingphoto

Source: Clairecodlingphoto

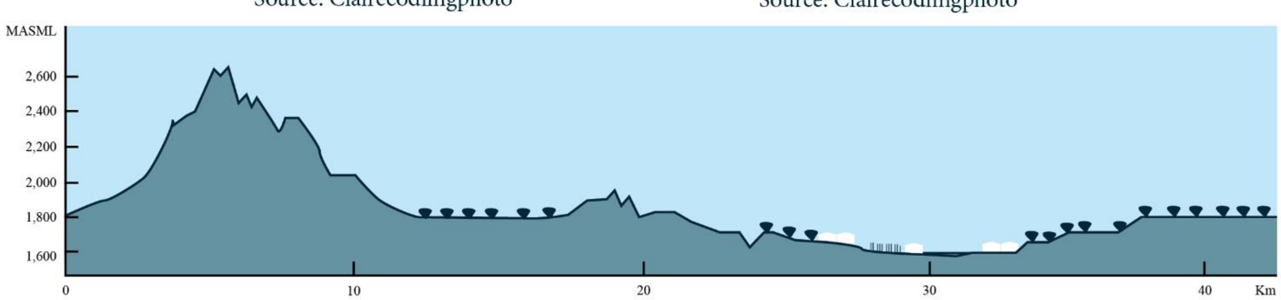
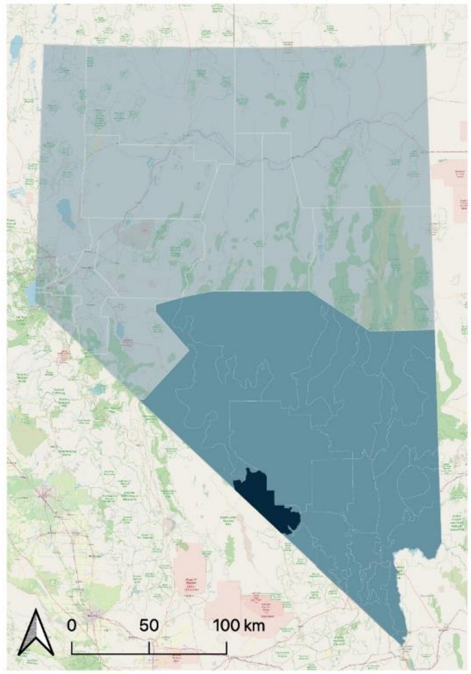


Figure 14. Panaca Valley Landscape Character Unit.

SN7. Amargosa

Dune area with historical precedents: Discoveries from ancient settlements (10,000 years ago), XIX gold and silver mining era, nuclear energy development and environmental justice movements nowadays[8]. Ash Meadows National Wildlife Refuge, an unique wetland ecosystem is found here.

8. McCracken, Robert (1992). A History of Amargosa Valley, Nevada. Nye County Press, Tonopah, Nevada.



Landscape Type
Rural/ Wild Natural

Area
2,859.98 km^2
1,104.24 mi^2

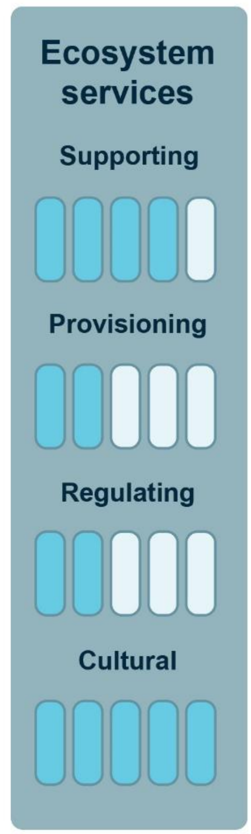
Basin
Mojave

Partnerships
Federal govt.
State govt.
Nye county
Western Shoshone
Southern Paiute people

Landscape Composition
Amargosa desert floodplains and a small number of disperse irrigation intensive farmlands (Image: Maps3D.io).

Source: Apple.com/maps/

Driving forces of landscape change
- Extraction of nonrenewable resources.
- Agricultural expansion and intensification.



#Amargosa, #Ashmeadows

Source: Randomzbimherz

Source: My Public Lands

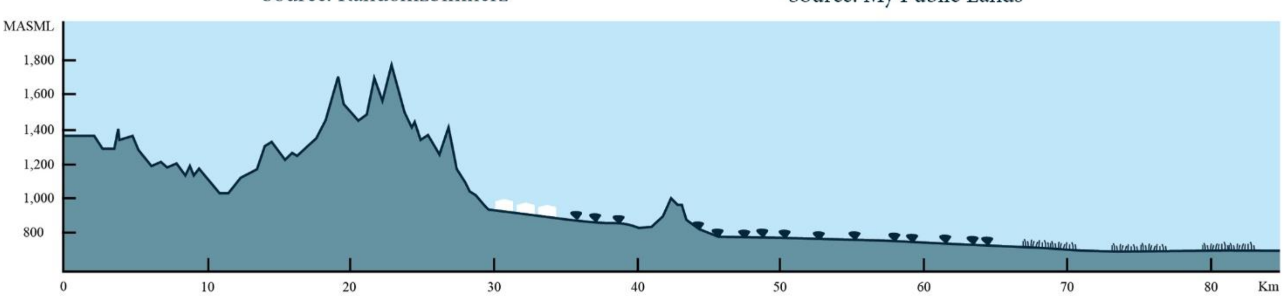
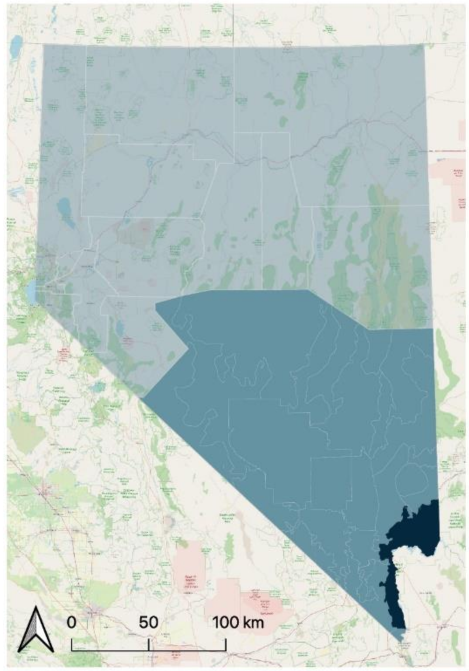


Figure 15. Amargosa Landscape Unit.

SN8. Lake Mead Wildlife

Hoover dam's construction in the 1930's. High water flow and wildlife disturbance along the Colorado lower basin.[9] Lake Mead, the largest U.S. reservoir is under full capacity caused by the U.S. South-West megadrought and intensive water withdrawals.[10]

9. National Park Service (2017). One Fish, Two Fish - Old Fish, New Fish. Boulder City, Nevada.
10. Sarlin, B. et al. (2021). Southwest grapples with impacts from a megadrought that has no end in sight. NBC news. Published in 09//30/21.

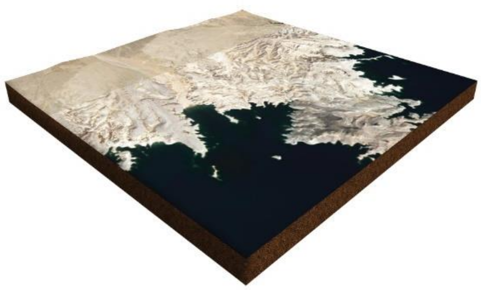


Landscape Type
Semi-natural

Area
4642.64 km²
1,792.53 mi²

Basin
Mojave

Partnerships
Federal govt.,
State govt.,
Clark county,
S.Paiute people,
Mojave people,
Chemehuevi people

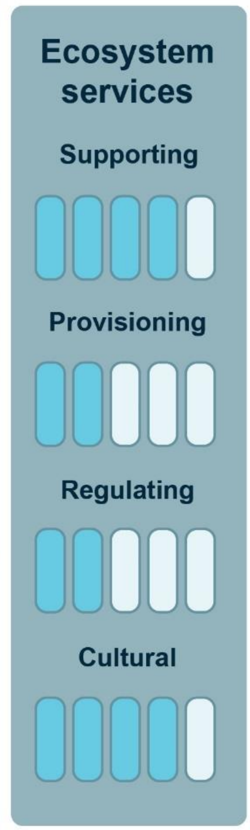


Landscape Composition
Highly disturbed. Surface water surrounded by arid slopes, and creseote bush (*Larrea tridentata*) dominated basins with some Mojave mountain woodland and shrubland (Image: Maps3D.io).

#LakeMead, #Lakemeadnationalpark

Source: Apple.com/maps/

Driving forces of landscape change
- Extraction of nonrenewable resources
- Agricultural expansion and intensification
- Urban and infrastructure development



Source: B_klinger86

Source: Ambicar_roadtrip

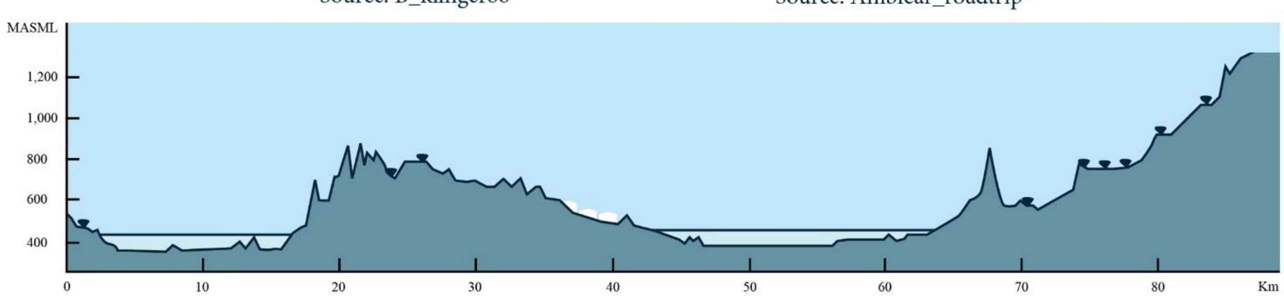
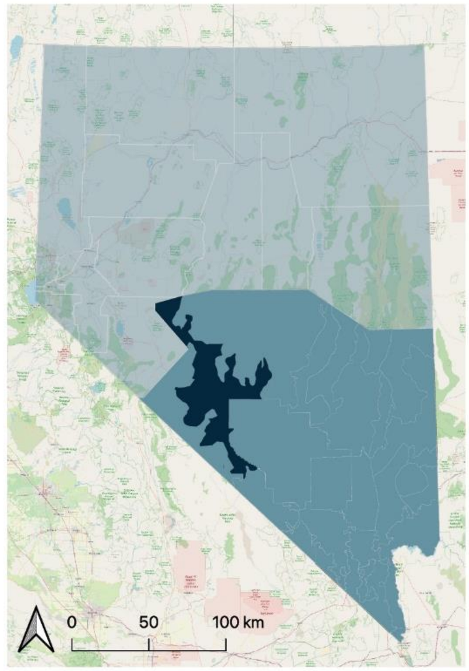


Figure 16. Lake Mead Landscape Character Unit.

SN9.Tonopah Dunes

Flat desert with isolated mountains and small hills. Crescent Dunes Solar Thermal Energy Project with an installed capacity of 110 MW. Low density residential area can be found in Tonopah and Gabbs cities.

Landscape Composition
Tonopah basin with few spare towns, irrigation intensive farmlands and solar farms (Image: Maps3D.io).



Landscape Type
Wild Natural

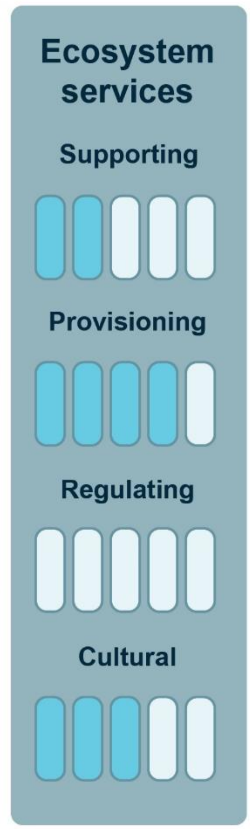
Area
9150.46 km^2
3,533.01 mi^2

Basin
Central Basin and Range

Partnerships
Federal govt., State govt., Lincoln county, Esmeralda county, Western Shoshone people

Source: Apple.com/maps/

Driving forces of landscape change
- Urban and infrastructure development
- Extraction of nonrenewable resources



#Tonopah, #Tonopahnevada

Source: Mmwilsonphoto

Source: Richieblessing

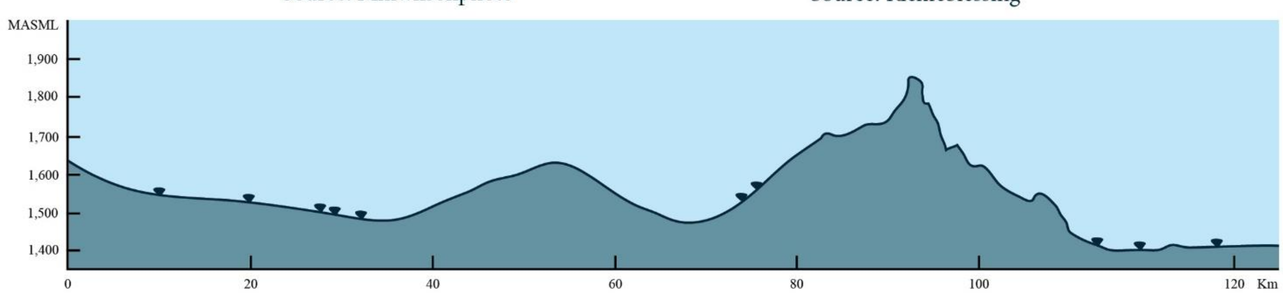
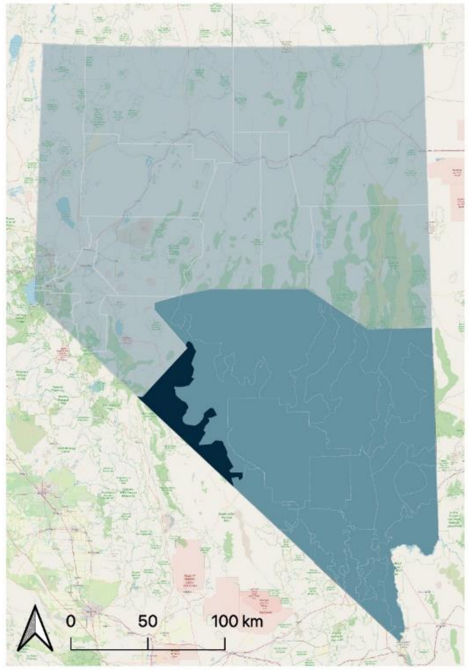


Figure 17. Tonopah Dunes Landscape Character Unit.

SN10. Silver Peak Mountains

Flat desert with isolated mountains and small hills. Crescent Dunes Solar Thermal Energy Project with an installed capacity of 110 MW. Low density residential area can be found in Tonopah and Gabbs cities.



Landscape Type
Wild Natural

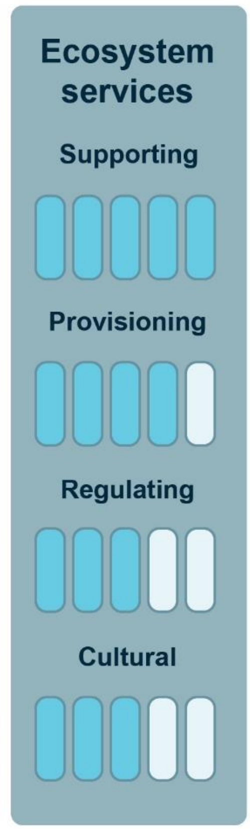
Area
6034.23 km^2
2,329.83 mi^2

Basin
Central Basin and Range

Partnerships
Federal govt., State govt., Lincoln county, Esmeralda county, Western Shoshone, Eastern Monache, and Northern Paiute people

Landscape Composition
Mountain foothills in the Sierra Nevada mountain range with small number of disperse irrigation intensive farmlands in lowlands (Image: Maps3D.io).

Source: Apple.com/maps/



Driving forces of landscape change
- Agricultural expansion and intensification
- Extraction of nonrenewable resources

#Silverpeakmountains

Source: Original_olivia17

Source: Summer.of.frose

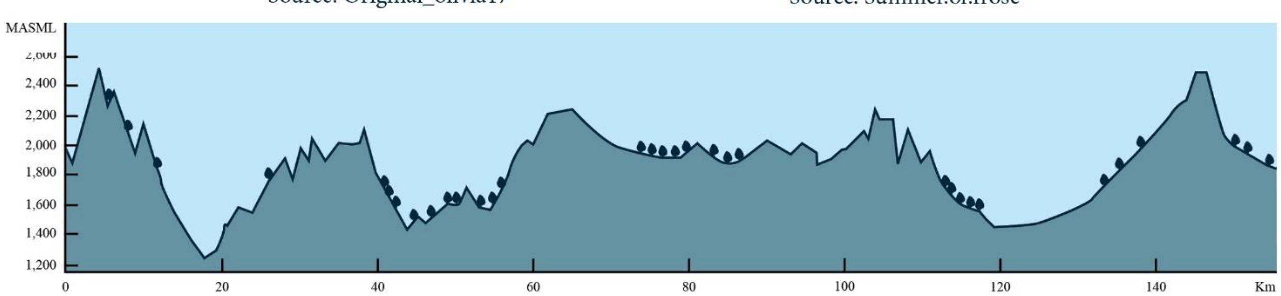
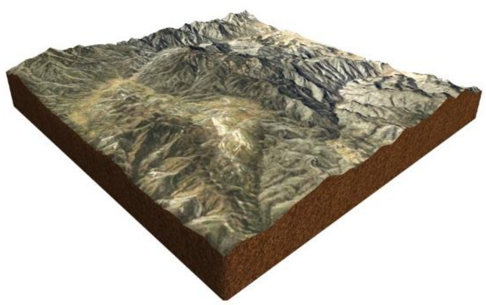


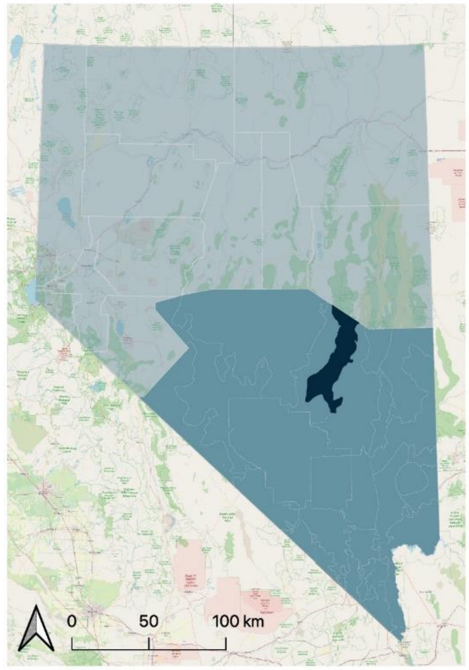
Figure 18. Silver Peak Mountains Landscape Character Unit.

SN11. Grant Range

Highly protected wildlife corridor: Humboldt National Area, Quinn Canyon and Red Mountain Wilderness Areas, Grant Range Wilderness Area, Riordans Weli and Blue Eagle Wilderness Study Areas.



Landscape Composition
Carbonate conifer and pinyon juniper (*Juniperus* spp.) woodland zone with high elevations and sagebrush (*Artemisia tridentata*) valleys (Image: Maps3D.io).



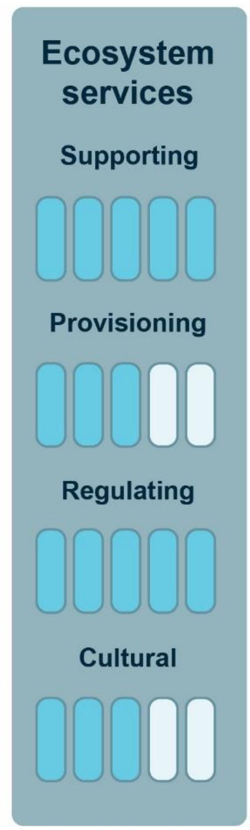
Source: Apple.com/maps/

Landscape Type
Wild Natural

Area
3,462.67 km^2
1,336.94 mi^2

Basin
Central Basin and Range

Partnerships
Federal govt., State govt., Nye cty., Lincoln cty., Western Shoshone people



Driving forces of landscape change
- Nature and heritage conservation activities

#Grantrange #grantrangewilderness

Source: Summer.of.frose

Source: G. Thomas

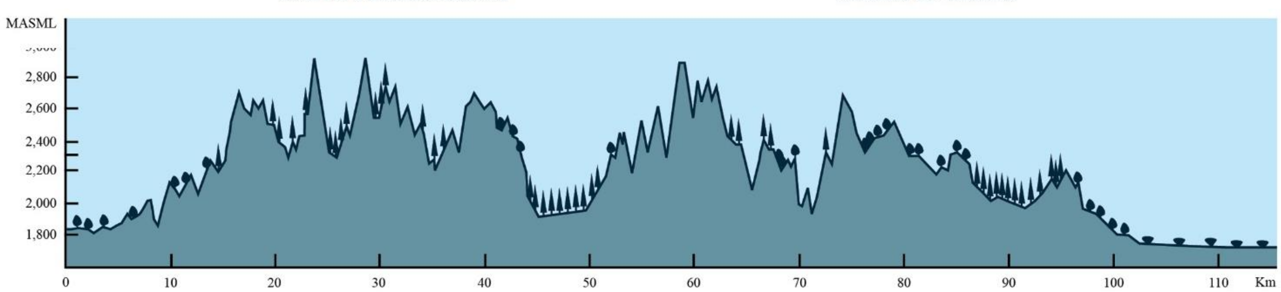
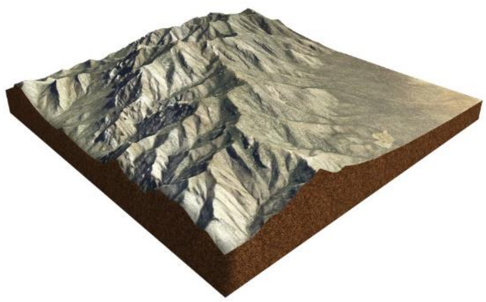


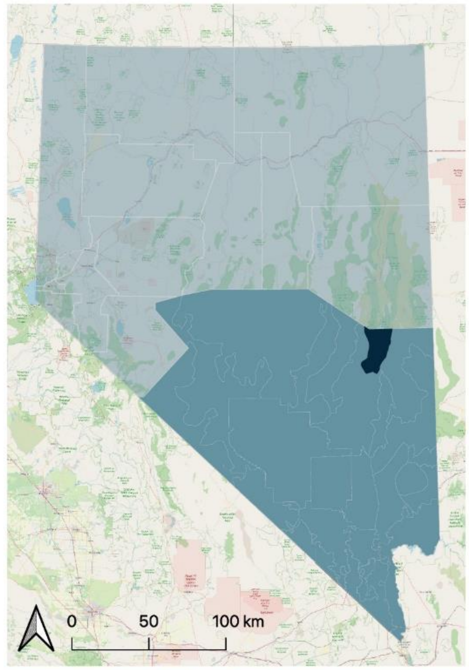
Figure 19. Grant Range Landscape Character Unit.

SN12. Shingle Peak

Protected wildlife corridor: Far South Egans and Mount Grafton Wilderness Areas.



Landscape Composition
Carbonate conifer and pinyon juniper (*Juniperus* spp.) woodland zone with high elevations, sagebrush (*Artemisia tridentata*) valleys, and shadscale (*Atriplex confertifolia*) dominated saline basins (Image: Maps3D.io).

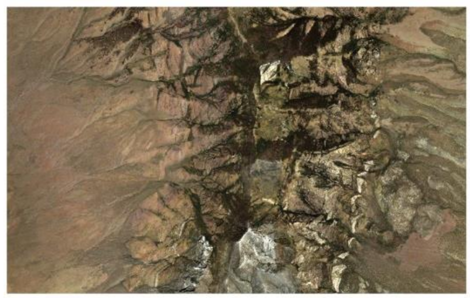


Landscape Type
Wild Natural

Area
1,530.56 km^2
590.95 mi^2

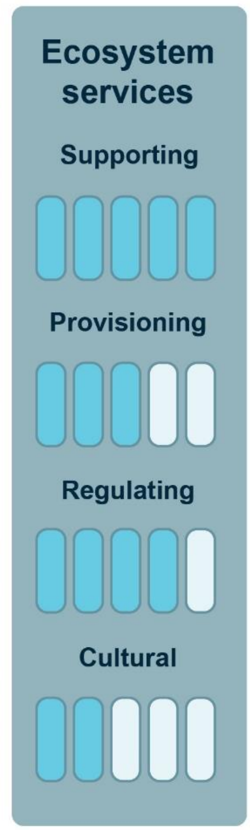
Basin
Central Basin and Range

Partnerships
Federal govt., State govt., Nye cty., Lincoln cty., Western Shoshone people



Source: Apple.com/maps/

Driving forces of landscape change
- Nature and heritage conservation activities



#Shinglepeak #Mountgraftonwilderness

Source: Niallmilne

Source: Stav_is_Lost

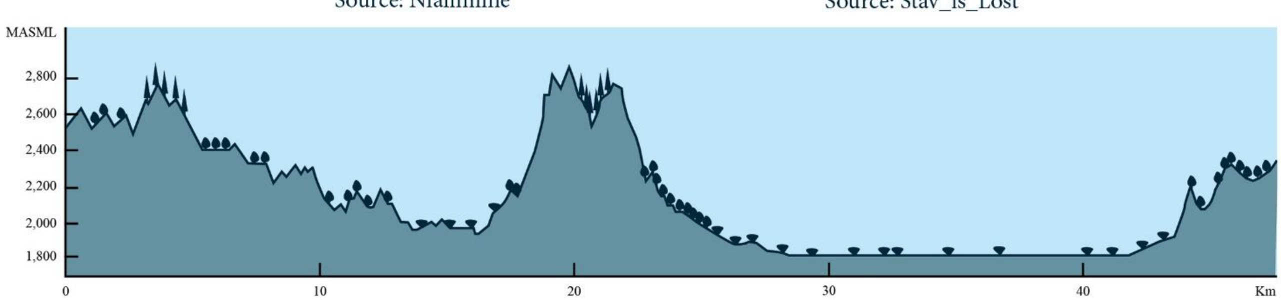


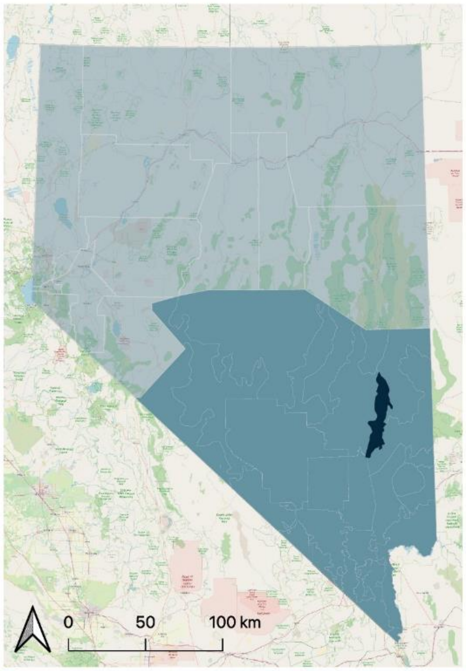
Figure 20. Shingle Peak Landscape Character Unit.

SN13. Delamar Valley

Flat lowlands. Dry Lake valley is heavily influenced by wind and water that constantly shift the valley sands and keeping vegetation from taking root.[11]

11. Prepelka, Benjamin (2019). Dry Lake Valley. Scenic USA.

Landscape Composition
Flatland transition of shadscale (*Atriplex confertifolia*) dominated saline basins, and the Tonopah basin (Image: Maps3D.io).



Landscape Type
Wild Natural

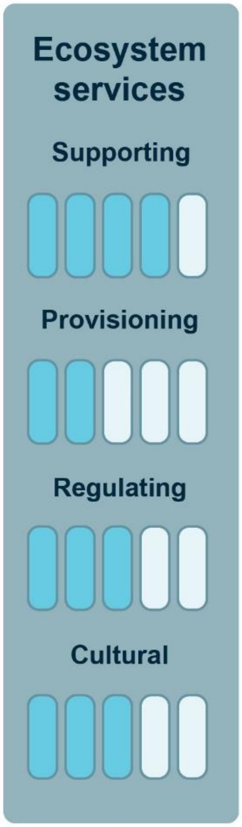
Area
1,577.54 km^2
609.09 mi^2

Basin
Central Basin and Range / Mojave

Partnerships
Federal govt., State govt., Lincoln cty., Western Shoshone people, Southern Paiute people

Source: Apple.com/maps/

Driving forces of landscape change
- Land abandonment



#Delamarnv #Drylake

Source: TheNewAtlantis

Source: Freethedust

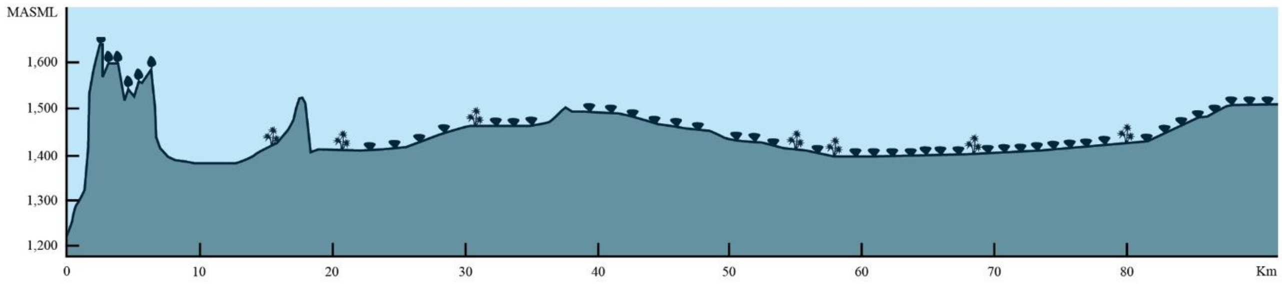
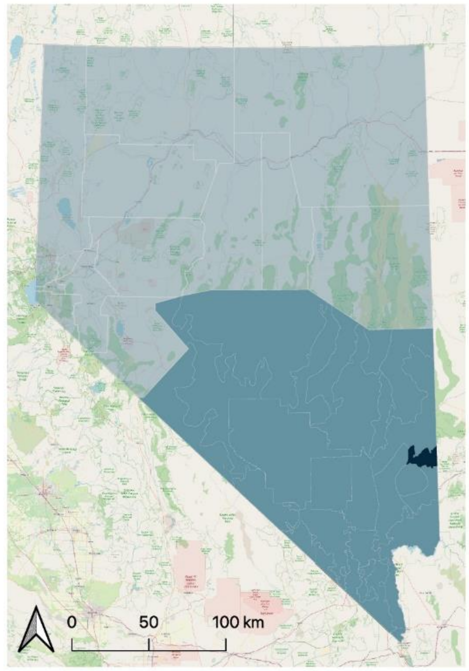


Figure 21. Delamar Valley Landscape Character Unit.

SN14. End of the Line

Isolated rocky hills and flatlands.

Landscape Composition
Creosote bush (*Larrea tridentata*) dominated, and basins arid footslopes enclosed by the Mormon peak, Snake range, and Virgin river (Image: Maps3D.io).



Source: Apple.com/maps/

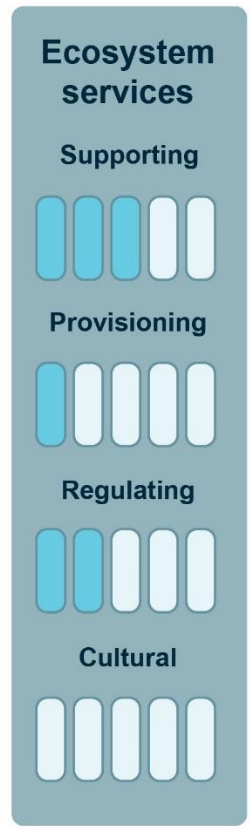
Driving forces of landscape change
- Nature and heritage conservation activities

Landscape Type
Wild Natural

Area
724.55 km^2
279.75 mi^2

Basin
Mojave

Partnerships
Federal govt., State govt., Lincoln cty., Western Shoshone people, Southern Paiute people



#Unknown

Source: Gmaps

Source: Gmaps

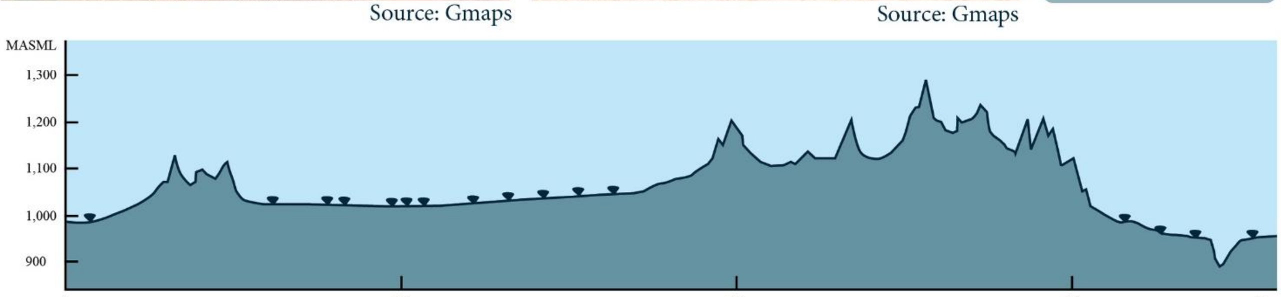
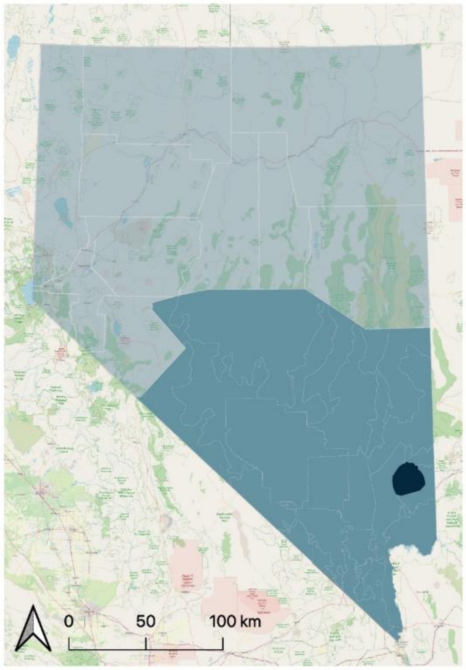


Figure 22. End of the Line Landscape Character Unit.

SN15. Mormon Mountains

Archeological sites of 10,000 years-old human settlements.[12]

12. Friends of Nevada Wilderness (2022). Mormon Mountains Wilderness, Nevada.



Landscape Type
Wild Natural

Area
1,338.6 km²
516.84 mi²

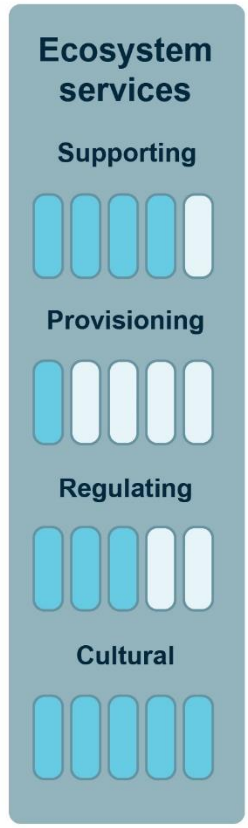
Basin
Mojave

Partnerships
Federal govt., State govt., Lincoln cty., Clark cty., Southern Paiute people

Landscape Composition
Mojave mountain conifer and pinyon juniper (*Juniperus* spp.) woodland and shrubland, and arid slopes (Image: Maps3D.io).

Source: Apple.com/maps/

Driving forces of landscape change
- Nature and heritage conservation
- Extraction of nonrenewable resources



#Mormonmountains

Source: Firstchurchofthemasochist

Source: Marjiebc

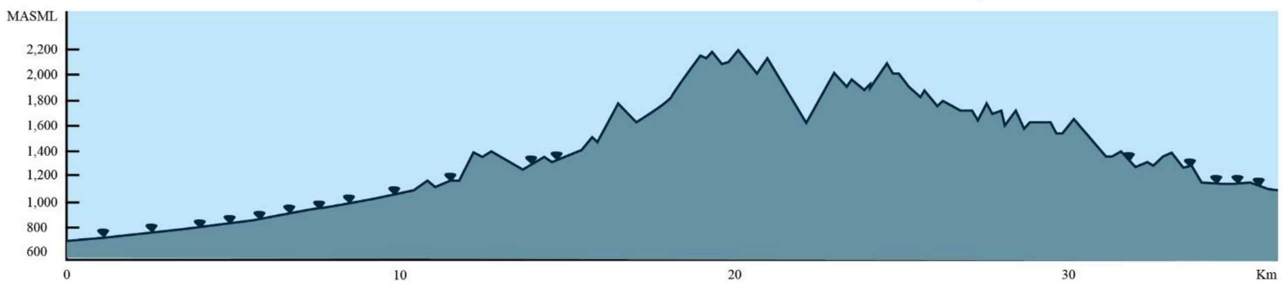
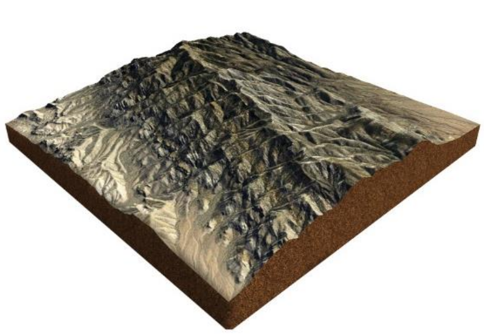


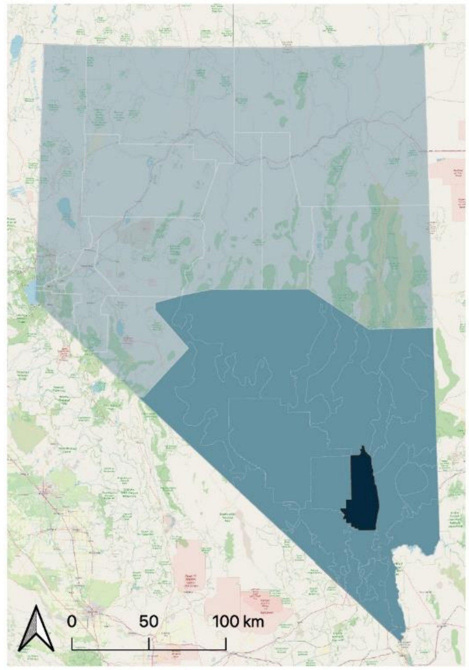
Figure 23. Mormon Mountains Character Unit.

SN16. Sheep Range

Dense forested mountainous area.



Landscape Composition
Mojave high elevation mountains with conifer and pinyon juniper (*Juniperus* spp.) woodland and shrubland, and arid slopes.
(Image: Maps3D.io).



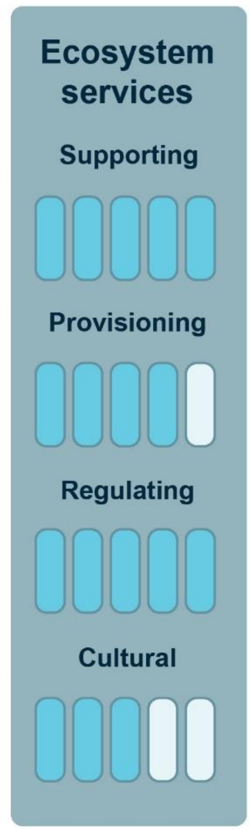
Source: Apple.com/maps/

Landscape Type
Wild Natural

Area
3,161.69 km^2
1,220.73 mi^2

Basin
Mojave

Partnerships
Federal govt., State govt., Lincoln cty., Clark cty., Western Shoshone people, Southern Paiute people



Driving forces of landscape change
- Nature and heritage conservation activities

#Sheeprange #sheeprangemountains

Source: Colinjones26

Source: Nevada_outside

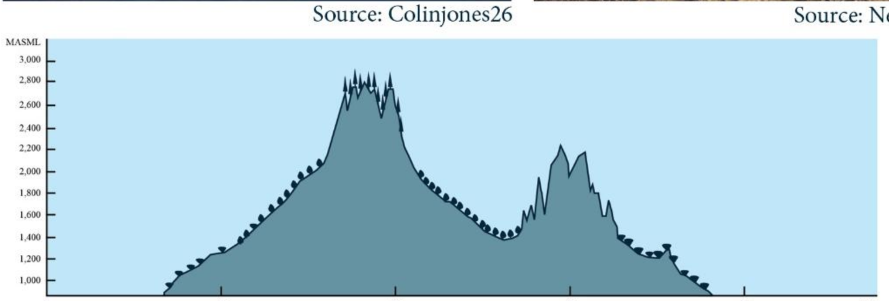
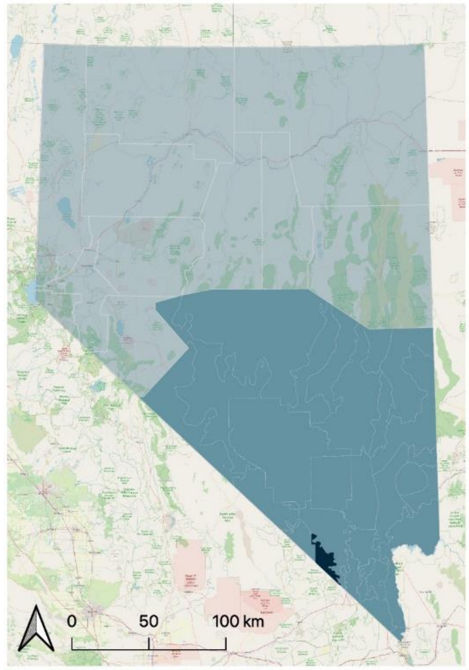


Figure 24. Sheep Range Landscape Character Unit.

SN17. Tecopa

Mostly flatlands.

Landscape Composition
Amargosa desert floodplains with an extremely low density urban area.
(Image: Maps3D.io).



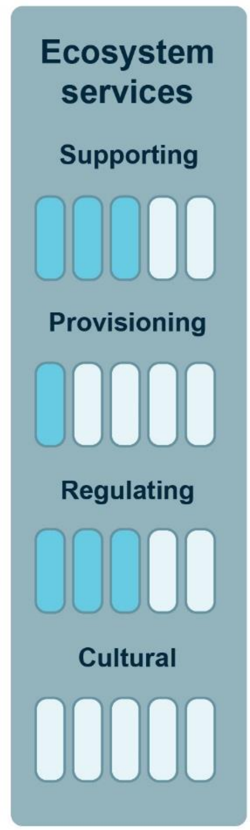
Source: Apple.com/maps/

Landscape Type
Wild Natural

Area
749.62 km^2
289.43 mi^2

Basin
Mojave

Partnerships
Federal govt., State govt.,Clark county, Western Shoshone people, Southern Paiute people, Chemehuevi people



Driving forces of landscape change
- Urban and infrastructure development

#Tecopa

Source: Gmaps

Source: Gmaps

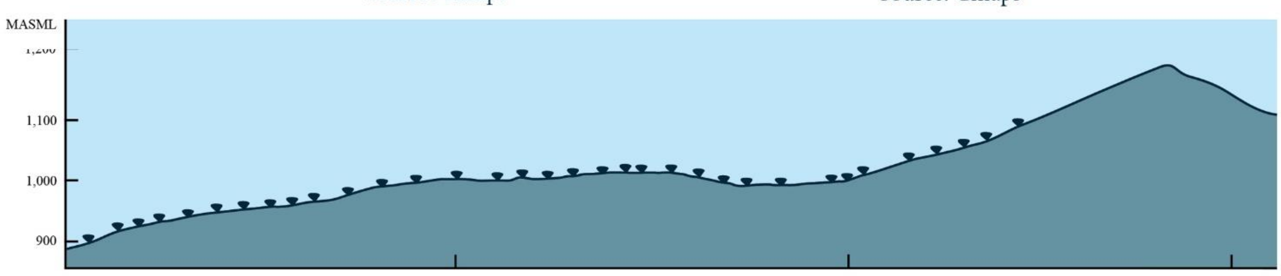
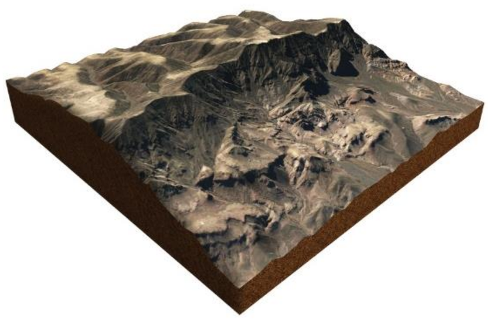


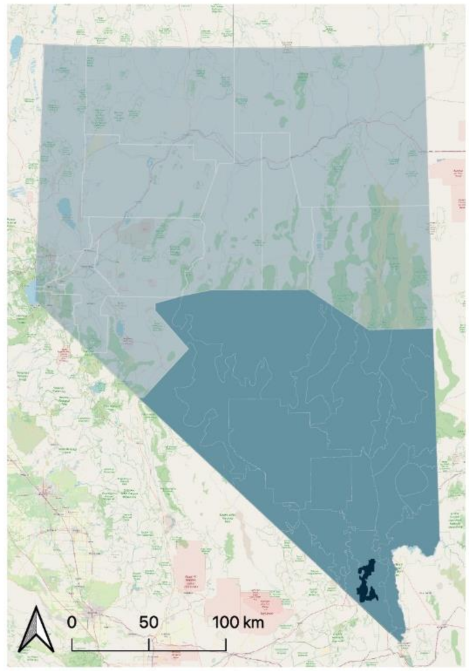
Figure 25. Tecopa Landscape Character Unit.

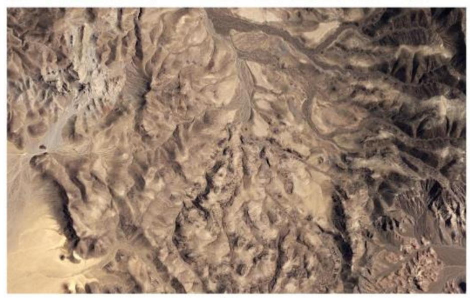
SN18. Sloan

Protected wildlife corridor: Sloan Canyon National Conservation Area, North and South McCullough Wilderness.



Landscape Composition
Mojave mountain conifer and pinyon juniper (*Juniperus* spp.) woodland and shrubland, and arid slopes (Image: Maps3D.io).





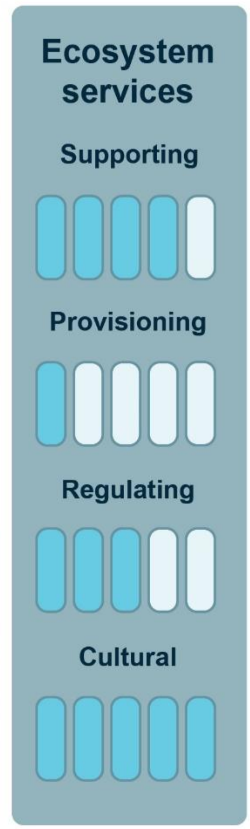
Source: Apple.com/maps/

Landscape Type
Wild Natural

Area
693.77 km^2
267.87 mi^2

Basin
Mojave

Partnerships
Federal govt.
State govt.
Clark county,
Western Shoshone people, Southern Paiute people, Chemehuevi people



Driving forces of landscape change
- Urban and infrastructure development
- Nature and heritage conservation

#Sloancanyon

Source: Bobby_fett

Source: Apchekid

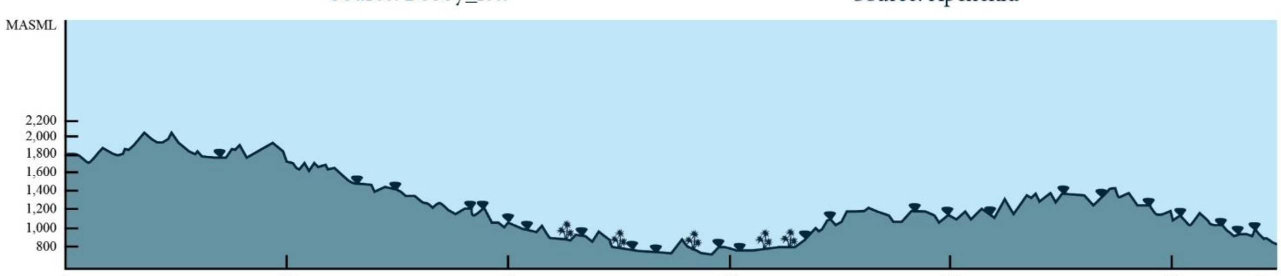
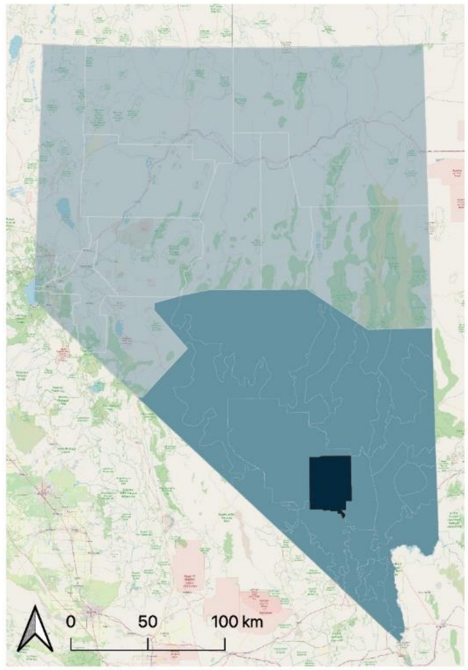


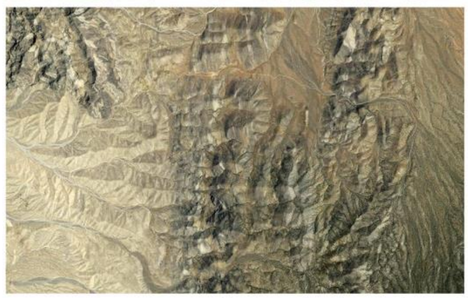
Figure 26. Sloan Landscape Character Unit.

SN19. Desert National Wild Refuge

Protected area with basin and low mountains ranges.

Landscape Composition
Cresote bush (*Larrea tridentata*) dominated basin, arid slopes, and Mojave playas. (Image: Maps3D.io).





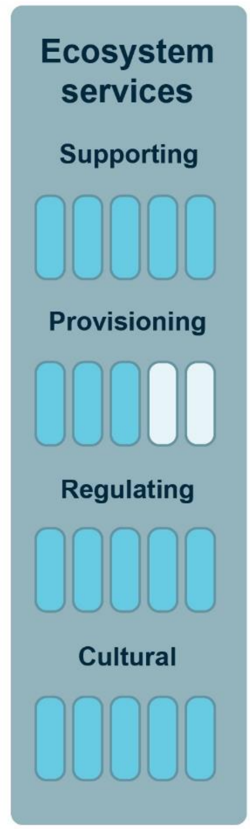
Source: Apple.com/maps/

Landscape Type
Wild Natural

Area
3,568.54 km^2
1,377.82 mi^2

Basin
Mojave

Partnerships
Federal govt.
State govt.
Clark county,
Lincoln county,
Western Shoshone people, Southern Paiute people



Driving forces of landscape change
- Nature and heritage conservation

#Desertnationalwildliferefuge
#Desertnational park

Source: Friendsofnvwild

Source: Charleshocevar

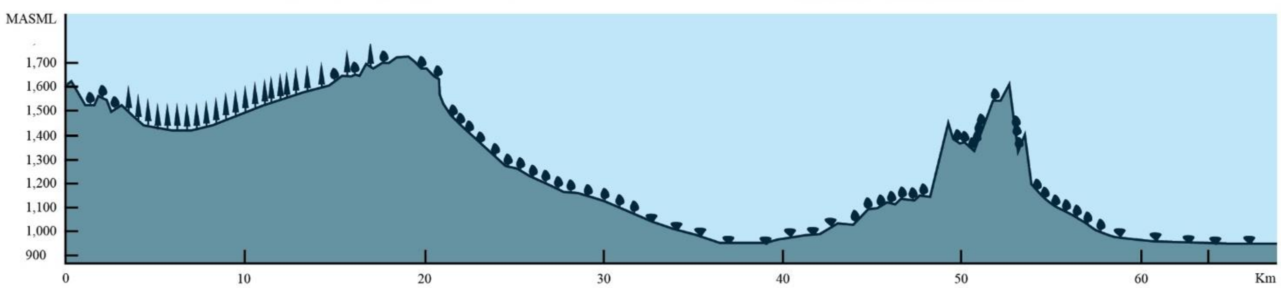
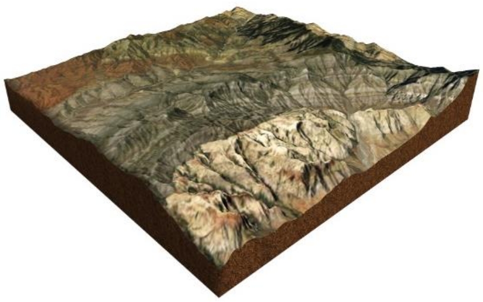


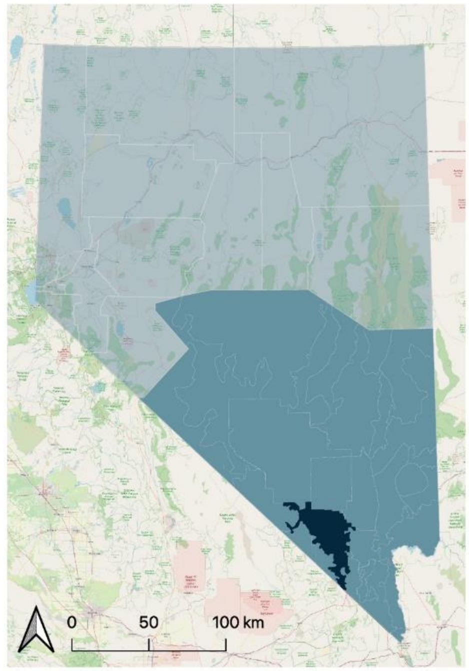
Figure 27. Desert National Wild Refuge Landscape Character Unit.

SN20. Spring Mountains

Protected wildlife corridor: Mount Charleston, La Madre Mountain Wilderness Area, Spring Mountains National Park Area, Toiyabe National Forest, Red Rock Canyon National Conservation Area.



Landscape Composition
Mojave high elevation mountains with conifer and pinyon juniper (*Juniperus* spp.) woodland and shrubland, and arid slopes (Image: Maps3D.io).



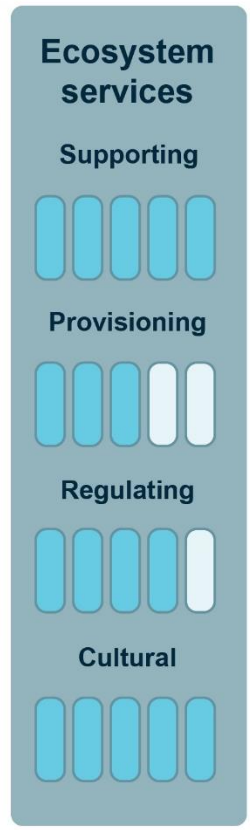
Source: Apple.com/maps/

Landscape Type
Wild Natural

Area
3,689 km^2
1,104.24 mi^2

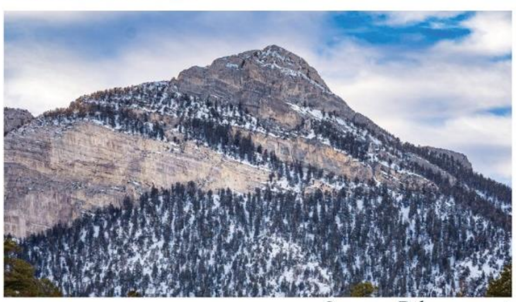
Basin
Mojave

Partnerships
Federal govt.
State govt.
Clark cty., Nye cty., Western Shoshone people, Southern Paiute people, Chemehuevi people



#Springmountains
#Springmountain
#Mountcharleston
#Redrockcanyon

Driving forces of landscape change
- Extraction of nonrenewable resources
- Urban and infrastructure development
- Nature and heritage conservation



Source: Rileycoop_t

Source: Medicjoe265

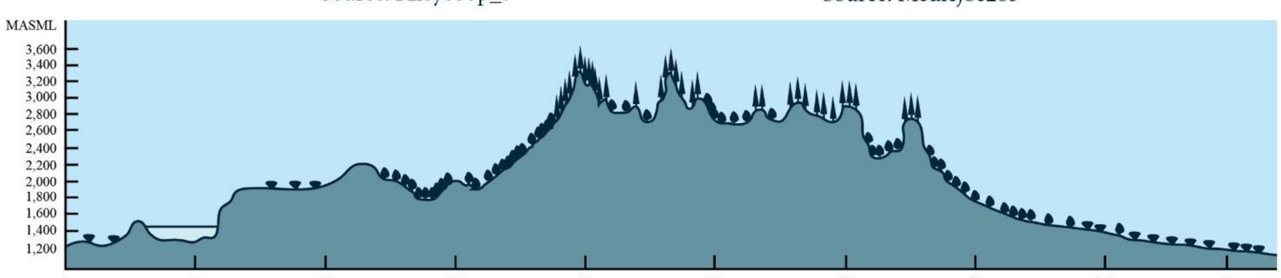
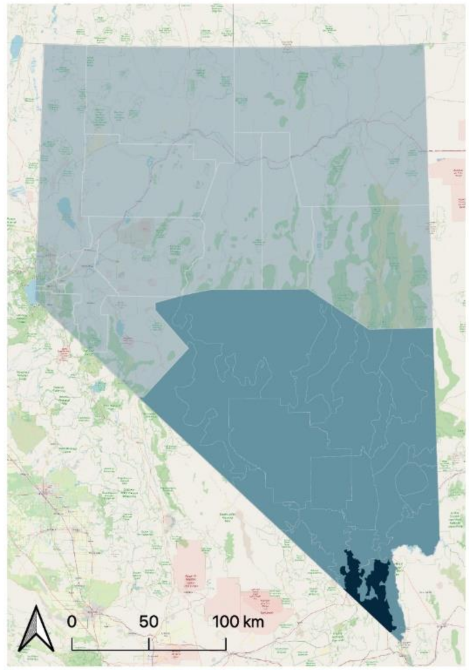


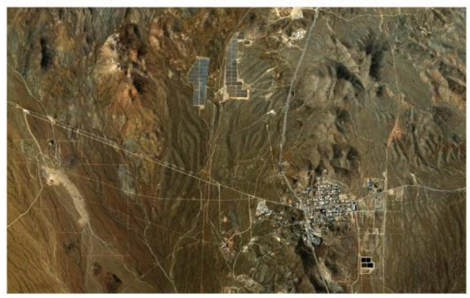
Figure 28. Spring Mountains Landscape Character Unit.

SN21. Desert Tortoise

Strong presence of Joshua trees. Main desert toroise's habitat in Nevada.

Landscape Composition
Intermediate disturbance in a cresote bush (*Larrea tridentata*) dominated basin with some gentle arid slopes with a few low-density urban areas and solar farms (Image: Maps3D.io).





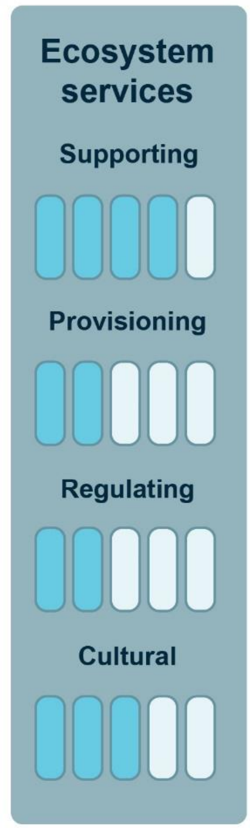
Source: Apple.com/maps/

Landscape Type
Wild Natural

Area
2,903.20 km^2
1,120.93 mi^2

Basin
Mojave

Partnerships
Federal govt.
State govt.
Clark county,
Southern Paiute people, Mojave people, Chemehuevi people



#Joshuatreeforest
#Searchlight
#Calnevari

Driving forces of landscape change
- Urban and infrastructure development

Source: Adayinrvlife

Source: Harriontheroad

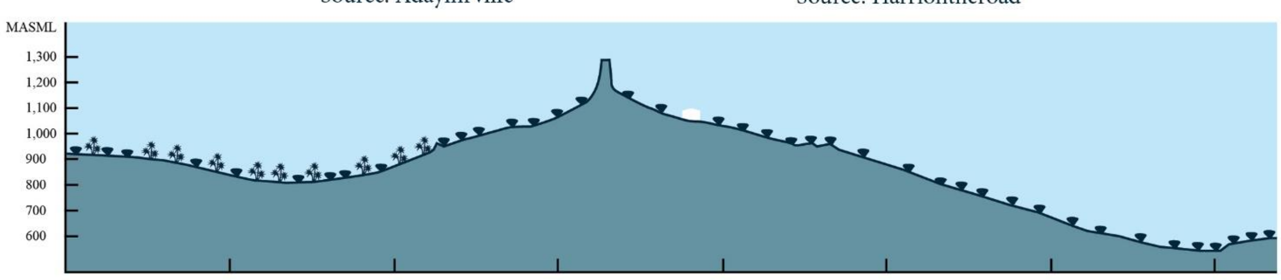
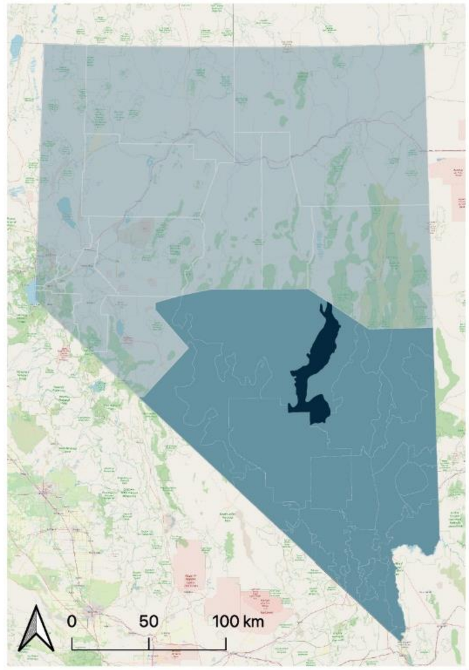


Figure 29. Desert Tortoise Landscape Character Unit.

SN22. Railroad Valley

Dry lake bed and flatlands.



Landscape Type
Wild Natural

Area
3,750.49 km^2
1,448.07 mi^2

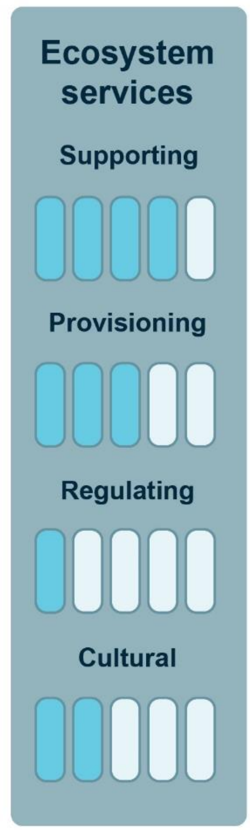
Basin
Central Basin and Range

Partnerships
Federal govt.
State govt.
Nye county, Lincoln county, Western Shoshone people

Landscape Composition
Tonopah basin with playas and a small number of few irrigation intensive farmlands (Image: Maps3D.io).

Source: Apple.com/maps/

Driving forces of landscape change
- Agricultural expansion and intensification



#Railroadwilderness

Source: G. Thomas

Source: GoodeidWorkingGroup

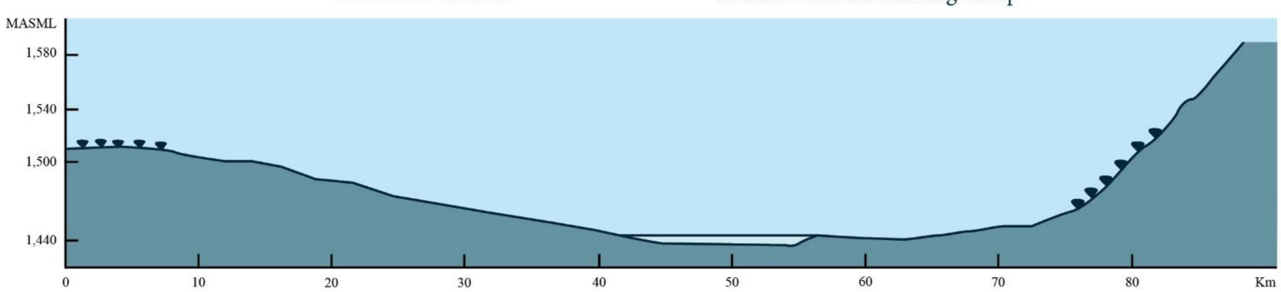
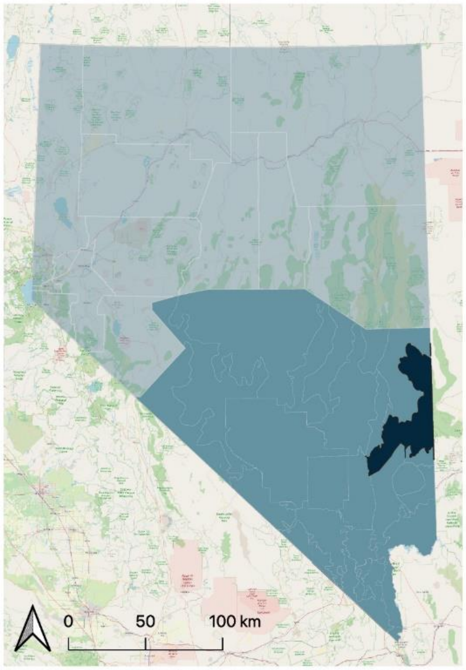


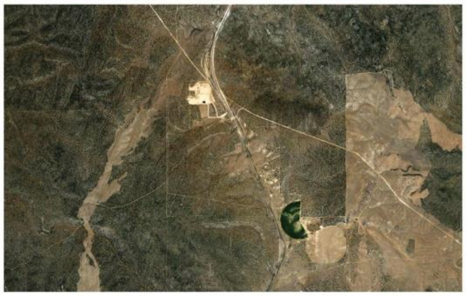
Figure 30. Railroad Valley Landscape Character Unit.

SN23. Snake Range

Protected wildlife corridor: Parsnip Peak, White Rock Range, Clover Mountains, and Delamar Mountains Wilderness Areas.

Landscape Composition
Woodland- and shrub-covered low mountains with sagebrush basins and slopes (Image: Maps3D.io).





Source: Apple.com/maps/

Landscape Type
Wild Natural

Area
5,451.69 km^2
2,104.91 mi^2

Basin
Central Basin and Range

Partnerships
Federal govt.
State govt.
Lincoln county,
Southern Paiute people

Ecosystem services

Supporting

Provisioning

Regulating

Cultural

#Snakerange
#Clovermountains
#Delamarmountains

Driving forces of landscape change
- Nature and heritage conservation
- Extraction of nonrenewable resources

Source: Bigwoodsoutwest

Source: Desertmoon2020

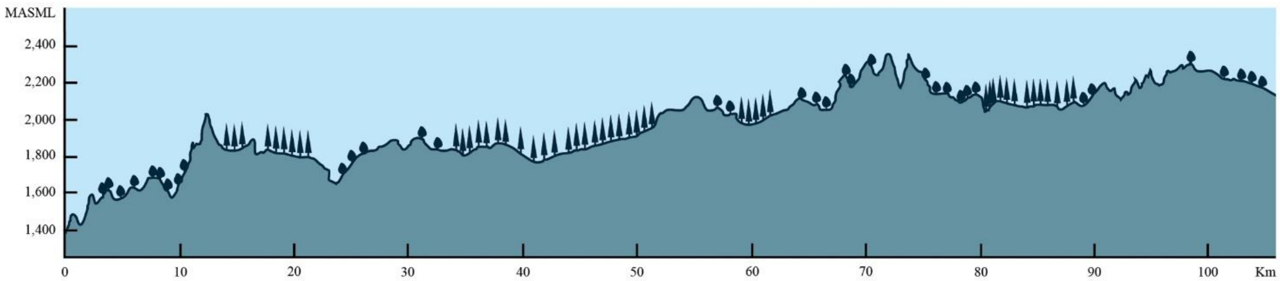


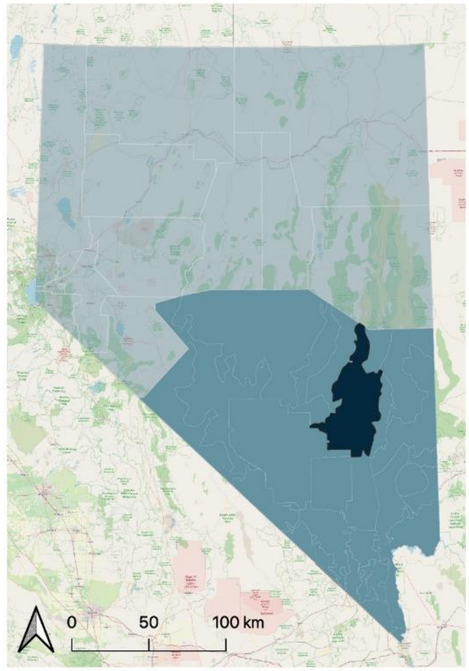
Figure 31. Snake Range Landscape Character Unit.

SN24. Basin and Range

Protected wildlife corridor: Basin and Range National Monument, Weepah Spring, Mount Irish Range, Big Rocks and South Pahroc Range Wilderness Areas.

Landscape Composition
Transition of carbonate sagebrush valleys, salt desert, isolated woodland zones, and Tonopah basin with some toplands (Image: Maps3D.io).

#Basinandrange
#weepahspringwilderness
#Mountirish



Source: Apple.com/maps/

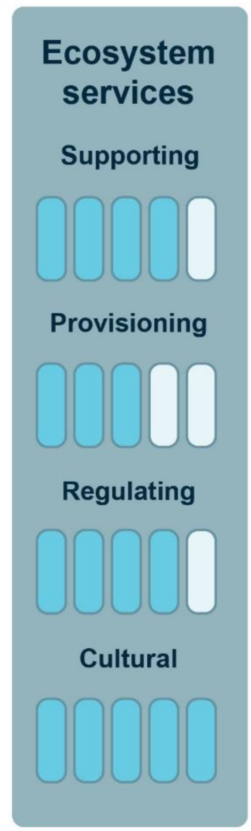
Driving forces of landscape change
- Nature and heritage conservation
- Extraction of nonrenewable resources

Landscape Type
Wild Natural

Area
7,145.42 km^2
2,758.86 mi^2

Basin
Central Basin and Range / Mojave

Partnerships
Federal govt., State govt., Lincoln cty., Nye cty., Western Shoshone, Southern Paiute people



Source: Travel Nevada

Source: Travel Nevada

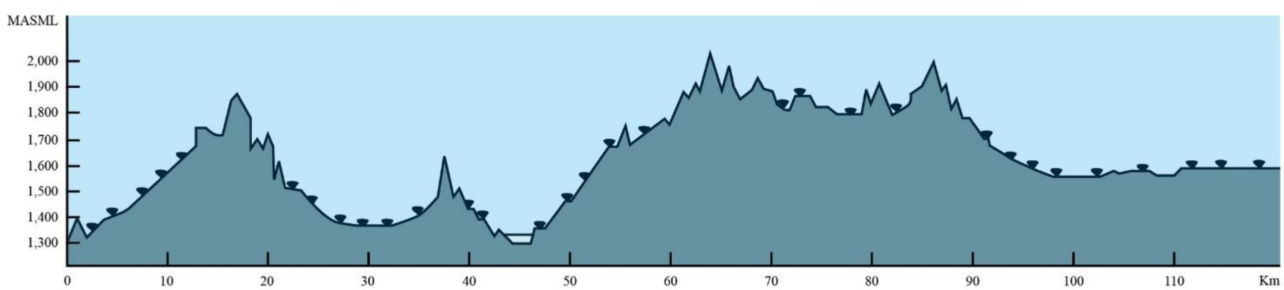


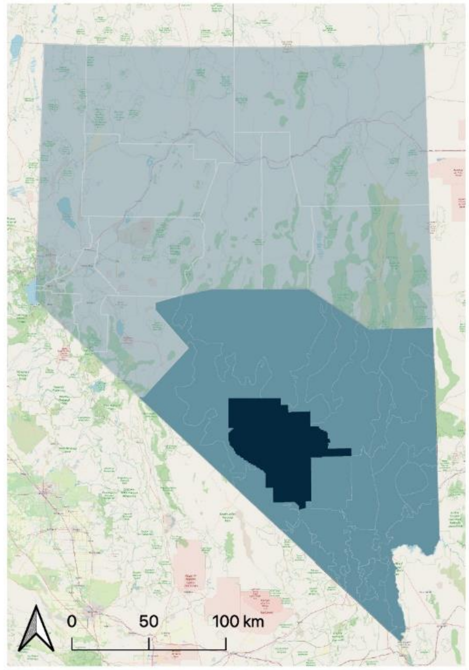
Figure 32. Basin and Range Landscape Character Unit.

SN25. Defense

Defined by National Securite Site land use. Area 51, Homey Airport, nuclear weapons testing, bombing testing, Fortune Training Area.

Landscape Composition

Administrative land-use unit. Central Nevada high valleys with mid-slope woodland and brushland in a transition with Tonopah basin. sagebush foothills, and uplands. Intermediate disturbance by bombing and landfills (Image: Maps3D.io).

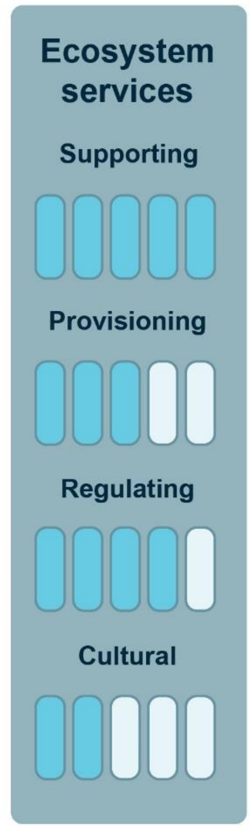


Landscape Type
Wild Natural

Area
12,085.5 km^2
4,666.24 mi^2

Basin
Central Basin and Range / Mojave

Partnerships
Federal govt., State govt., Lincoln cty., Nye cty., Western Shoshone, Southern Paiute people



Source: Apple.com/maps/

Driving forces of landscape change
- Urban and infrastructure development
- Extraction of nonrenewable resources

#Area51

Source: The New Atlantis

Source: Emmet Gowin

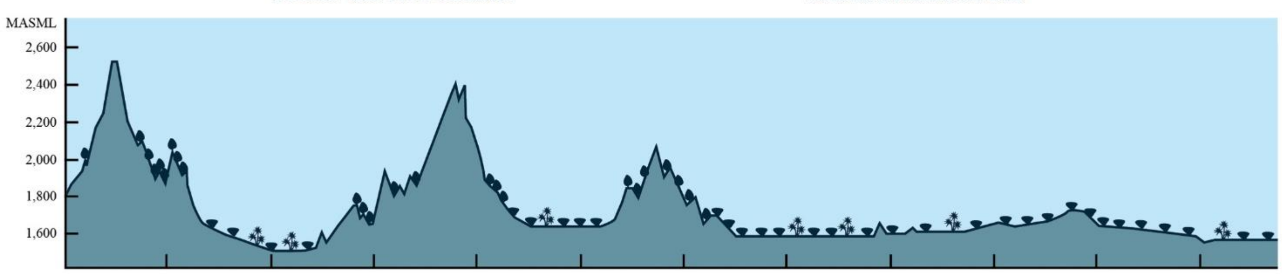
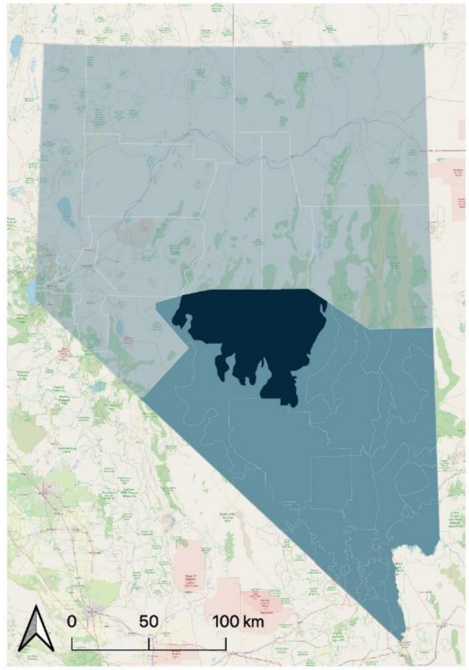


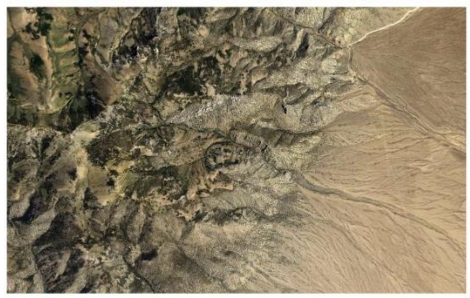
Figure 33. Defense Landscape Character Unit.

SN26. Toiyabe Range

Highly protected wildlife corridor: Toiyabe National forest and baisins.

Landscape Composition
Central Nevada Bald mountains with mid-slope woodland and brushland in transition with Central Nevada high valleys (Image: Maps3D.io).





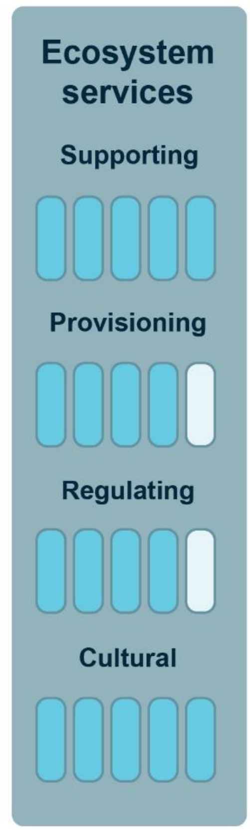
Source: Apple.com/maps/

Landscape Type
Wild Natural

Area
18,213.54 km^2
7,032.28 mi^2

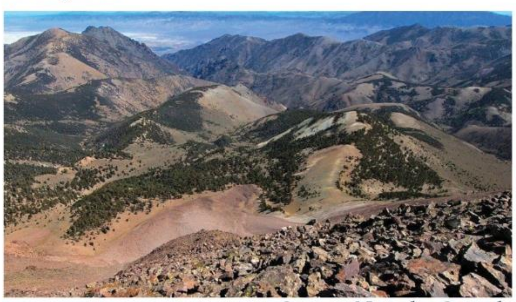
Basin
Central Basin and Range

Partnerships
Federal govt., State govt., Nye cty., Western Shoshone,



Driving forces of landscape change
- Nature and heritage conservation
- Extraction of nonrenewable resources

#Toiyabenationalforest
#Toiyabe



Source: Nevada_Outside

Source: Xnevadanx

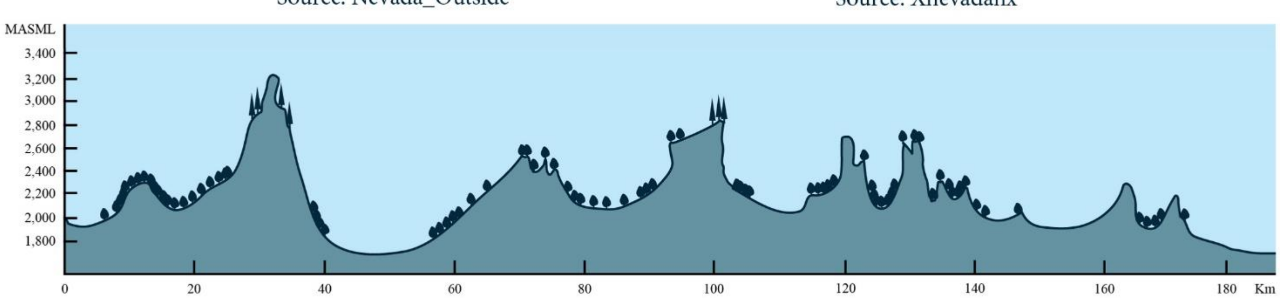


Figure 34. Toiyabe Range Landscape Character Unit.

WEF nexus interconnections are expressed in the landscape. Concerning water and energy demand, the study identifies the landscape units with driving forces such as urban and infrastructure development, agricultural expansion, and intensification. The map (Figure 35) shows the region's high freshwater and energy demand landscape units. Meanwhile, the second map (Figure 36) shows landscape units with farms and other forms of food production. Lastly, the third map (Figure 37) indicates the landscape units with higher to lower WEF nexus concentrations. These operational landscapes contrast with the more natural landscapes; nonetheless, ecosystem services are equally important.

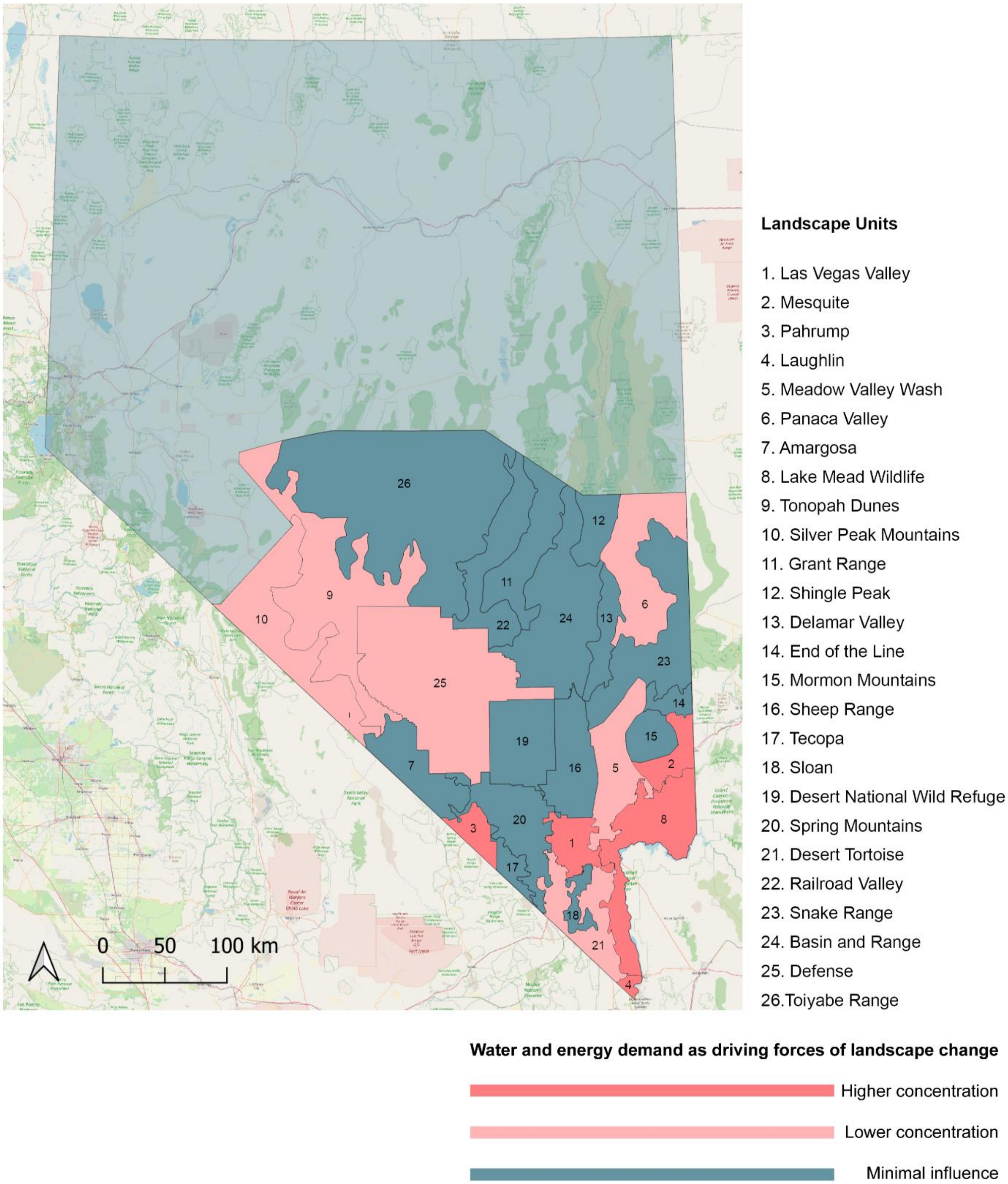


Figure 35. Regional water and energy demand as driving forces of landscape change.

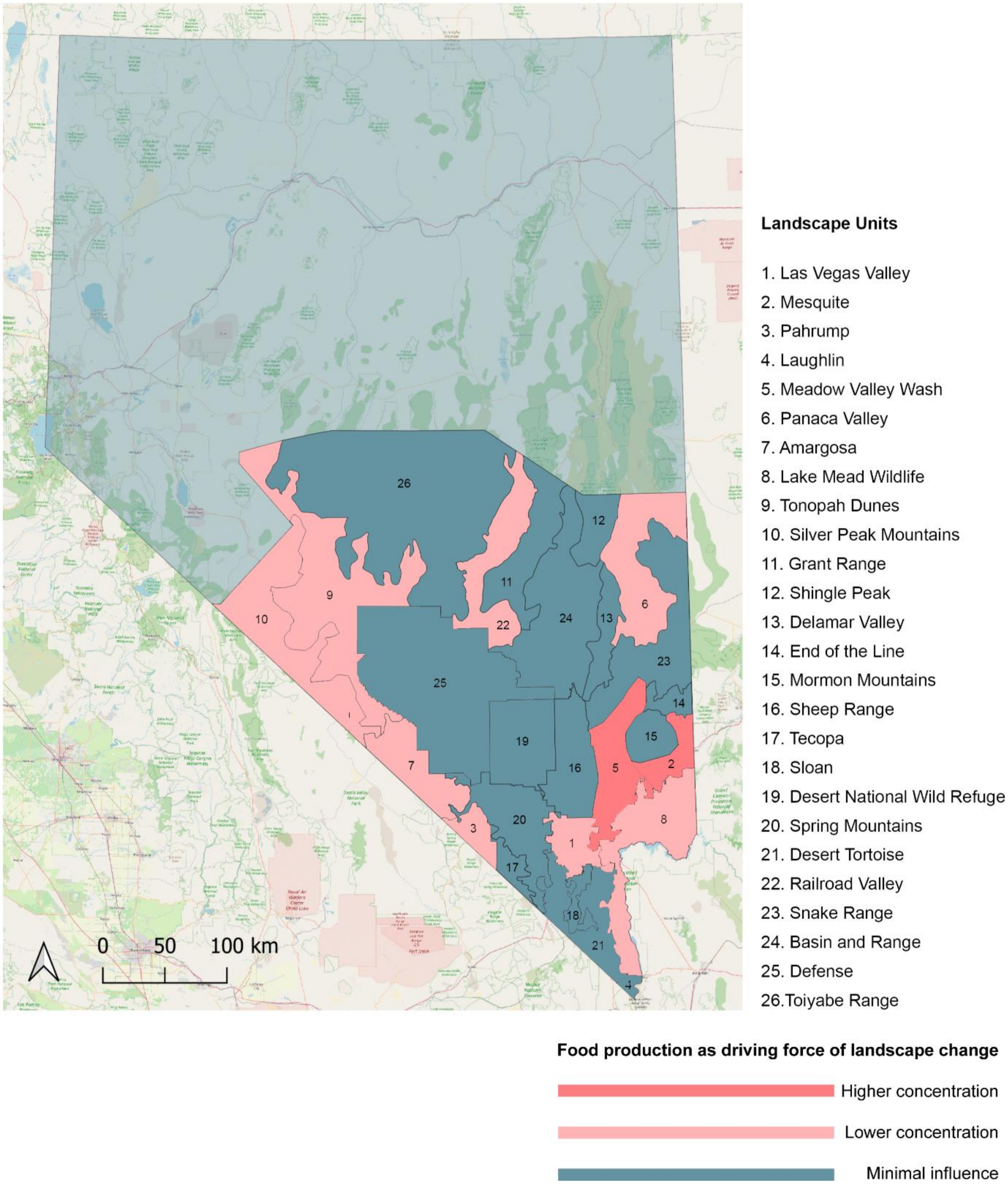


Figure 36. Southern Nevada's food production as driving force of landscape change.

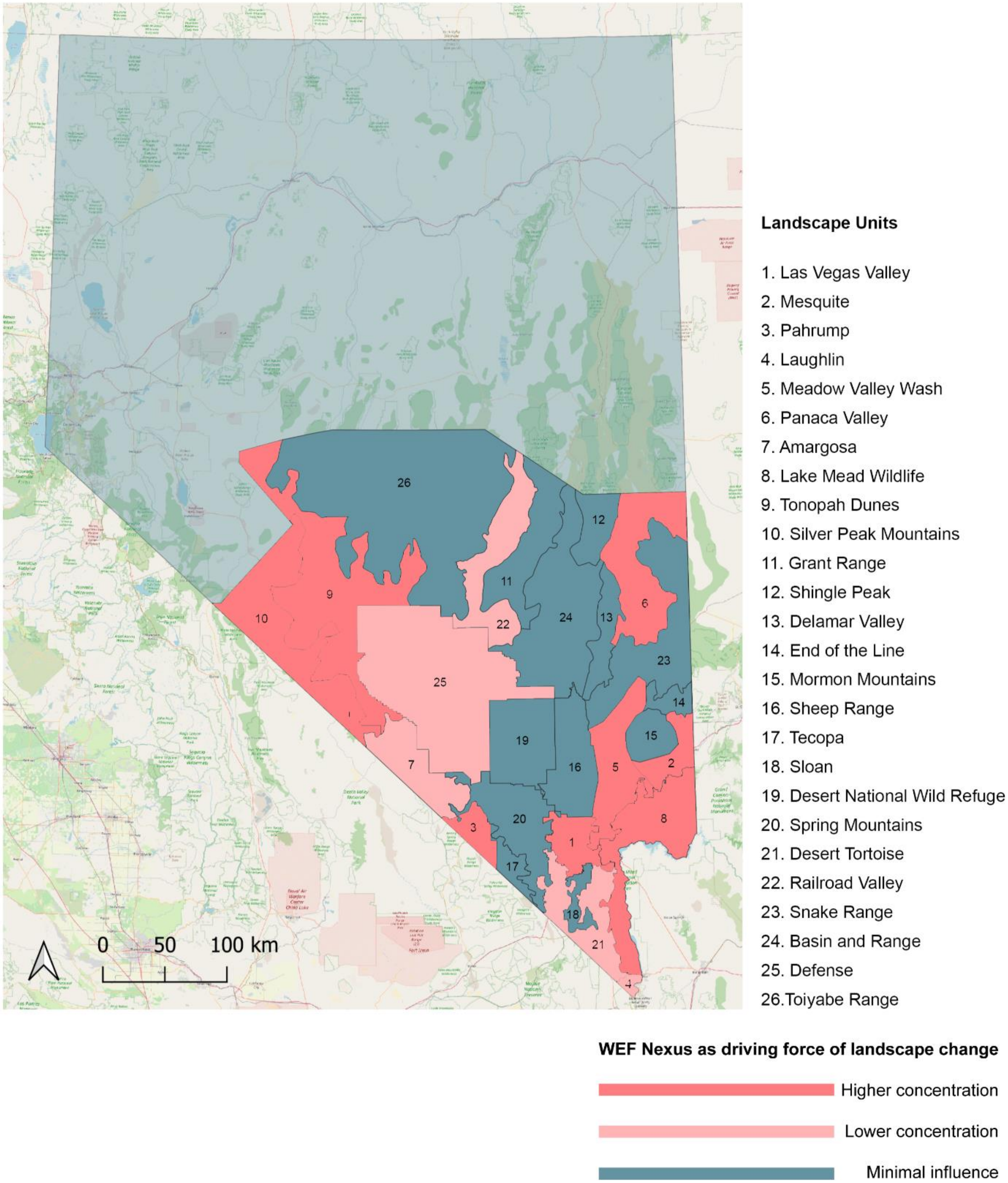


Figure 37. Southern Nevada's WEF Nexus as driving force of landscape change.

4.9. Conclusions

A place-based approach to WEF Nexus as Landscape Characterization Assessment can contribute to refining the strategies by understanding the existing pressures in a particular region. This urban region scale identifies a local lexicon that could encourage stakeholders from different disciplines to contribute and collaborate to calibrating the framework, adding, and editing information that could help strategic projects' implementation and operations. A second benefit is that a landscape approach includes everything and everyone. Compared to other methods, the landscape approach aims to collect more voices and information instead of looking at a simplification of variables by adding more knowledge and data. Participation in this approach can be conducted in stages and is unnecessary to compel people to understand technical concepts.

The Landscape Characterization Assessment's main contribution is adding spatial specificity to the WEF nexus dilemma. The method that can be replicated exposes regional WEF nexus driving forces and trade-offs. Nonetheless, a deeper analysis is required to describe the processes in detail. WEF nexus operational landscape units can be an excellent beginning to implement solutions. However, the assessment shows that essential ecosystem services are represented in operational as preserved landscapes.

Contrary to the expected results, Southern Nevada WEF challenges are distributed in four areas: Laughlin-Las Vegas Valley-Mesquite corridor, Pahrump, Panaca Valley, and Silver Mountains-Tonopah Dunes. By fragmenting the WEF nexus challenge, more possibilities to bring real solutions rather than an abstract "monolithic" quest. The same happens to Southern Nevada; The urban region does not have to be considered a "white canvas" anymore, where nuclear disposal, uncompromising solar farms, and urban development appear under unilateral decisions.

Several gaps in the framework follow from the study and would benefit from further research:

1. The study requires a field survey to optimize landscape unit demarcation and to increase visual records. Unfortunately, time and funding restrictions prevented it.

2. Native people's cosmovision: the characterization compels more knowledge about the sacred lands and cultural appreciation.

3. Habitat specificities: some endangered species are in specific places. The framework must highlight those caves, wetlands, dunes, corridors, and specific communities.

4. Ecological carrying capacity: outlining a maximum ecosystem disturbance contributes to better defining the available areas to expand or reduce WEF projects' footprint.

Chapter 5. Nexuscapes dynamics: WEF nexus under a circular economy and a landscape approach

5.1. Summary of chapter 5

Nexuscapes is a WEF Nexus systematic approach that aims for sustainable management across sectors and at multiple scales that combines a place-specific approach informed with indicators such as the SDG's goals, circular economy, GHG emissions, and other environmental parameters can better understand the landscape condition and prioritize and delegate activities. A Food-Energy-Water Nexus works as a transdisciplinary method that is strategic and specific by design. Spatial and sustainability boundaries are well-defined, allowing a better understanding of the context. This integrative model is regenerative because it responds to a healthier relationship with the place. Backcasting is a scenario model involving one desired scenario, which entails visioning and analyzing the process of working backward the Nexuscapes dynamic model to achieve an enhanced future. The rationale for using backcasting in a WEF dynamic system model is to exhibit the urgency and lack of time that decision-makers must exhibit. An integrative method such as the landscape approach does not leave variables out of the equation, reducing pressures caused by silo-thinking, uncertainty, and lack of transparency. The urban region scope and combination of Doughnut Economics and Landscape Characterization give a sufficient description of the WEF strategies that can be beneficial and effective for a whole urban region, in this case, Southern Nevada. This balance reveals social and environmental interlinkages that are critical but underestimated in specialized sectors and other WEF approaches.

5.2. Introduction

Resource management, natural capital preservation, climate crisis, and population dynamics demand cross-sectorial coherence and integration in social-ecological policies and resource management processes (Lehmann, 2019a; Swatuk et al., 2018). The Nexus reflects the need for a multidimensional and systematic compass for support and guidance for enhanced and decentralized decisions on these circular economy challenges, fostering efficiency and reducing negative externalities (Lehmann, 2018).

As Martinez-Hernandez noted, any WEF nexus decision will require first quantification and social and environmental analysis and understanding (Martinez-Hernandez et al., 2017). The last two chapters combined Landscape Characterization and Doughnut Economics frameworks to address enhanced and integrated resource management solutions. Landscapes are driving forces to capture the conflicts of social and economic interest and the alternatives for resolving human-environment systems without deteriorating the ecosystem services (Giampietro et al., 2014; Houet et al., 2010; Wiggering, 2014). This combined place-specific approach informed with indicators such as the SDG's goals, circular economy, GHG emissions, and other environmental parameters can better understand the landscape condition and prioritize and delegate activities to specific stakeholders (Masson-Delmotte, 2021; UNISDR, 2015).

A WEF Nexus systematic approach aims for sustainable management across sectors and at multiple scales. The framework requires measurable objectives, effective organizational communication, and strategic and sustainable inputs are uncertain and limited when alignment, transparency, collaboration, or participatory methods are minimal. Research and public agencies have identified intra-sectoral trade-offs in this intertwined complex system in the last couple of decades. Doughnuts Economics provides a holistic framework which all the sectors can work within. This executive scope identifies what variables exceed our ecological capacity or are scarce in some social security aspects. WEF Nexus is reinforced by understanding the magnitude of our challenge according to our sustainability goals. Another positive characteristic is that strategic nexus projects and initiatives can be oriented and assessed from different perspectives, inviting us to rethink the best selection of inputs to introduce into the system.

On the other hand, the model does not provide spatial specificity. As a result, some variables are barely perceptible, driving us to miss variables to connect or solutions out of the stakeholder's responsibilities.

Meanwhile, a landscape approach for WEF Nexus brings space and context into the picture. A Landscape Characterization Assessment facilitates driving forces, stakeholders, and variables identification and articulation. As a result, specific initiatives and projects can be aligned and monitored effectively. This participatory method provides the landscape as a common language among stakeholders, including children.

Nonetheless, LCA oversees the magnitude and urgency of the solutions that can be implemented. A Food-Energy-Water Nexus encompassed in a circular economy using a landscape approach works as a transdisciplinary method that is strategic and specific by design. Spatial and sustainability boundaries are well-defined, allowing a better understanding of the context and our capabilities. Participation can be conducted at different stages of the decision-making process but also has the flexibility to be self-conducted, as is the case for this study.

The quantitative method applied in Doughnut Economics matches the qualitative method utilized in a Landscape Characterization Assessment on a regional scale guide's endeavor to regenerative, distributive, and meaningful strategies or inputs under stakeholders' interest and responsibility. This integrative model, called Nexuscapes for the first time used in this research, is regenerative because it responds to a healthier relationship with other living systems. It is distributive by promoting a more equitable distribution of jobs, governance, and educational opportunities, among other aspects that add to well-being. Finally, it is meaningful because the landscape enhances our sense of belonging and identity. Other virtues of this scheme are that other social-environmental variables and timeframes can be considered, adding a synergistic effect to the given solutions, and reducing uncertainty and pressures in other areas.

This chapter reconsiders the social aspects of decision-making by exploring backcasting scenario methods to generate transformative knowledge that can be utilized in a more participatory government model toward a more sustainable transition and resource optimization framework (Bürgi et al., 2017; Payet-Burin et al., 2019). The model aims to minimize tradeoffs between the different WEF policies and programs without oversimplifying the stakeholders' narratives, cultural expressions, or scientific data.

Scenario quantitative models offer possible futures from current trends. Backcasting is a scenario model involving one desired scenario, which entails visioning and analyzing the process of working backward to achieve an enhanced future (Hoolohan et al., 2018). According to Alänge & Holmberg, the first step for a Backcasting model is defining the objectives; the second step includes a context assessment and building a reality-aware picture showing current trends. In this case, the sustainable planetary ceiling and social foundations applied in the Doughnut Economics model; the third step is related to developing a sustainable and suitable future vision; The last step is to develop strategies and activities toward the shared future vision (Alänge & Holmberg, n.d.). WEF nexus objective and reliable scenarios can be defined by involving a broader group of independent stakeholders, including experts from different disciplines who identify critical trade-offs, contributes to the credibility, coherence, and relevance of the narrative, and understand the evolution of today's decision-making (Hoolohan et al., 2018; Stoy et al., 2018).

The rationale for using backcasting in a WEF dynamic system model is to exhibit the urgency and lack of time that decision-makers must implement effective and aligned strategies. The backcasting scenario functions as a bridge between science and practice, the need to simplify specialized language to involve a broader audience in the community using visual and memorable materials, creating and defining a more inclusive qualitative decision-making, negotiations, and policy storylines integrating complex dynamics of social-ecological systems (Cortes Arevalo et al., 2020; Harmáčková & Vačkář, 2018; Hoolohan et al., 2019; Proctor et al., 2021). Envisioning an enhanced desirable future can effectively convert scientific data into tangible actions with legitimate support of the community, reducing pressures caused by silo-thinking, uncertainty, lack of transparency, or poor participatory planning (Amadei, 2019; Proctor et al., 2021).

Nevertheless, even if the model achieves attractive solutions and the right balance between WEF sectors, it has also worked with the other landscape components. An integrative method such as the landscape approach has a particular characteristic: it is a framework that does not leave variables out. Public health, cultural heritage, job creation, education, mobility, or waste cannot be eliminated. WEF strategies can also result in sustainable development maladaptation or trade-offs with adverse impacts deteriorating some social foundations or overshooting some ecological ceiling fields (Masson-Delmotte, 2021). Consequently, it is essential to bring in interdisciplinary agenda models to contribute actively to implementing sustainable objectives with minimal adverse lateral effects by sharing knowledge, awareness, experiences, discussing, and communicating the connections and interdependencies between the components in urban region systems (Cortes Arevalo et al., 2020; Hoolohan et al., 2018).

5.3. Hypothesis

How can Landscape Characterization Assessment and Doughnuts Economics integrate the WEF nexus solutions using a backcasting system dynamics model?

5.4. Methods

The research conducts a 2050 backcasting scenario associated with WEF Nexus system dynamics for the study area. This method combines qualitative research by identifying landscape attributes and quantitative research by measuring strategies through a circular economy scope. Both are visual methods that enable new explorations of this field. Backcasting is just a testing method, but it can be substituted or complemented by other methods.

The steps of these multiple methods are:

Step 1: Identify ten WEF strategies for the region that can amend those WEF pressures and challenges. This study gathered a WEF strategies compilation related to the magnitude found through Doughnuts Economics and Landscape Characterization context, spatial specificity, and carrying capacity. Nine urban regenerative strategies were selected. Each strategy requires data linking it to at least one of the WEF indicators used in the Doughnut economics framework.

Step 2: Create a WEF nexus dynamics system based on Doughnuts Economics indicator, Landscape Characterization assessment, population growth, and ten WEF strategies using Stella

Architects. The model considers population growth as the most relevant variable. The population segment corresponds to the region.

Step 3: To generate a relationship matrix to show WEF strategies' spatial compatibility. Some strategies are physically incompatible, requiring them to be allocated independently.

Step 4: To produce a matrix of these ten WEF strategies with the Economic Doughnuts indicator and understand their positive, null, and negative relationships. Depending on each WEF strategy's details, the model will react differently to the Economic Doughnuts framework. This matrix is based on table 3.

Step 5: To generate a general matrix using WEF strategies and suitable landscape units and their spatial capability. Landscape suitability means that some WEF strategies' requirements add synergy or reduce their footprint in specific landscape units.

Step 6: To find an enhanced WEF nexus scenario by testing different WEF strategies combinations in a harmonious balance according to landscape suitability. An enhanced WEF nexus scenario requires a positive input in Doughnut Economics' WEF indicators and a minimal negative impact on other environmental parameters.

Step 7: To use backcasting scenario to show a timeline of how we can achieve this scenario in a critical path. The timeline shows a possible path to progressively achieving the goal.

Step 8: To generate three maps and translate them into three artworks to visualize how that enhanced scenario on the most targeted landscape units looks in the future. Visual materials using maps and artworks will help to communicate the complex WEF strategies content to diverse stakeholders. The artwork captures the interdependent social-ecological dynamics, WEF strategies, and their potential impact on the landscape unit in the medium-term future.

5.5. Model Development

After understanding the magnitude and context of the WEF challenge in the Southern Nevada urban region, this research layout below a WEF strategies compilation that can be quantified in the Doughnuts economic model and are suitable to the study area (Amadei, 2019; Bieber et al., 2018; European Union, 2020; Holt et al., 2016; Kabisch et al., 2017; Lehmann, 2019a, 2019b; Raworth, 2022; Sarni, 2015; Subedi et al., 2020; UNISDR, 2015; U.S. Global Change Program, 2018):

Water sector: access to affordable and clean water, water conservation, rainwater harvesting, achieving and improving safe water standards, and proper sanitation systems.

Energy sector: reduce traveling, minimize flights, wind farms, information and product digitalization, affordable and reliable energy supply, and decarbonizing transportation.

Food sector: distribution and availability of nutritious and affordable food, soil restoration, enhancing food safety, and regional food stability.

Water-energy sectors: solar farms, geothermal farms, desalination plants, wastewater recycling, hydroelectric energy, and xeriscaping policies.

Water-food sectors: drought-resistant crops.

Energy-food sectors: biogas from landfills.

Water-energy-food sectors: land conservation and restoring multifunctional landscapes ensuring vital ecosystem services and biodiversity, upscaling and replicating interconnected nature-based solutions offering restored habitats and artificial features reducing ecosystem disturbance, waste reduction, enhancing resource productivity and reducing resource consumption through technological innovation, waste as resource enabling remanufacturing and recycling, second or third-generation biofuels, and public policies coherency and coordination.

For enhancing FEW securities in the region, nine WEF strategies were selected: sustainable building standards update (SB), groundwater recharge (GR), distributed solar energy (SE), vertical wind energy (WE), geothermal energy (GE), electric vehicles incentives (EV), food banks (FB), hydroponic farming (HF) and Regenerative desert farming (RF).

Strategy 1. Sustainable building standards update (SB)

Water and energy footprint in construction can be reduced by including passive building design regulations. In addition, the population in the region is expected to grow by one million (Center for Business and Economic Research, 2021), which translated into the demand for thousands of new residential and commercial buildings.

Sustainable building standards include:

- Using building orientation, light colors, correct window placement and sizes, daylighting, and adequate cross ventilation (Lehmann, 2019b; J. Williams, 2019).

- Reducing materials and waste production, recycling, and recovery of resources (Lehmann, 2019a).

- Carbon capture and storage in building materials (Williams, 2019).

- Energy efficiency by thermal insulation, insulated glazing, use of low consumption equipment, and efficient lighting control systems (Bieber et al., 2018)

- Water conservation and reuse systems through turning grey water into green water systems, use of low flow fixtures, and landscape with water-smart xeriscaping principles

- Increasing inclusive mixed-use urban living in medium-density neighborhoods resources (Lehmann, 2019a).

- Using modular off-site construction (Lehmann, 2019b).

Interlinkages: water-Energy.

Estimated water reduction: 40% in new housing (Thomollari et al., 2017).

Estimated energy savings: 50% in new housing (World Green Building Council, 2022).

Carrying capacity restrictions: none.

Estimated activation time: immediately.

Suitability criteria:

C1. Built environments.

C2. Urban centers with a population of over 5,000.

Strategy 2. Groundwater recharge (GR)

One potential adaptation of agriculture to drought is water banking, storing excess surface water in groundwater aquifers (U.S. Global Change Program, 2018). Some experts recommend that policies should focus on water preservation rather than increasing farm watering efficiencies through newer irrigation systems (Scanlon et al., 2017). Aquifer recharge ensures water for maintaining ecosystems as long as it prevents pollution (Brears, 2018b). The most important benefit is that this subsurface storage method avoids significant evaporative losses compared to the conventional reservoir (Scanlon et al., 2017).

Interlinkages: water-Energy.

Return flow: 37% in urban uses and 15% in agriculture (Winkelman et al., 2017)

Units: acres feet annually.

Estimated installation time: 2 weeks (Groundwater Governance, 2022).

Suitability criteria:

C1. Acres with a concentration of three or five land cover: rivers and streams, lakes and playas, springs, wetlands, and phreatophytes (S. Williams, 2022).

C2. Area with very high to high soil permeability and without hard pan soil (Maurer et al., 2004).

C3. Proximity: close to the energy and water supply (Limit 20 km).

C4. Proximity: close to urban centers and farmlands (Limit 20 km).

Strategy 3. Distributed Solar Energy (SE)

In the short term, the sun is the most reliable resource for electrical generation by renewable energy sources in the region. Nowadays, solar farms can be configurated to avoid destructive land-use changes by placing them on roofs, parking lot canopies, roads, water, or distributed in areas with low ecosystem services, especially the ones related to terrestrial wildlife connectivity and habitat provision (Dale et al., 2011; U.S. Global Change Program, 2018). However, the strategy must be integrated into an energy-storage system, transmission grids, and water supply to be fully effective.

Interlinkages: water-energy.

The area required is 10 acres to produce one megawatt (MW) electricity (Wyatt & Kristian, 2021).

Energy per capita: 67 MWh (228 million BTU) (U.S. Energy Information Administration, 2020).

Carrying capacity restrictions: the research study recommends a limit cover of 30% in landscape units with urban centers and farmlands and 10% in preserved landscapes.

Estimated installation time: 5 years (Hyder, 2022).

Suitability criteria:

C1. Extensive flat surfaces (Min. 100 acres).

C2. Proximity: close to energy demand and water supply (Limit 20 km).

C3. Low supporting ecosystem services (1 or 2).

C4. Under a permitted land use.

Strategy 4. Vertical Wind energy (WE)

Vertical wind turbines are 15% more efficient than horizontal axis models (Hansen et al., 2021). This intermittent renewable energy does not require water (Scanlon et al., 2017). The same as solar farms, wind energy requires energy storage systems and being close to transmission grids

(Dale et al., 2011). A sensorial and environmental assessment can provide a scheme to diminish the negative impacts on the landscape (Dale et al., 2011).

Resource: energy.

Area required: 0.5 acres to produce one megawatt (MW) of electricity with one vertical wind turbine with an estimated height of 80 meters (Renewables Now, 2022).

Carrying capacity restrictions: The study recommends a limit cover of 10% in landscape units with urban centers, 30% in farmlands, and 10% in preserved landscapes.

Estimated installation time: 6 months (The European Wind Energy Association, 2016)

Suitability criteria:

C1. Proximity: close to energy demand (Limit 20 km).

C2. Wind speed above seven m/s (AWS Truepower, 2022).

C3. Low supporting ecosystem services (1 or 2).

C4. Under a permitted land use.

Strategy 5. Geothermal energy (GE)

Geothermal energy is another intermittent renewable energy for electricity generation. It is a cost-effective system that decreases greenhouse gas emissions but requires water for cooling and reinjection (Kamila et al., 2021).

Interlinkages: water-energy.

Area required: 0.09 acres to produce one megawatt (MW) (el Haj Assad et al., 2017).

Carrying capacity restrictions: one per suitable landscape unit.

Estimated installation time: 7 years (*Geothermal Project Timelines*, 2016).

Suitability criteria:

C1. Proximity: close to energy demand and water supply (Limit 20 km).

C2. Geothermal zones under permitted land use.

Strategy 6. Electric vehicles incentives (EV)

Nevada has 0.85 cars per capita (U.S. Census Bureau, 2021). Decarbonizing mobility requires changes in land use and transport policies. For this strategy, the study focuses on sustainable mobility solutions. Transportation is the pillar of economic activity, connecting products and people across urban and rural landscapes (U.S. Global Change Program, 2018). Energy-efficient multi-modal transportation prioritizes pedestrian mobility, biking, and massive electric transport systems over private cars and trucks. The number of electric vehicles rising in demand, going from 7,381 in 2019 to 17,162 in 2021 (Akers, 2022), will increase the dependency on electrical infrastructure if another transportation mode is not encouraged.

Resource: energy.

Estimated electric vehicle growth rate: 66% per year (Akers, 2022).

Average energy consumption of fully electric vehicles: 200 kW/km (Electric Vehicle Database, 2022)

Average driven mileage per year per capita in Nevada: 8,828 miles (14,207 kilometers) (Electric Vehicle Database, 2022)

Average energy consumption of one fully electric vehicle per year: 2,841 MW/year.

Carrying capacity restrictions: none.

Estimated activation time: immediately.

Suitability criteria:

C1. Built environments.

Strategy 7. Food banks (FB)

Initiatives like Three Square food banks and other Feeding America programs in Nevada can provide nutritious food across the region using dynamic logistics and storage systems to reach individuals, children, and families, providing millions of meals per year through a network of volunteers and donors (Three Square, 2022).

Interlinkages: water-energy-food.

Food insecurity rate: 12.6 - 14.5% (Three Square, 2022).

Meals are required annually to close the gap between what is available and the need for food: 46.3 million (Three Square, 2022).

Average cold storage energy consumption: 25kwh per square foot (Naya Energy, 2018).

Carrying capacity restrictions: none.

Estimated activation time: immediately.

Suitability criteria:

C1. Built environments.

Strategy 8. Hydroponic farming (HF)

Irrigation systems use 70% of water available in the state on 6.1 million acres of farms (Southern Nevada Water Authority, 2020). However, hydroponic systems reduce water use by over 70% simultaneously, increasing yield tenfold (Farming Base, 2022; Nederhoff & Stanghellini, 2010).

Interlinkages: water-energy-food.

Carrying capacity restrictions: the study recommends a limit cover of 10% in landscape units with urban centers and farmlands, substituting areas of traditional agriculture.

Average energy consumption: 68.78 MWh per acre of agriculture (Molin & Martin, 2018).

Average energy consumption: 82 times more than conventional agriculture (Barbosa et al., 2015).

Average water consumption: 70% less than conventional (Nederhoff & Stanghellini, 2010).

Estimated installation time: 8 weeks (Tschudi, 2021).

Suitability criteria:

C1. Proximity: close to the energy and water supply (Limit 20 km).

C2. Farmlands and on-built environments.

C3. Landscapes units with an established farm activity.

C4. Under a permitted land use.

Strategy 9. Regenerative desert farming (RF)

Food logistics is considered an approach to importing or exporting water (Scanlon et al., 2017). The region must redesign the crops to be more productive and profitable water-wise options. The use of dripping irrigation systems, living fences, crop diversification, organic waste for soil fertility, and long-term carbon storage are some of the practices required for a healthier farming community (Borrelli & Mela, 2018; Brears, 2018b; Garcia et al., 2019; Sarni, 2015).

Interlinkages: water-energy-food.

Average energy consumption: 50% less than conventional agriculture

Average water consumption: 60% less water than conventional agriculture (Chu, 2017).

Yield crop: 90% more than conventional agriculture (Chu, 2017).

Estimated installation time: 3 years (Wszelaki et al., 2012).

Suitability criteria:

C1. Proximity: close to energy and water supply (Limit 20 km).

C2. Farmlands and on built environments.

C3. Landscapes units with an established farm activity.

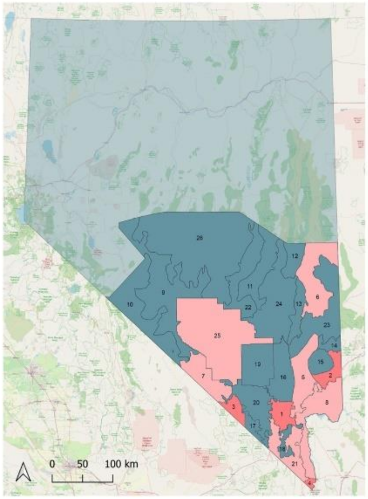
C4. Under a permitted land use.

After understanding each WEF strategies criteria, the study assesses suitability for every landscape unit (Table 6):

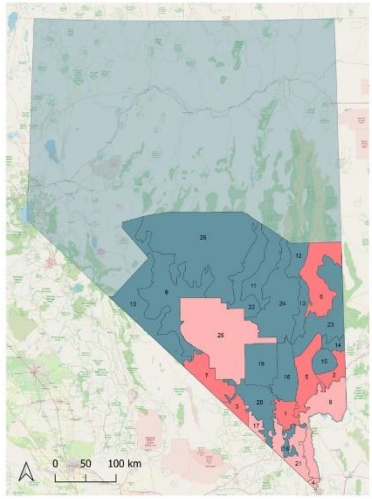
Table 6. Landscape characterization assessment using WEF strategies.

Code	Landscape Unit	SB			GR					SE					WE					GE			EV		FB		HF					RF				
		C1	C2	T	C1	C2	C3	C4	T	C1	C2	C3	C4	T	C1	C2	C3	C4	T	C1	C2	T	C1	T	C1	T	C1	C2	C3	C4	T	C1	C2	C3	C4	T
SNV1	Las Vegas Valley	•	•	2	•	•	•	•	4	•	•	•	•	4	•	-	•	•	3	•	•	2	•	1	•	1	•	•	-	•	3	•	•	-	•	3
SNV2	Mesquite	•	•	2	•	•	•	•	4	-	•	-	•	2	•	•	-	•	3	•	-	1	•	1	•	1	•	•	•	•	4	•	•	•	•	4
SNV3	Pahrump	•	•	2	•	•	•	•	4	•	•	-	•	3	•	-	-	•	2	•	-	1	•	1	•	1	•	•	•	•	4	•	•	•	•	4
SNV4	Laughlin	•	•	2	-	•	•	•	3	•	•	-	•	3	•	-	-	•	2	•	-	1	•	1	•	1	•	•	-	•	3	•	•	-	•	3
SNV5	Meadow Valley Wash	•	-	1	•	•	•	•	4	-	•	-	•	2	•	•	-	•	3	•	•	2	•	1	•	1	•	•	•	•	4	•	•	•	•	4
SNV6	Panaca Valley	•	-	1	•	•	•	•	4	•	•	-	•	3	•	-	-	•	2	•	•	2	•	1	•	1	•	•	•	•	4	•	•	•	•	4
SNV7	Amargosa	•	-	1	•	•	•	•	4	•	•	-	-	2	•	-	-	-	1	•	•	2	•	1	•	1	•	•	•	-	3	•	•	•	-	3
SNV8	Lake Mead Wildlife	•	-	1	•	-	•	•	3	•	•	-	-	2	•	•	-	-	2	•	-	1	•	1	•	1	•	•	-	-	2	•	•	-	-	2
SNV9	Tonopah Dunes	-	-	0	•	•	-	-	2	•	-	-	•	2	-	•	-	•	2	-	•	1	-	0	-	0	-	-	•	•	2	-	-	•	•	2
SNV10	Silver Peak Mountains	-	-	0	•	•	-	-	2	-	-	-	•	1	-	•	-	•	2	-	•	1	-	0	-	0	-	-	•	•	2	-	-	•	•	2
SNV11	Grant Range	-	-	0	•	•	-	-	2	-	-	-	-	0	-	-	-	-	0	-	•	1	-	0	-	0	-	-	-	-	0	-	-	-	-	0
SNV12	Shingle Peak	-	-	0	•	-	-	-	1	•	-	-	-	1	-	-	-	-	0	-	•	1	-	0	-	0	-	-	-	-	0	-	-	-	-	0
SNV13	Delamar Valley	-	-	0	-	-	-	-	0	•	-	-	•	2	-	-	-	•	1	-	•	1	-	0	-	0	-	-	-	•	1	-	-	-	•	1
SNV14	End of the Line	-	-	0	-	-	-	-	0	•	-	-	•	2	-	-	-	•	1	-	-	0	-	0	-	0	-	-	-	•	1	-	-	-	•	1
SNV15	Mormon Mountains	-	-	0	-	-	-	-	0	-	-	-	•	1	-	-	-	•	1	-	-	0	-	0	-	0	-	-	-	•	1	-	-	-	•	1
SNV16	Sheep Range	-	-	0	•	-	-	-	1	-	-	-	•	1	-	-	-	•	1	-	-	0	-	0	-	0	-	-	-	•	1	-	-	-	•	1
SNV17	Tecopa	-	-	0	•	-	•	•	3	•	•	-	•	3	•	-	-	•	2	•	-	1	-	0	-	0	•	-	-	•	1	•	-	-	•	1
SNV18	Sloan	-	-	0	-	-	-	•	1	-	-	-	-	0	-	-	-	-	0	-	-	0	-	0	-	0	-	-	-	-	0	-	-	-	-	0
SNV19	Desert National W. R.	-	-	0	•	•	-	-	2	-	-	-	-	0	-	-	-	-	0	-	-	0	-	0	-	0	-	-	-	-	0	-	-	-	-	0
SNV20	Spring Mountains	-	-	0	•	-	-	•	2	-	-	-	-	0	-	-	-	-	0	-	-	0	-	0	-	0	-	-	-	-	0	-	-	-	-	0
SNV21	Desert Tortoise	•	-	1	-	•	•	•	3	•	•	-	-	2	•	•	-	-	2	•	-	1	•	1	•	1	•	•	-	-	2	•	•	-	-	2
SNV22	Railroad Valley	-	-	0	•	•	-	-	2	•	-	-	•	2	-	-	-	•	1	-	•	1	-	0	-	0	-	-	•	•	2	-	-	•	•	2
SNV23	Snake Range	-	-	0	•	-	-	-	1	-	-	-	-	0	-	-	-	-	0	-	-	0	-	0	-	0	-	-	-	-	0	-	-	-	-	0
SNV24	Basin and Range	-	-	0	•	•	-	-	2	-	-	-	-	0	-	-	-	-	0	-	-	0	-	0	-	0	-	-	-	-	0	-	-	-	-	0
SNV25	Defense	•	-	1	•	•	•	-	3	•	•	-	-	2	•	•	-	-	2	•	•	2	•	1	•	1	•	•	-	-	2	•	•	-	-	2
SNV26	Toiyabe Range	-	-	0	•	•	-	-	2	-	-	-	-	0	-	•	-	-	1	-	•	1	-	0	-	0	-	-	-	-	0	-	-	-	-	0

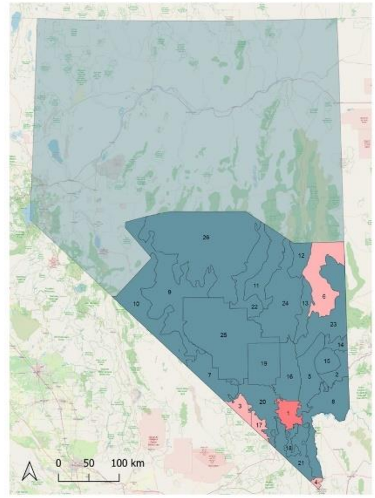
In darker blue, the highest total suitability values for each WEF strategy. In lighter blue, an intermediate suitability is considered. The values with low suitability are in white.



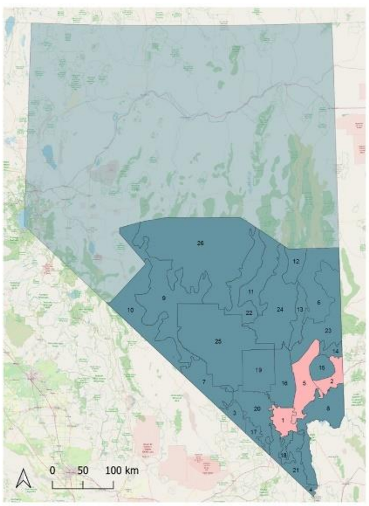
Strategy 1. Sustainable building standards update (SB)



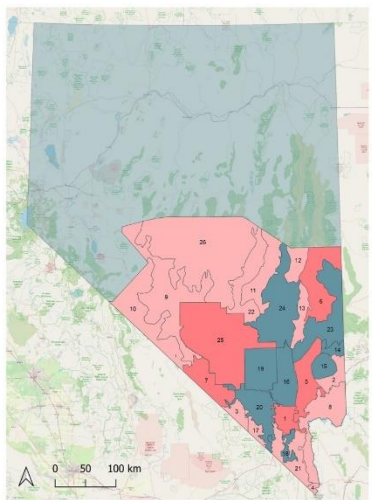
Strategy 2. Groundwater recharge (GR)



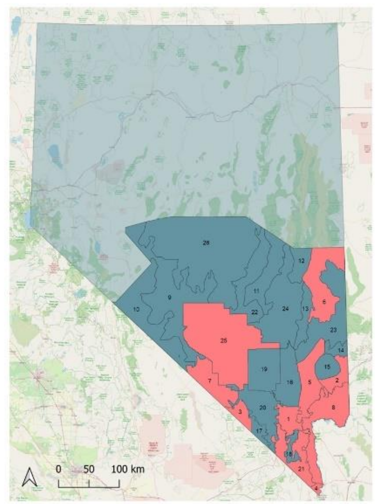
Strategy 3. Distributed Solar Energy (SE)



Strategy 4. Vertical Wind energy (WE)

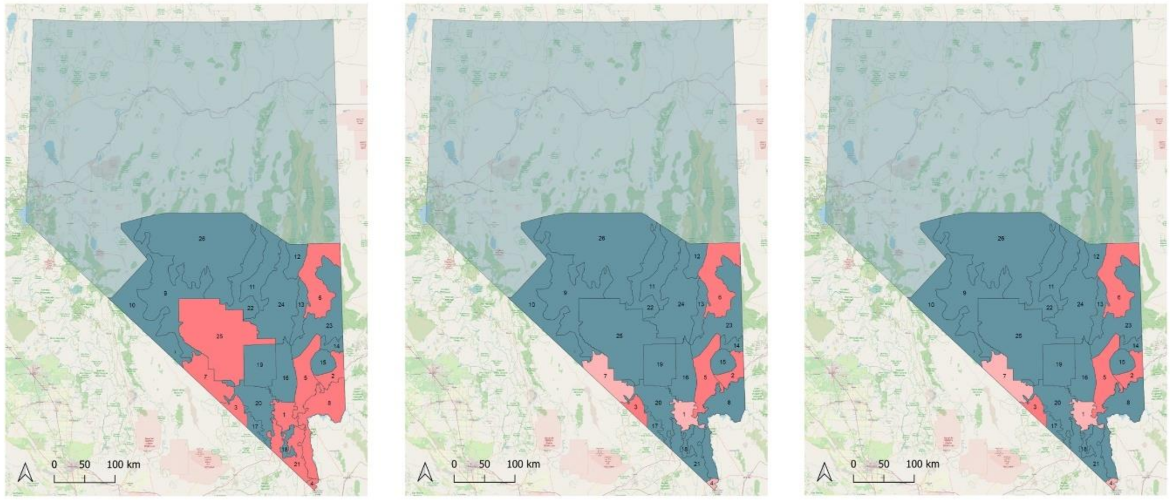


Strategy 5. Geothermal energy (GE)



Strategy 6. Electric vehicles incentives (EV)

Figure 38. Southern Nevada's landscape suitability for each chosen WEF strategy (1-6).



Strategy 7. Food banks (FB) | Strategy 8. Hydroponic farming (HF) | Strategy 9. Regenerative desert farming (RF)

Landscape Units

1. Las Vegas Valley
2. Mesquite
3. Pahrump
4. Laughlin
5. Meadow Valley Wash
6. Panaca Valley
7. Amargosa
8. Lake Mead Wildlife
9. Tonopah Dunes
10. Silver Peak Mountains
11. Grant Range
12. Shingle Peak
13. Delamar Valley
14. End of the Line
15. Mormon Mountains
16. Sheep Range
17. Tecopa
18. Sloan
19. Desert National Wild Refuge
20. Spring Mountains
21. Desert Tortoise
22. Railroad Valley
23. Snake Range
24. Basin and Range
25. Defense
26. Toiyabe Range

Figure 39. Southern Nevada's landscape suitability for each chosen WEF strategy (7-9).

WEF strategies configuration is relevant for place-based models. The following relationship table shows the spatial compatibility between strategies:

Table 7. WEF strategies' spatial compatibility.

	SB	GR	SE	WE	GE	EV	FB	HF	RF
SB									
GR	1								
SE	1	1							
WE	1	1	1						
GE	1	1	1	1					
EV	1	1	1	1	1				
FB	1	1	1	1	1	1			
HF	1	1	1	1	-1	1	1		
RF	1	1	1	1	-1	1	-1	-1	

The following table (Table 8) is based on Doughnut Economic relationship table. Some relationships changed to strategic specificities through estimated positive or negative relationships. Unknown relationships or without sufficient evidence are defined as well.

Table 8. WEF strategies relationships to Doughnut Economics indicators.

	SB	GR	SE	WE	GE	EV	FB	HF	RF
FO	•	1	•	•	•	•	1	1	1
HE	1	1	1	1	1	1	1	1	1
ED	1	/	/	/	/	/	/	1	1
IN	1	•	1	1	1	•	1	1	1
SA	1	1	•	•	•	/	/	/	/
EN	1	-1	1	1	1	-1	-1	-1	•
NE	1	/	/	/	/	/	/	/	/
HO	1	/	•	•	•	/	/	/	/
GE	/	/	/	/	/	/	/	/	/
SE	1	/	/	/	/	/	/	/	/
PV	/	/	/	/	/	/	/	/	/
PJ	/	/	/	/	/	/	/	/	/
CC	-1	-1	-1	-1	-1	-1	-1	-1	-1
OA	/	/	/	/	/	/	/	/	/
CH	-1	•	1	1	1	1	1	1	-1
NP	•	•	/	/	/	/	/	•	-1
FW	-1	-1	1	-1	1	•	1	-1	-1
LC	1	•	1	1	1	•	•	•	-1
BL	1	•	1	1	1	•	•	•	-1
AP	•	/	-1	-1	-1	-1	/	/	/
OD	-1	/	•	•	•	•	•	/	/

1	Positive correlation
-1	Negative correlation
•	Mixed or not clear
/	Insufficient evidence

Southern Nevada's Nexuscapes system dynamics (Figure 40) include the following sectors: Population growth, freshwater withdrawal, energy demand, energy accessibility, food insecurity, children's food sufficiency, farm productivity, nine WEF strategies, Doughnut economics' WEF indicators and WEF strategies interlinkages, WEF strategies' spatial compatibility, WEF strategies and landscape units' suitability, and doughnut economic swifts per WEF strategy. The model's equations list is included in Appendix 2.

Figure 40. Nexuscapes system dynamics.

Figure 41. Nexuscapes dynamics system based on DE indicators, LCA, and nine WEF strategies (Year 2022).

For calibration and testing, the model uses extreme variables in population (1 to 10 million people) without any WEF strategy implemented show expected results (Figure 42 and 43):

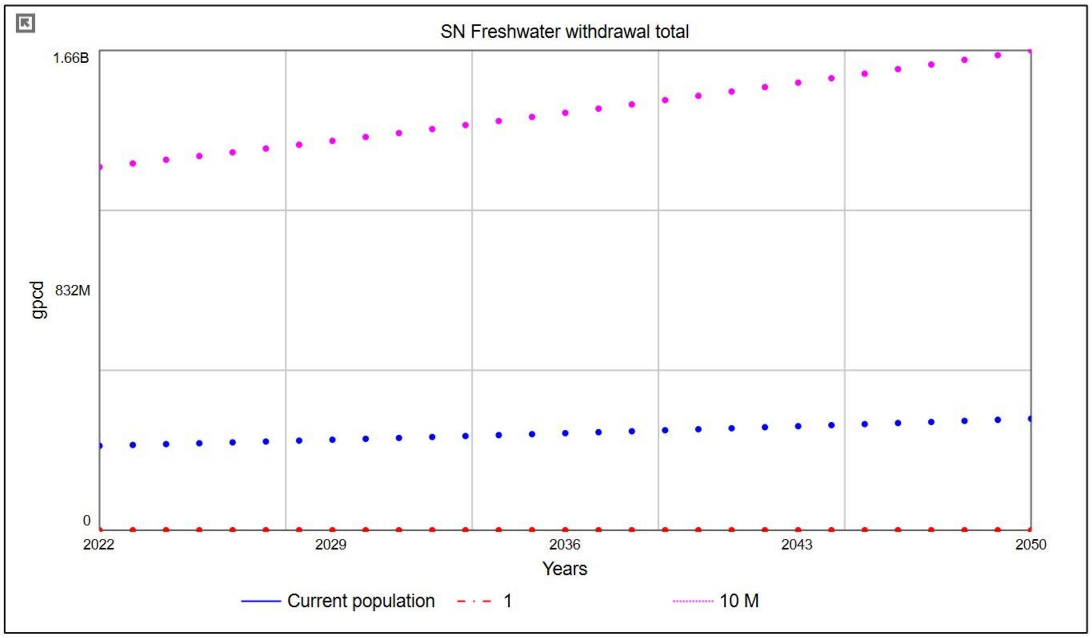


Figure 42. Total freshwater withdrawal.

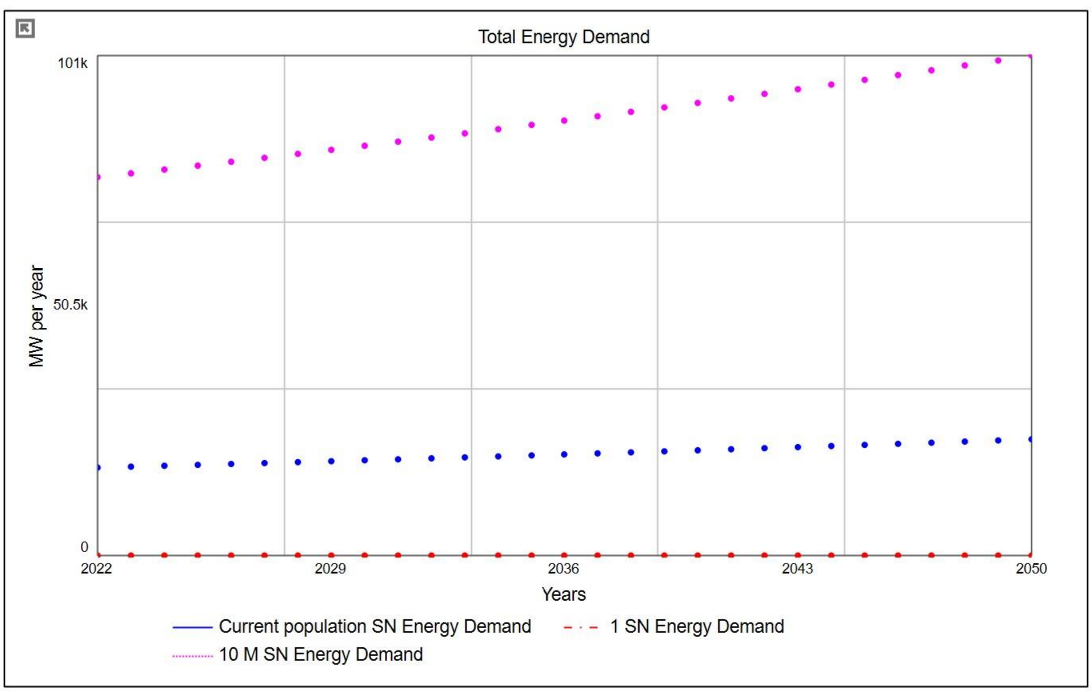


Figure 43. Total energy demand.

5.5. Results

The enhanced WEF nexus Southern Nevada 2050 scenario consists in the following strategies taken at the present day: 1) 37.6 millions of gpcd savings in new housing by updating building standards adopting sustainable practices; 2) Embracing sustainable energy codes in new housing and saving 5.5 GWh per year; 3) 50% of the domestic water directed to urban groundwater recharge can save 71.5 million of gpcd; 4) 50% of the domestic water used directed to natural groundwater recharge or reuse it in farms can save 29.05 million of gpcd; 5) 20 GWh per year generated by distributed solar energy; 6) 1.5 GWh per year by vertical wind energy; 7) 2.5 GWh per year by geothermal energy; 8) 1.4 million of electric vehicles including electric bikes, electric public transportation and automobiles; 9) 330 millions of meal per year distributed by food banks; 10) 3,000 acres of hydroponic farming and 11) 25,000 of regenerative desert farming (Figure 41 and table 9).

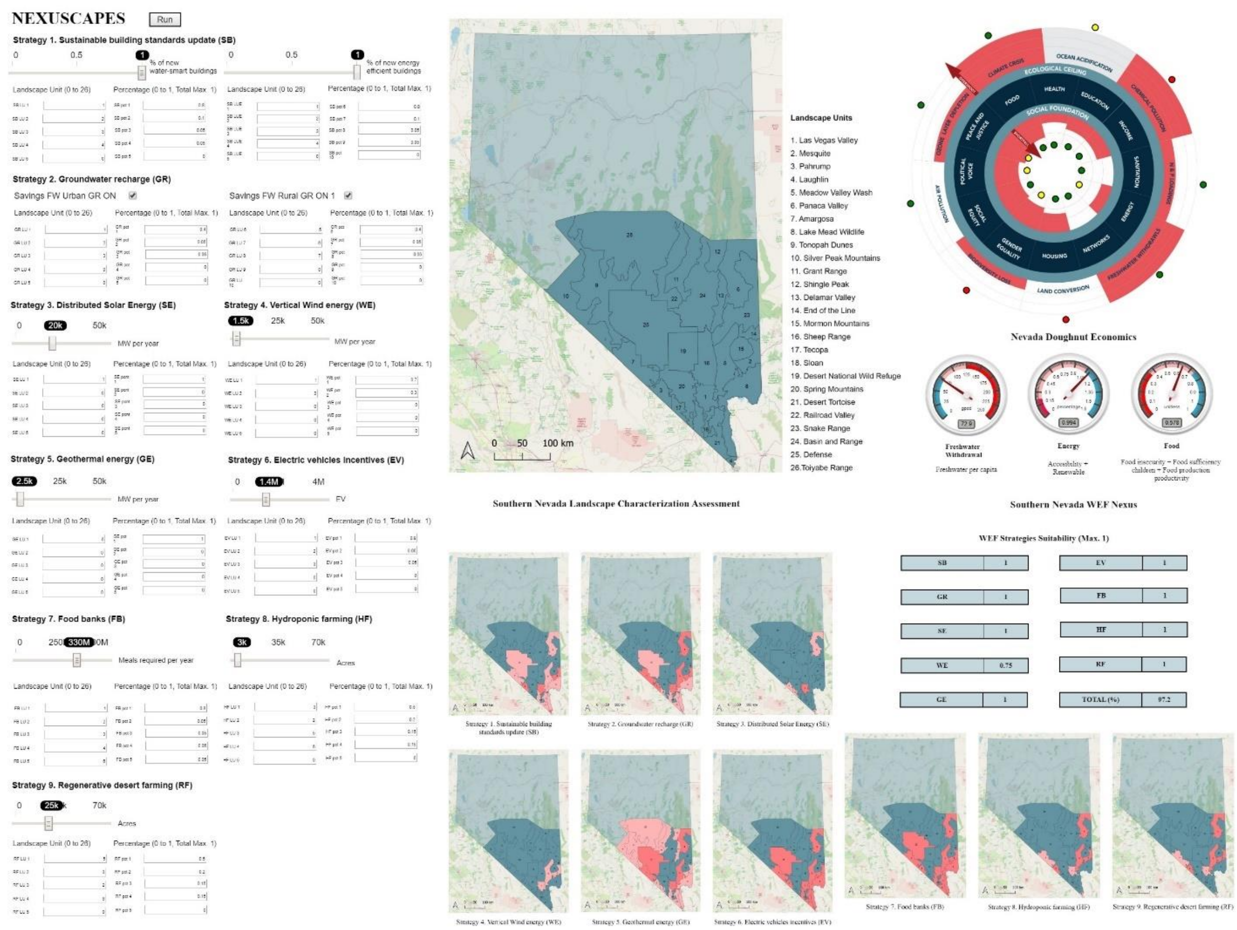


Figure 44. An enhanced WEF nexus scenario and a critical path using backcasting method (Year 2050).

Table 9. WEF nexus backcasting scenario timeline.

WEF Strategies	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	Units
Sustainable building standards update (Water savings in new housing)	1.34	2.69	4.03	5.37	6.71	8.06	9.40	10.74	12.09	13.43	14.77	16.11	17.46	18.80	20.14	21.49	22.83	24.17	25.51	26.86	28.20	29.54	30.89	32.23	33.57	34.91	36.26	37.6	millions of gpcd
Sustainable building standards update (Energy savings in new housing)	0.20	0.39	0.59	0.79	0.98	1.18	1.38	1.57	1.77	1.96	2.16	2.36	2.55	2.75	2.95	3.14	3.34	3.54	3.73	3.93	4.13	4.32	4.52	4.71	4.91	5.11	5.30	5.5	GWh per year
Urban groundwater recharge	2.55	5.11	7.66	10.21	12.77	15.32	17.88	20.43	22.98	25.54	28.09	30.64	33.20	35.75	38.30	40.86	43.41	45.96	48.52	51.07	53.63	56.18	58.73	61.29	63.84	66.39	68.95	71.5	millions of gpcd
Natural groundwater recharge	1.04	2.08	3.11	4.15	5.19	6.23	7.26	8.30	9.34	10.38	11.41	12.45	13.49	14.53	15.56	16.60	17.64	18.68	19.71	20.75	21.79	22.83	23.86	24.90	25.94	26.98	28.01	29.05	millions of gpcd
Distributed solar energy						0.87	1.74	2.61	3.48	4.35	5.22	6.09	6.96	7.83	8.70	9.57	10.43	11.30	12.17	13.04	13.91	14.78	15.65	16.52	17.39	18.26	19.13	20.00	GWh per year
Vertical wind energy	0.05	0.11	0.16	0.21	0.27	0.32	0.38	0.43	0.48	0.54	0.59	0.64	0.70	0.75	0.80	0.86	0.91	0.96	1.02	1.07	1.13	1.18	1.23	1.29	1.34	1.39	1.45	1.5	GWh per year
Geothermal energy								0.12	0.24	0.36	0.48	0.60	0.71	0.83	0.95	1.07	1.19	1.31	1.43	1.55	1.67	1.79	1.90	2.02	2.14	2.26	2.38	2.5	GWh per year
Electric vehicles incentives	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.4	millions of EV's
Foodbanks	11.79	23.57	35.36	47.14	58.93	70.71	82.50	94.29	106.07	117.86	129.64	141.43	153.21	165.00	176.79	188.57	200.36	212.14	223.93	235.71	247.50	259.29	271.07	282.86	294.64	306.43	318.21	330	millions of meals per year
Hydroponic farming	0.11	0.21	0.32	0.43	0.54	0.64	0.75	0.86	0.96	1.07	1.18	1.29	1.39	1.50	1.61	1.71	1.82	1.93	2.04	2.14	2.25	2.36	2.46	2.57	2.68	2.79	2.89	3	thousand of acres
Regenerative desert farming				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	thousand of acres

With a result of 97.2% of landscape suitability and the following Doughnut Economics indicators improvements by 2050: Freshwater withdrawals from 126 to 72.9 gpcd; Energy from 64% to 99.9% by an increase in the use of renewables and keeping energy accesibility; Food from 51.7% to 57.8% by tackling food insecurity through an extensive food bank program and increasing yield by substituting conventional crops by hydroponic farms and regenerative desert farming (Table 10).

Table 10. Enhanced Southern Nevada 2050 WEF backcasting scenario.

Results	2022	2050
Freshwater withdrawal	126	72.9
Energy	64.0%	99.9%
Food	51.7%	57.8%

Trade-offs exist in other Doughnut Economics indicators as chemical pollution, land conversion, and biodiversity loss. Chemical pollution can be controlled by an integrative zero waste management, meanwhile landscape conversion and biodiversity loss can be mitigated with an expansion of natural protected areas and wildlife corridors on landscape units with high support ecosystem services.

Synergies occur with social foundation indicators including health, education, income, sanitation, networks, housing, and social equity. Same ensues with environmental indicators by reducing GHG emissions, nitrogen and phosphorus loadings, air pollution and ozone depleting substances.

The following (Figures 43-46) maps show the operational landscape units with a higher demand on WEF resources in the 2050 backcasting scenario. To illustrate these maps, the study includes three artworks embodying WEF strategies driving forces in their corresponding landscape units (Figures 47-52).

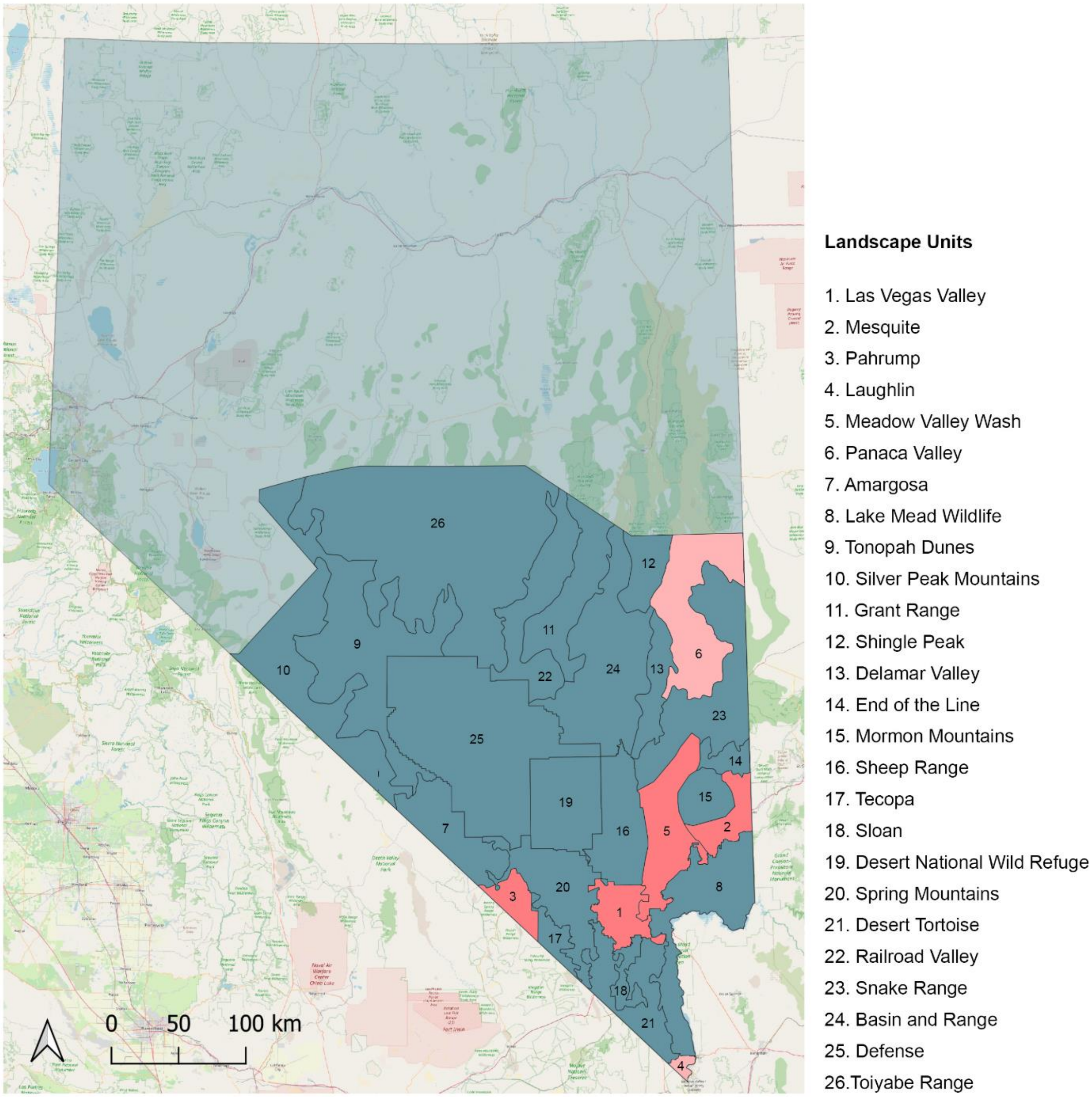


Figure 45. Southern Nevada waterscapes 2050.

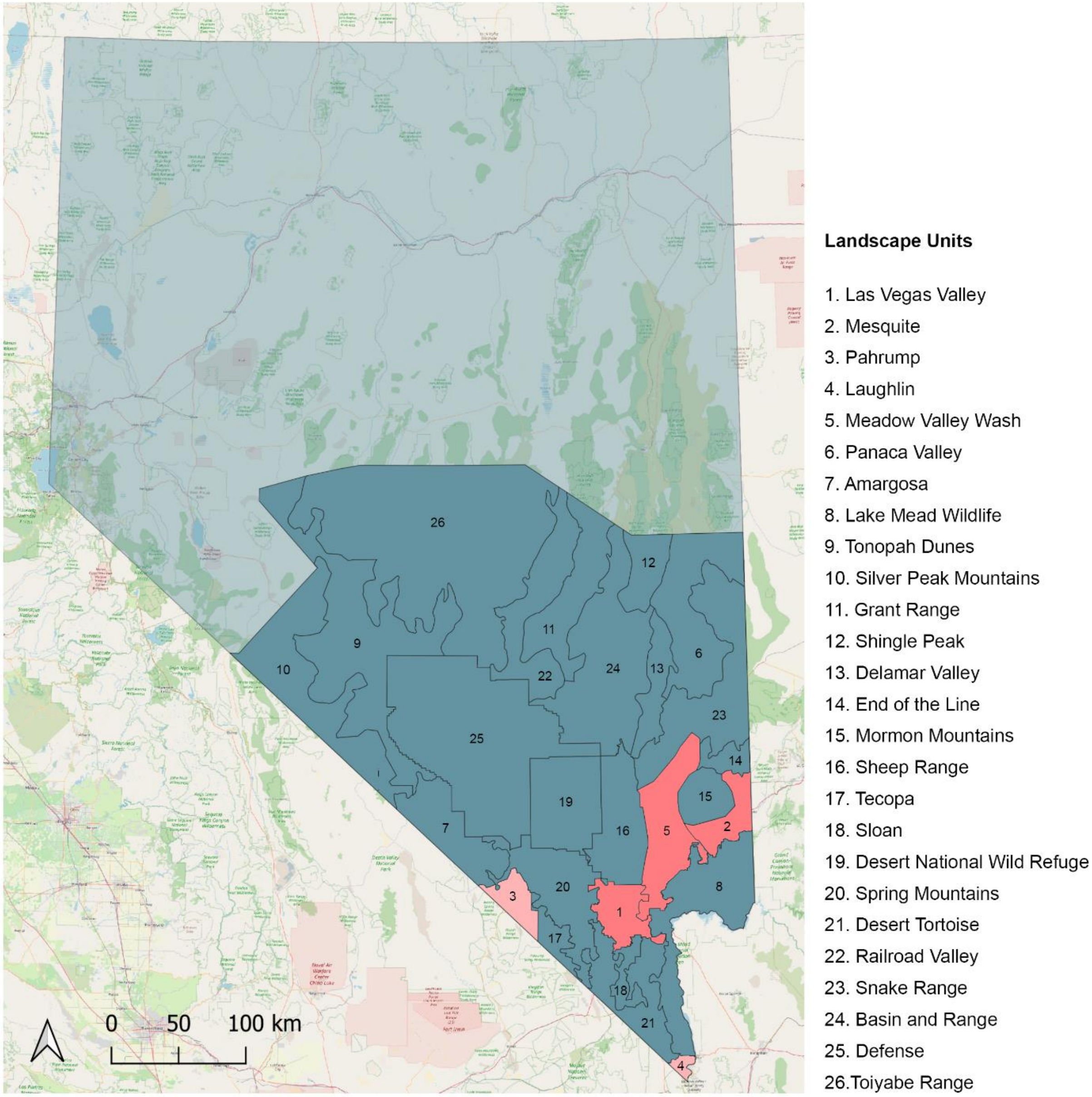


Figure 46. Southern Nevada energyscapes 2050.

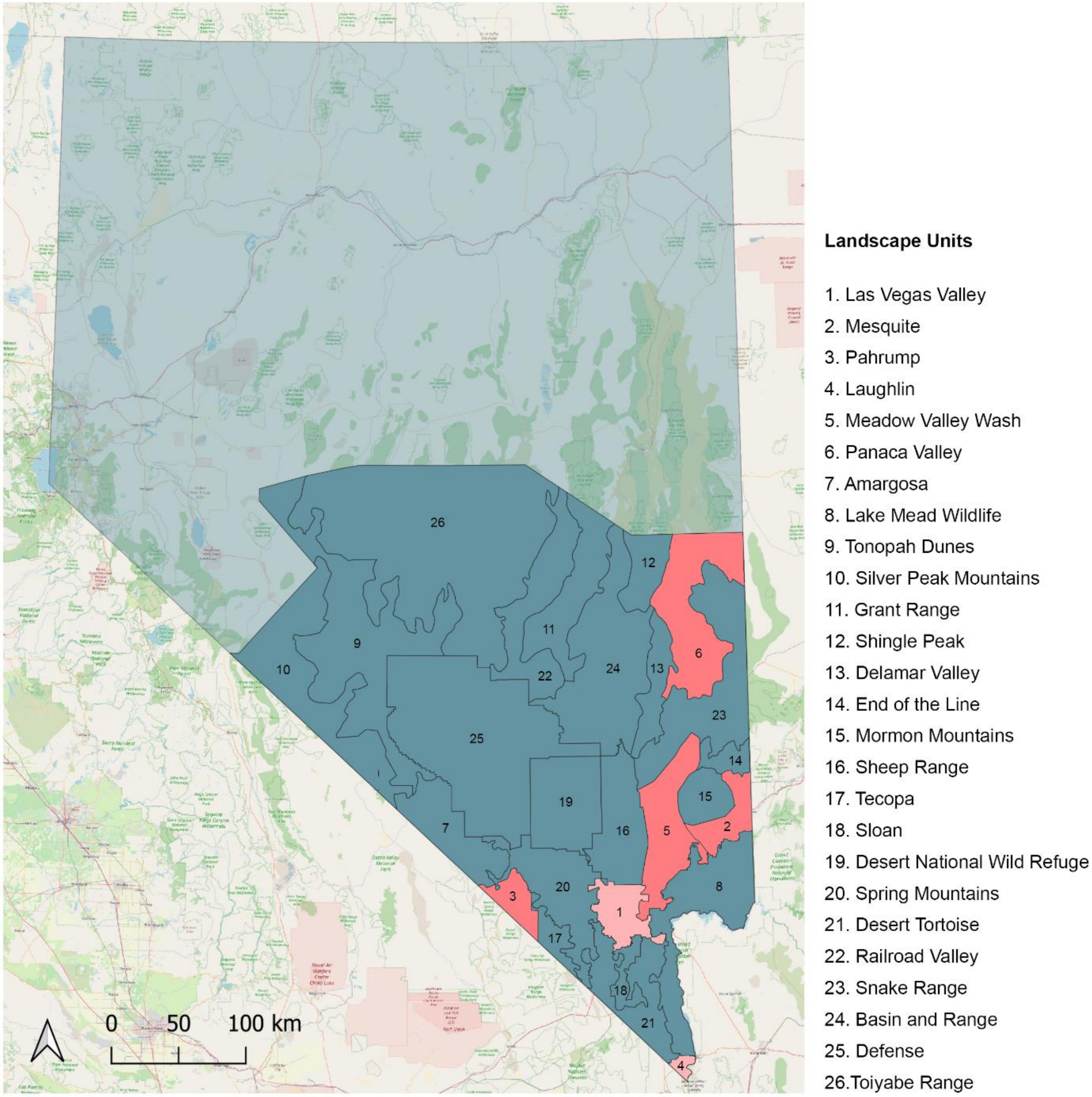


Figure 47. Southern Nevada foodscapes 2050.

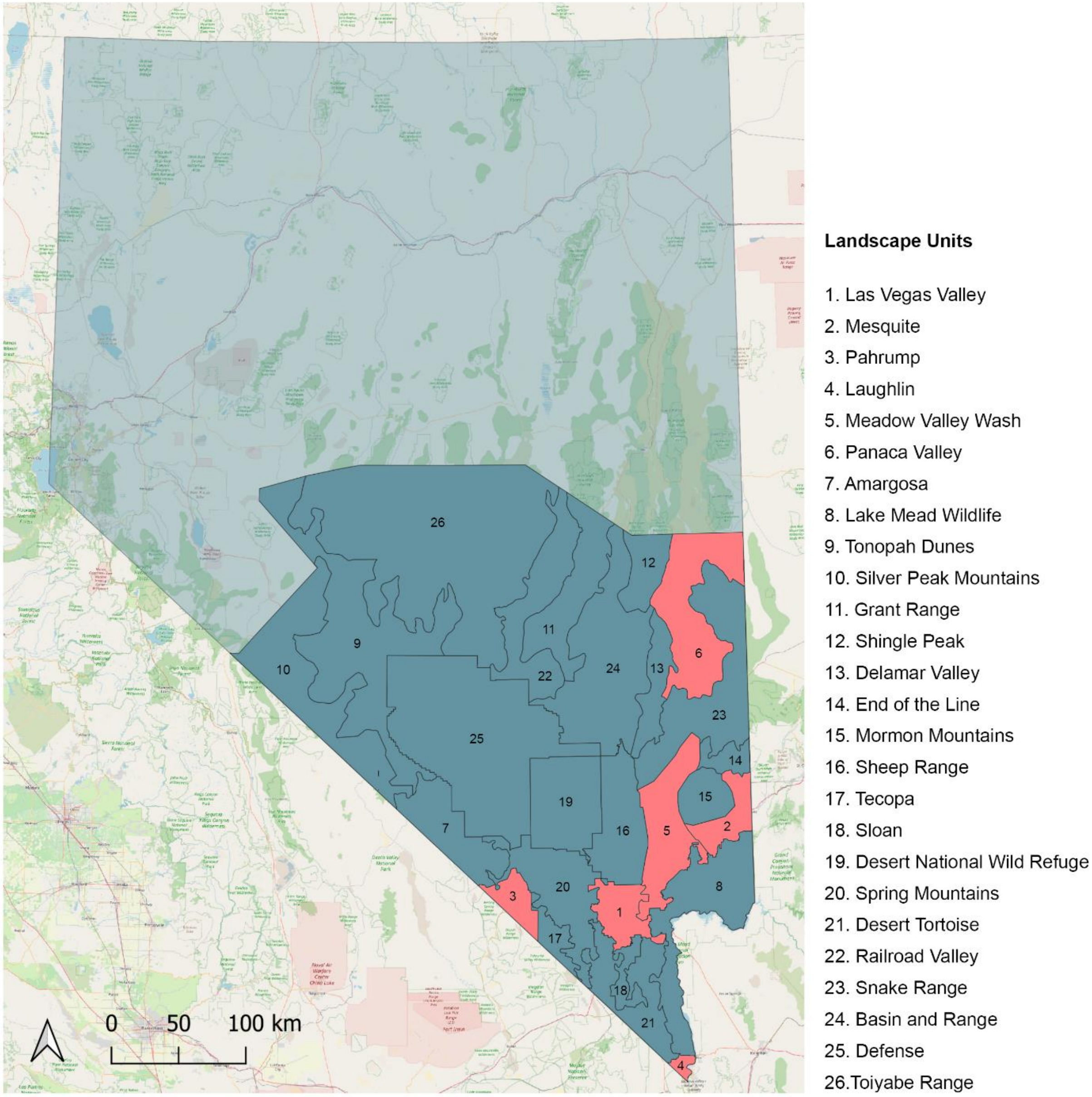


Figure 48. Southern Nevada WEF nexus landscapes 2050.

Figure 49. Las Vegas valley, 2022 *(Source: Loopnet, 2022).*

Figure 50. Las Vegas valley based on WEF nexus backcasting scenario 2050 (By the author).

Figure 51. Mesquite, 2022 (Source: The Medicare Store, 2022).

Figure 52. Mesquite based on WEF nexus backcasting scenario, 2050 (By the author).

Figure 53. Meadow Valley Wash (Source: Stan Shebs, 2007).

Figure 54. Meadow Valley Wash based on WEF nexus backcasting scenario, 2050 (By the author).

5.6. Conclusions

Nexuscapes offers a WEF Nexus method open to collaborative schemes by using a coordinated narrative from a natural or social sciences perspective; even a technologic solution design can be assessed. The urban region scope and the combination of Doughnut Economics and Landscape Characterization give a sufficient description of the WEF strategies that can be beneficial and effective for a whole region without overcharging urban centers or destroying preserved landscapes. This balance reveals social and environmental interlinkages that are critical but underestimated in specialized sectors and other WEF approaches.

WEF-related initiatives can be assessed using Nexuscapes. The model requires informed strategies that can be assembled for each DE indicator. In the same way, the model considers land capability and suitability, both relevant to stakeholders. The method suggests that indicators have an equal value, and social and environmental systems can be successfully achieved through a harmonic interlinkage between them and the spatial context. The backcasting scenario shows that enhanced combinations of strategies and landscapes exist through harmonic configurations in urban centers and distributed across the region.

In Southern Nevada, water strategies are concentrated around critical urban centers such as Las Vegas Valley, Mesquite, Pahrump, and Caliente, places where water demand is high, and springs and superficial waters are available. Farming enhancements through hydroponics and regenerative agriculture without expanding the farming’s land footprint along with groundwater recharge and other existing practices could create a sustainable water management policy in the Southwest of the country. Meanwhile, renewable energy strategies such as new solar, wind farms, and geothermal power plants could reduce water and food pressures in the same areas. Areas with current farming activities, such as Mesquite, Pahrump, Meadow Valley Wash, and

Panaca Valley, can benefit. The model decreases uncertainty about the future of the lands, and it can hasten the promulgation of more protected natural areas.

Even though Nexuscapes requires more specific data for linking WEF strategies with the dynamic framework than the generated in the DE and LC, the model remains accessible for transdisciplinary planning and engaged civic governance, attending to local specific decisions that articulate in a more complex and global context. Open co-creation is a singular opportunity to build a coordinated shared vision for a more thriving regional future.

Chapter 6. Conclusions and future recommendations

6.1. Conclusions

This study contributes dynamism and spatial qualities to the Doughnuts Economics model. This recent economic model based on social foundations and planet boundaries provides a sustainable state picture; meanwhile, Nexuscapes provides a portrait that is constantly changing our daily decisions and running towards a shared future. Raworth's model decouples human well-being from economic growth, giving the ultimate target to social and environmental aspects that are critical for us and the planet, including water-energy-food nexus and other variables that are blocking or supporting the sustainable management of these resources and are most of the time excluded. This research compiled synergies and tradeoffs among these parameters, but strategy specificity is required to adjust interlinkages. WEF Nexus, through DE lenses, expands the spectrum of strategies that also must answer to social inequity, biodiversity loss, and transparency, among other critical aspects of sustainability.

The landscape approach contributed to the couple DE model with a place, aiming to visualize the suitability and capacity of possible solutions to WEF nexus pressures and collectively explore the landscapes' potential. The results show that multifunctional operational landscapes are more advantageous than monofunctional landscapes, releasing pressure on natural areas that can be utilized as protected corridors to safeguard ecosystem services benefits. These multi-layered and articulated operational landscapes envision a world of shorter distances, confirming that urbanized areas are the most "natural habitat" for humans but require healthy ecosystems to keep thriving. Landscape characterization adapts and incorporates these socio-cultural and environmental factors on an engaging regional scale.

The research study shows that integrating a transdisciplinary place-based framework is possible. The dynamic system model Nexuscapes is a scenario-testing platform that combines both frameworks. The magnitude and spatial specificity improve WEF systems' affordability, reliability, and sustainability. A backcasting scenario shows that enhanced futures can be achieved through diverse disciplines and multiple sectors and keep a coherent articulation or identify conflict points and social behaviors that should be attended to.

Nexuscapes aims to evolve into an artificial intelligence instrument for foreseeing optimal scenarios and accelerating the formation of smarter governments. As a result, public agencies and strategic programs should evolve from conventional secluded planning toward an integrated and sustainable informed framework for proactive decision-making.

Compared with other WEF nexus methods, Nexuscapes breaks conventional narratives by embracing complexity through synthesis rather than oversimplifying variables. It is an integrative systematic method that can optimize the use of funding and talents of the region through design. WEF nexus models require a socioecological boundary to preserve the ecosystem's complexity and are accepted in implied cultures. This method can be replicated in other urban regions of the United States with other strategies and distinct findings. Local narratives and identifying particular landscape components could help unlock the ambiguous and distorting positions around sustainability. By opening the strategic planning tool to the public, significant qualitative and quantitative research from a broad spectrum of disciplines can be integrated to feed up the model through calibrating the model, establishing new WEF strategies, and supporting the Landscape Characterization, among other updates.

Finally, this research contributes to interdisciplinary research, allowing citizens to build up, adapt, configure, and monitor the long-term big picture required to motivate, organize, and integrate critical sectors of our society in a permanent crisis age.

6.2. Future recommendations

Doughnut Economics requires more understanding of the tradeoffs and synergies among parameters. The DE model used for an urban region attains more collaboration among stakeholders. The model requires more development toward a dynamic system that can be easily operated and shared with diverse regional sectors and stakeholders. DE parameters and WEF strategies could be standardized for every state of the country, allowing the dissemination of this collaborative planning.

Some DE parameters are difficult to obtain and update, specifically nitrogen and phosphorus loading and ozone depletion layer indicators. A yearly index delivered through specialized agencies could improve the framework.

Another parameter that requires review is energy. Fuels for transportation were not included, even though they have a significant role in the current climate crisis. This adjustment will make possible new scenarios that include electricity power plant expansions, biofuel, hydrogen, or any other new renewable fuels.

Landscape characterization assessment must evolve and be more frequently used in circular economy research. The framework must evolve from historic preservation and visual assessments to a planning and narrative tool that blends past, present, and future harmonically and sustainably. LCA entails being updated with environmental systems such as ecosystem services and wildlife connectivity to be recognized in WEF Nexus research and other climate change mitigation and adaptation approaches. Spatial digitalization and access to this data can enhance WEF strategy configuration. A decision-making interface formulated by images, maps, and dynamic graphics brings natural resources and complex systems towards a hermeneutic interpretation fed by analysis, science communication, and design.

For policymakers, I recommend utilizing integrative platforms to identify trade-offs that are not easy to detect, starting with the policies and programs that are operating in the region. This integrative planning is translated in time and budget savings, by reducing redundant procedures. At the same time, governments should create a specific department or committee for monitoring risks, reporting opportunities, updating verified data, and produce science communication from the findings and achievements.

Southern Nevada Characterization requires a field study to adjust the proposed landscape units. Information from future consultations with Native people and Land Bureau Management could bring a more robust cultural heritage protection and administrative understanding, reshaping some of the landscape units and improving their description.

Nexuscapes must evolve towards a more sophisticated program integrating not only WEF nexus variables but also projects, programs, and policies that can improve sustainability standards more efficiently and well-coordinated. Time and budget resources should also be included. An inclusive collaborative open-source urban region observatory acquiesced by committed representatives from universities, industry, non-profit organizations, authorities, and under-represented stakeholders who could operate and calibrate the model with more knowledge, information, data, and values obtained from reliable sources to keep data quality.

The integrative place-specific framework requires activating living labs because they are joining points between top-down and grassroots approaches. The construction of living labs for each strategy used in this research study can boost sustainable practices in Southern Nevada by innovating real-life processes and local settings (Steen & van Bueren, 2017). Several sources prove that public satisfactoriness with WEF nexus strategies can enable, update, or inhibit implementation on critical climate related policies and measures (Masson-Delmotte, 2021; Morrison et al., 2018). WEF nexus research can be benefited by continuing bridging synergies and trade-offs with other sustainability parameters. In the end, optimization, efficiency, and innovation on the interlinkages between the systems constitute a circular economy.

Appendices

Appendix A. Glossary

Backcasting: Participatory approach for dealing with system innovations using desirable future visions and stakeholder involvement (Quist et al., 2006).

Biodiversity: Variety of life, including variation among genes, species and functional traits. It is often measured as: richness is a measure of the number of unique life forms; evenness is a measure of the equitability among life forms; and heterogeneity is the dissimilarity among life forms (Cardinale et al., 2012).

Biodiversity loss: Negative change of dismantling the Earth's ecosystems, eliminating genes, species and biological traits that reduces ecosystem functions and, decreases the ecosystem stability (Cardinale et al., 2012).

Carrying capacity: Number of organisms (Population) that a region can support by limited availability and arrangement of food, cover, shelter, water, and space (USDA, 2012).

Circular economy: Concept that promotes resource minimization and the adoption of cleaner technologies while maintaining the value of products, materials, and resources in the economy for as long as possible and minimizing waste generation. A more sustainable economy is designed to thrive, not to grow (Raworth, 2017; Santonen et al., 2017).

Climate change: Refers to a statistically defined change in the average and/or variability of the climate system, this includes the atmosphere, the water cycle, the land surface, ice, and the living components of Earth (Nature, 2018).

Core values: Consist of those clusters of ideas that are central to self-identities and that generate a sense of community (Neal & Youngelson-Neal, 2017) (Neal & Youngelson-Neal, 2017).

Cultural Ecosystem Services: Related to a broad spectrum of cultures, knowledge systems, religions, tangible and intangible heritage values, frequent social interactions, aesthetic appreciation, and recreational activities that improve health and well-being (García et al., 2020; Tengberg et al., 2012).

Cultural heritage: Legacy of physical artefacts and intangible attributes of a group or society that are inherited from past generations, maintained in the present and bestowed for the benefit of future generations (Hartmann, 2020).

Decision making process: To address some direction or solution after a systematic analysis of different alternatives (Kester et al., 2011).

Ecosystem functions: Ecological processes that control the fluxes of energy, nutrients and organic matter through an environment (Cardinale et al., 2012).

Ecosystem services: Suite of benefits that ecosystems provide to people. Ecosystem services are grouped on four broad types—supporting, provisioning, regulating and cultural (Cardinale et al., 2012).

Environmental overshoot: Excess values in environmental indicators over the precautionary planet boundaries, increasing risks and damage to human wellbeing (Raworth, 2017).

Habitat connectivity: The degree of functional connectivity between patches of optimal habitat for individual species (Correa Ayram et al., 2016).

Integrated water resource management: Process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (Hassing et al., 2009).

Landscape: Land area perceived by people whose character is the result of the action and interaction of natural and human factors (Primdahl & Kristensen, 2016; Warnock & Griffiths, 2015a).

Landscape character assessment: Process of identifying and describing the unique combination of elements and features that make landscapes distinctive by mapping and describing character types and areas. They also show how the landscape is perceived, experienced, and valued by people (Tudor, 2014).

Landscape driving forces: Human activities and natural processes that cause land cover and landscape feature changes and influence landscapes' trajectories (Houet et al., 2010).

Landscape narrative: The term designates the interplay and mutual relationship that develops between landscape and narrative. They intersect with sites, accumulate as layers of history, organize sequences, and inhere in the materials and processes of the landscape. In various ways, stories "take place" (Potteiger, 1998)

Landscape processes: Actions or events that are caused by some agency (wind, water, economics) and occur in succession or proceed in stages toward some end (Potteiger, 1998).

Landscape unit: Spatial framework characterized by differences in the natural and cultural dimensions of the landscape (Warnock & Griffiths, 2015).

Narrative: Coming from the Latin *gnarus* and the Indo-European root *gna*, “to know”. It implies a knowledge acquired through action and the contingencies of lived experience. It is composed by Story (content: events, characters, and settings) and Telling (expression: landscape, film, verbal, dance, manifestation) (Potteiger, 1998).

Nexus: Focal point that bundles a series of connections and links, such as a system of urban infrastructure (Lehmann, 2018).

Nexuscapes: Emerging concept of a transdisciplinary method that integrates Doughnut Economics, landscape characterization and system dynamics designed for resources planning, decision-making, and governance.

Place-based approach: Method oriented to a site context.

Precautionary principle: In cases “where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation” (von Haaren et al., 2019).

Provisioning Ecosystem Services: Provisioning services: It relates directly or indirectly to land suitability for producing plant biomass and other useful resources (García et al., 2020).

Public engagement: Open dialogue and sympathetic interaction between people in general or specific groups from the community and specialists working in partnership for a certain goal.

Region: Territory where people's frequent interaction with the environment fabricates distinctive cultural and natural landscape features.

Regulating Ecosystem Services: The benefits obtained from the regulation of ecosystem processes, including the regulation of climate, water, and some human diseases (von Haaren et al., 2019).

Renewable energy: Energy that comes from sources that are readily replenishable on short-time scales (Nature, 2021).

Social foundation shortfall: Deficit of basic standards of human wellbeing (Raworth, 2017).

Strategic communication: Use of information flowing into the organization (research) to plan and carry out a communication campaign addressing the relationship between an organization and its publics (Botan, 2018).

Supporting Ecosystem Services: Ecosystem services that are necessary for the maintenance of all other ecosystem services (von Haaren et al., 2019).

System Dynamics: Non-linear behavior problem-oriented modelling (Keyhanpour et al., 2021).

Topography: Description of a place.

Urban regeneration: Transformation of industrial or urban decaying areas into more livable, functional, and sustainable places.

Urban resilience: Ability of an urban system-and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales-to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity (Meerow et al., 2016).

Urban region: unique socio-environmental cohesive or semi-cohesive influence area that have one or more urban nucleus that can operate more sophisticated social wellbeing required nowadays in a globalized world.

Wildlife habitat: Areas distributed horizontally and vertically across the landscape that fulfill the needs of a specific wildlife species for the basic requirements of food, water, reproduction (nesting), and protection against predators and competitors (cover) (Grebner et al., 2012).

****
Doughnut_Economic_swifts:
****
EV_DE_swift[Food_A] = 0
UNITS: unitless
EV_DE_swift[Food_B] = 0
UNITS: unitless
EV_DE_swift[Food_C] = 0
UNITS: unitless
EV_DE_swift[Health_A] = IF EV_on>0 THEN 1 ELSE 0
UNITS: unitless
EV_DE_swift[Health_B] = IF EV_on>0 THEN 1 ELSE 0
UNITS: unitless
EV_DE_swift[Education_A] = 0
UNITS: unitless
EV_DE_swift[Education_B] = 0
UNITS: unitless
EV_DE_swift[Income_A] = 0
UNITS: unitless
EV_DE_swift[Income_B] = 0
UNITS: unitless
EV_DE_swift[Sanitation] = 0
UNITS: unitless
EV_DE_swift[Energy_A] = IF EV_on>0 THEN -1 ELSE 0
UNITS: unitless
EV_DE_swift[Energy_B] = IF EV_on>0 THEN -1 ELSE 0
UNITS: unitless
EV_DE_swift[Networks] = 0
UNITS: unitless
EV_DE_swift[Housing_A] = 0
UNITS: unitless
EV_DE_swift[Housing_B] = 0
UNITS: unitless
EV_DE_swift[Gender_Equality_A] = 0
UNITS: unitless
EV_DE_swift[Gender_Equality_B] = 0
UNITS: unitless
EV_DE_swift[Social_Equity] = 0
UNITS: unitless
EV_DE_swift[Political_voice] = 0
UNITS: unitless
EV_DE_swift[Peace_and_Justice_A] = 0
UNITS: unitless
EV_DE_swift[Peace_and_Justice_B] = 0

UNITS: unitless
EV_DE_swift[Climate_Crisis] = IF EV_on>0 THEN -1 ELSE 0
UNITS: unitless
EV_DE_swift[Ocean_Acidification] = 0
UNITS: unitless
EV_DE_swift[Chemical_Pollution] = IF EV_on>0 THEN 1 ELSE 0
UNITS: unitless
EV_DE_swift[Nitrogen_Loading] = 0
UNITS: unitless
EV_DE_swift[Phosphorus_Loading] = 0
UNITS: unitless
EV_DE_swift[Freswater_Withdrawals] = 0
UNITS: unitless
EV_DE_swift[Land_Conversion] = 0
UNITS: unitless
EV_DE_swift[Biodiversity_Loss] = 0
UNITS: unitless
EV_DE_swift[Air_Pollution] = IF EV_on>0 THEN -1 ELSE 0
UNITS: unitless
EV_DE_swift[Ozone_Layer_Depletion] = 0
UNITS: unitless
FB_DE_swift[Food_A] = IF Meals_per_year>0 THEN 1 ELSE 0
UNITS: unitless
FB_DE_swift[Food_B] = IF Meals_per_year>0 THEN 1 ELSE 0
UNITS: unitless
FB_DE_swift[Food_C] = IF Meals_per_year>0 THEN 1 ELSE 0
UNITS: unitless
FB_DE_swift[Health_A] = IF Meals_per_year>0 THEN 1 ELSE 0
UNITS: unitless
FB_DE_swift[Health_B] = IF Meals_per_year>0 THEN 1 ELSE 0
UNITS: unitless
FB_DE_swift[Education_A] = 0
UNITS: unitless
FB_DE_swift[Education_B] = 0
UNITS: unitless
FB_DE_swift[Income_A] = IF Meals_per_year>0 THEN 1 ELSE 0
UNITS: unitless
FB_DE_swift[Income_B] = IF Meals_per_year>0 THEN 1 ELSE 0
UNITS: unitless
FB_DE_swift[Sanitation] = 0
UNITS: unitless
FB_DE_swift[Energy_A] = IF Meals_per_year>0 THEN -1 ELSE 0
UNITS: unitless
FB_DE_swift[Energy_B] = IF Meals_per_year>0 THEN -1 ELSE 0
UNITS: unitless
FB_DE_swift[Networks] = 0

UNITS: unitless
FB_DE_swift[Housing_A] = 0
UNITS: unitless
FB_DE_swift[Housing_B] = 0
UNITS: unitless
FB_DE_swift[Gender_Equality_A] = 0
UNITS: unitless
FB_DE_swift[Gender_Equality_B] = 0
UNITS: unitless
FB_DE_swift[Social_Equity] = 0
UNITS: unitless
FB_DE_swift[Political_voice] = 0
UNITS: unitless
FB_DE_swift[Peace_and_Justice_A] = 0
UNITS: unitless
FB_DE_swift[Peace_and_Justice_B] = 0
UNITS: unitless
FB_DE_swift[Climate_Crisis] = IF Meals_per_year>0 THEN -1 ELSE 0
UNITS: unitless
FB_DE_swift[Ocean_Acidification] = 0
UNITS: unitless
FB_DE_swift[Chemical_Pollution] = IF Meals_per_year>0 THEN 1 ELSE 0
UNITS: unitless
FB_DE_swift[Nitrogen_Loading] = 0
UNITS: unitless
FB_DE_swift[Phosphorus_Loading] = 0
UNITS: unitless
FB_DE_swift[Freswater_Withdrawals] = IF Meals_per_year>0 THEN 1 ELSE 0
UNITS: unitless
FB_DE_swift[Land_Conversion] = 0
UNITS: unitless
FB_DE_swift[Biodiversity_Loss] = 0
UNITS: unitless
FB_DE_swift[Air_Pollution] = 0
UNITS: unitless
FB_DE_swift[Ozone_Layer_Depletion] = 0
UNITS: unitless
GE_DE_swift[Food_A] = 0
UNITS: unitless
GE_DE_swift[Food_B] = 0
UNITS: unitless
GE_DE_swift[Food_C] = 0
UNITS: unitless
GE_DE_swift[Health_A] = IF GE_ON>0 THEN 1 ELSE 0
UNITS: unitless
GE_DE_swift[Health_B] = IF GE_ON>0 THEN 1 ELSE 0

UNITS: unitless
GE_DE_swift[Education_A] = 0
UNITS: unitless
GE_DE_swift[Education_B] = 0
UNITS: unitless
GE_DE_swift[Income_A] = IF GE_ON>0 THEN 1 ELSE 0
UNITS: unitless
GE_DE_swift[Income_B] = IF GE_ON>0 THEN 1 ELSE 0
UNITS: unitless
GE_DE_swift[Sanitation] = 0
UNITS: unitless
GE_DE_swift[Energy_A] = IF GE_ON>0 THEN 1 ELSE 0
UNITS: unitless
GE_DE_swift[Energy_B] = IF GE_ON>0 THEN 1 ELSE 0
UNITS: unitless
GE_DE_swift[Networks] = 0
UNITS: unitless
GE_DE_swift[Housing_A] = 0
UNITS: unitless
GE_DE_swift[Housing_B] = 0
UNITS: unitless
GE_DE_swift[Gender_Equality_A] = 0
UNITS: unitless
GE_DE_swift[Gender_Equality_B] = 0
UNITS: unitless
GE_DE_swift[Social_Equity] = 0
UNITS: unitless
GE_DE_swift[Political_voice] = 0
UNITS: unitless
GE_DE_swift[Peace_and_Justice_A] = 0
UNITS: unitless
GE_DE_swift[Peace_and_Justice_B] = 0
UNITS: unitless
GE_DE_swift[Climate_Crisis] = IF GE_ON>0 THEN -1 ELSE 0
UNITS: unitless
GE_DE_swift[Ocean_Acidification] = 0
UNITS: unitless
GE_DE_swift[Chemical_Pollution] = IF GE_ON>0 THEN 1 ELSE 0
UNITS: unitless
GE_DE_swift[Nitrogen_Loading] = 0
UNITS: unitless
GE_DE_swift[Phosphorus_Loading] = 0
UNITS: unitless
GE_DE_swift[Freswater_Withdrawals] = IF GE_ON>0 THEN 1 ELSE 0
UNITS: unitless
GE_DE_swift[Land_Conversion] = IF GE_ON>0 THEN 1 ELSE 0

UNITS: unitless
GE_DE_swift[Biodiversity_Loss] = IF GE_ON>0 THEN 1 ELSE 0
UNITS: unitless
GE_DE_swift[Air_Pollution] = IF GE_ON>0 THEN -1 ELSE 0
UNITS: unitless
GE_DE_swift[Ozone_Layer_Depletion] = 0
UNITS: unitless
GR_DE_swift[Food_A] = IF (Savings_FW_Urban_GR_ON>0 OR Savings_FW_Rural_GR_ON_1>0) THEN 1 ELSE 0
UNITS: unitless
GR_DE_swift[Food_B] = IF (Savings_FW_Urban_GR_ON>0 OR Savings_FW_Rural_GR_ON_1>0) THEN 1 ELSE 0
UNITS: unitless
GR_DE_swift[Food_C] = IF (Savings_FW_Urban_GR_ON>0 OR Savings_FW_Rural_GR_ON_1>0) THEN 1 ELSE 0
UNITS: unitless
GR_DE_swift[Health_A] = IF (Savings_FW_Urban_GR_ON>0 OR Savings_FW_Rural_GR_ON_1>0) THEN 1 ELSE 0
UNITS: unitless
GR_DE_swift[Health_B] = IF (Savings_FW_Urban_GR_ON>0 OR Savings_FW_Rural_GR_ON_1>0) THEN 1 ELSE 0
UNITS: unitless
GR_DE_swift[Education_A] = 0
UNITS: unitless
GR_DE_swift[Education_B] = 0
UNITS: unitless
GR_DE_swift[Income_A] = 0
UNITS: unitless
GR_DE_swift[Income_B] = 0
UNITS: unitless
GR_DE_swift[Sanitation] = IF (Savings_FW_Urban_GR_ON>0 OR Savings_FW_Rural_GR_ON_1>0) THEN 1 ELSE 0
UNITS: unitless
GR_DE_swift[Energy_A] = IF (Savings_FW_Urban_GR_ON>0 OR Savings_FW_Rural_GR_ON_1>0) THEN -1 ELSE 0
UNITS: unitless
GR_DE_swift[Energy_B] = IF (Savings_FW_Urban_GR_ON>0 OR Savings_FW_Rural_GR_ON_1>0) THEN -1 ELSE 0
UNITS: unitless
GR_DE_swift[Networks] = 0
UNITS: unitless
GR_DE_swift[Housing_A] = 0
UNITS: unitless
GR_DE_swift[Housing_B] = 0
UNITS: unitless
GR_DE_swift[Gender_Equality_A] = 0

UNITS: unitless
GR_DE_swift[Gender_Equality_B] = 0
UNITS: unitless
GR_DE_swift[Social_Equity] = 0
UNITS: unitless
GR_DE_swift[Political_voice] = 0
UNITS: unitless
GR_DE_swift[Peace_and_Justice_A] = 0
UNITS: unitless
GR_DE_swift[Peace_and_Justice_B] = 0
UNITS: unitless
GR_DE_swift[Climate_Crisis] = IF (Savings_FW_Urban_GR_ON>0 OR Savings_FW_Rural_GR_ON_1>0) THEN -1 ELSE 0
UNITS: unitless
GR_DE_swift[Ocean_Acidification] = 0
UNITS: unitless
GR_DE_swift[Chemical_Pollution] = 0
UNITS: unitless
GR_DE_swift[Nitrogen_Loading] = 0
UNITS: unitless
GR_DE_swift[Phosphorus_Loading] = 0
UNITS: unitless
GR_DE_swift[Freswater_Withdrawals] = IF (Savings_FW_Urban_GR_ON>0 OR Savings_FW_Rural_GR_ON_1>0) THEN -1 ELSE 0
UNITS: unitless
GR_DE_swift[Land_Conversion] = 0
UNITS: unitless
GR_DE_swift[Biodiversity_Loss] = 0
UNITS: unitless
GR_DE_swift[Air_Pollution] = 0
UNITS: unitless
GR_DE_swift[Ozone_Layer_Depletion] = 0
UNITS: unitless
HF_DE_swift[Food_A] = IF Number_of_HF_acres>0 THEN 1 ELSE 0
UNITS: unitless
HF_DE_swift[Food_B] = IF Number_of_HF_acres>0 THEN 1 ELSE 0
UNITS: unitless
HF_DE_swift[Food_C] = IF Number_of_HF_acres>0 THEN 1 ELSE 0
UNITS: unitless
HF_DE_swift[Health_A] = IF Number_of_HF_acres>0 THEN 1 ELSE 0
UNITS: unitless
HF_DE_swift[Health_B] = IF Number_of_HF_acres>0 THEN 1 ELSE 0
UNITS: unitless
HF_DE_swift[Education_A] = IF Number_of_HF_acres>0 THEN 1 ELSE 0
UNITS: unitless
HF_DE_swift[Education_B] = IF Number_of_HF_acres>0 THEN 1 ELSE 0

UNITS: unitless
HF_DE_swift[Income_A] = IF Number_of_HF_acres>0 THEN 1 ELSE 0
UNITS: unitless
HF_DE_swift[Income_B] = IF Number_of_HF_acres>0 THEN 1 ELSE 0
UNITS: unitless
HF_DE_swift[Sanitation] = 0
UNITS: unitless
HF_DE_swift[Energy_A] = IF Number_of_HF_acres>0 THEN -1 ELSE 0
UNITS: unitless
HF_DE_swift[Energy_B] = IF Number_of_HF_acres>0 THEN -1 ELSE 0
UNITS: unitless
HF_DE_swift[Networks] = 0
UNITS: unitless
HF_DE_swift[Housing_A] = 0
UNITS: unitless
HF_DE_swift[Housing_B] = 0
UNITS: unitless
HF_DE_swift[Gender_Equality_A] = 0
UNITS: unitless
HF_DE_swift[Gender_Equality_B] = 0
UNITS: unitless
HF_DE_swift[Social_Equity] = 0
UNITS: unitless
HF_DE_swift[Political_voice] = 0
UNITS: unitless
HF_DE_swift[Peace_and_Justice_A] = 0
UNITS: unitless
HF_DE_swift[Peace_and_Justice_B] = 0
UNITS: unitless
HF_DE_swift[Climate_Crisis] = IF Number_of_HF_acres>0 THEN -1 ELSE 0
UNITS: unitless
HF_DE_swift[Ocean_Acidification] = 0
UNITS: unitless
HF_DE_swift[Chemical_Pollution] = IF Number_of_HF_acres>0 THEN 1 ELSE 0
UNITS: unitless
HF_DE_swift[Nitrogen_Loading] = 0
UNITS: unitless
HF_DE_swift[Phosphorus_Loading] = 0
UNITS: unitless
HF_DE_swift[Freswater_Withdrawals] = IF Number_of_HF_acres>0 THEN -1 ELSE 0
UNITS: unitless
HF_DE_swift[Land_Conversion] = 0
UNITS: unitless
HF_DE_swift[Biodiversity_Loss] = 0
UNITS: unitless
HF_DE_swift[Air_Pollution] = 0

UNITS: unitless
HF_DE_swift[Ozone_Layer_Depletion] = 0
UNITS: unitless
RF_DE_swift[Food_A] = IF Number_of_RF_acres>0 THEN 1 ELSE 0
UNITS: unitless
RF_DE_swift[Food_B] = IF Number_of_RF_acres>0 THEN 1 ELSE 0
UNITS: unitless
RF_DE_swift[Food_C] = IF Number_of_RF_acres>0 THEN 1 ELSE 0
UNITS: unitless
RF_DE_swift[Health_A] = IF Number_of_RF_acres>0 THEN 1 ELSE 0
UNITS: unitless
RF_DE_swift[Health_B] = IF Number_of_RF_acres>0 THEN 1 ELSE 0
UNITS: unitless
RF_DE_swift[Education_A] = IF Number_of_RF_acres>0 THEN 1 ELSE 0
UNITS: unitless
RF_DE_swift[Education_B] = IF Number_of_RF_acres>0 THEN 1 ELSE 0
UNITS: unitless
RF_DE_swift[Income_A] = IF Number_of_RF_acres>0 THEN 1 ELSE 0
UNITS: unitless
RF_DE_swift[Income_B] = IF Number_of_RF_acres>0 THEN 1 ELSE 0
UNITS: unitless
RF_DE_swift[Sanitation] = 0
UNITS: unitless
RF_DE_swift[Energy_A] = 0
UNITS: unitless
RF_DE_swift[Energy_B] = 0
UNITS: unitless
RF_DE_swift[Networks] = 0
UNITS: unitless
RF_DE_swift[Housing_A] = 0
UNITS: unitless
RF_DE_swift[Housing_B] = 0
UNITS: unitless
RF_DE_swift[Gender_Equality_A] = 0
UNITS: unitless
RF_DE_swift[Gender_Equality_B] = 0
UNITS: unitless
RF_DE_swift[Social_Equity] = 0
UNITS: unitless
RF_DE_swift[Political_voice] = 0
UNITS: unitless
RF_DE_swift[Peace_and_Justice_A] = 0
UNITS: unitless
RF_DE_swift[Peace_and_Justice_B] = 0
UNITS: unitless
RF_DE_swift[Climate_Crisis] = IF Number_of_RF_acres>0 THEN -1 ELSE 0

UNITS: unitless
RF_DE_swift[Ocean_Acidification] = 0
UNITS: unitless
RF_DE_swift[Chemical_Pollution] = IF Number_of_RF_acres>0 THEN -1 ELSE 0
UNITS: unitless
RF_DE_swift[Nitrogen_Loading] = IF Number_of_RF_acres>0 THEN -1 ELSE 0
UNITS: unitless
RF_DE_swift[Phosphorus_Loading] = IF Number_of_RF_acres>0 THEN -1 ELSE 0
UNITS: unitless
RF_DE_swift[Freswater_Withdrawals] = IF Number_of_RF_acres>0 THEN -1 ELSE 0
UNITS: unitless
RF_DE_swift[Land_Conversion] = IF Number_of_RF_acres>0 THEN -1 ELSE 0
UNITS: unitless
RF_DE_swift[Biodiversity_Loss] = IF Number_of_RF_acres>0 THEN -1 ELSE 0
UNITS: unitless
RF_DE_swift[Air_Pollution] = 0
UNITS: unitless
RF_DE_swift[Ozone_Layer_Depletion] = 0
UNITS: unitless
SB_DE_swift[Food_A] = 0
UNITS: unitless
SB_DE_swift[Food_B] = 0
UNITS: unitless
SB_DE_swift[Food_C] = 0
UNITS: unitless
SB_DE_swift[Health_A] = IF (Savings_freshwater_on>0 OR Savings_energy_on>0) THEN 1 ELSE 0
UNITS: unitless
SB_DE_swift[Health_B] = IF (Savings_freshwater_on>0 OR Savings_energy_on>0) THEN 1 ELSE 0
UNITS: unitless
SB_DE_swift[Education_A] = IF (Savings_freshwater_on>0 OR Savings_energy_on>0) THEN 1 ELSE 0
UNITS: unitless
SB_DE_swift[Education_B] = IF (Savings_freshwater_on>0 OR Savings_energy_on>0) THEN 1 ELSE 0
UNITS: unitless
SB_DE_swift[Income_A] = IF (Savings_freshwater_on>0 OR Savings_energy_on>0) THEN 1 ELSE 0
UNITS: unitless
SB_DE_swift[Income_B] = IF (Savings_freshwater_on>0 OR Savings_energy_on>0) THEN 1 ELSE 0
UNITS: unitless
SB_DE_swift[Sanitation] = IF (Savings_freshwater_on>0 OR Savings_energy_on>0) THEN 1 ELSE 0
UNITS: unitless

SB_DE_swift[Energy_A] = IF (Savings_freshwater_on>0 OR Savings_energy_on>0) THEN 1 ELSE 0
UNITS: unitless
SB_DE_swift[Energy_B] = IF (Savings_freshwater_on>0 OR Savings_energy_on>0) THEN 1 ELSE 0
UNITS: unitless
SB_DE_swift[Networks] = IF (Savings_freshwater_on>0 OR Savings_energy_on>0) THEN 1 ELSE 0
UNITS: unitless
SB_DE_swift[Housing_A] = IF (Savings_freshwater_on>0 OR Savings_energy_on>0) THEN 1 ELSE 0
UNITS: unitless
SB_DE_swift[Housing_B] = IF (Savings_freshwater_on>0 OR Savings_energy_on>0) THEN 1 ELSE 0
UNITS: unitless
SB_DE_swift[Gender_Equality_A] = 0
UNITS: unitless
SB_DE_swift[Gender_Equality_B] = 0
UNITS: unitless
SB_DE_swift[Social_Equity] = IF (Savings_freshwater_on>0 OR Savings_energy_on>0) THEN 1 ELSE 0
UNITS: unitless
SB_DE_swift[Political_voice] = 0
UNITS: unitless
SB_DE_swift[Peace_and_Justice_A] = 0
UNITS: unitless
SB_DE_swift[Peace_and_Justice_B] = 0
UNITS: unitless
SB_DE_swift[Climate_Crisis] = IF (Savings_freshwater_on>0 OR Savings_energy_on>0) THEN -1 ELSE 0
UNITS: unitless
SB_DE_swift[Ocean_Acidification] = 0
UNITS: unitless
SB_DE_swift[Chemical_Pollution] = IF (Savings_freshwater_on>0 OR Savings_energy_on>0) THEN -1 ELSE 0
UNITS: unitless
SB_DE_swift[Nitrogen_Loading] = 0
UNITS: unitless
SB_DE_swift[Phosphorus_Loading] = 0
UNITS: unitless
SB_DE_swift[Freswater_Withdrawals] = IF (Savings_freshwater_on>0 OR Savings_energy_on>0) THEN -1 ELSE 0
UNITS: unitless
SB_DE_swift[Land_Conversion] = IF (Savings_freshwater_on>0 OR Savings_energy_on>0) THEN 1 ELSE 0
UNITS: unitless

SB_DE_swift[Biodiversity_Loss] = IF (Savings_freshwater_on>0 OR Savings_energy_on>0) THEN 1 ELSE 0
UNITS: unitless
SB_DE_swift[Air_Pollution] = 0
UNITS: unitless
SB_DE_swift[Ozone_Layer_Depletion] = IF (Savings_freshwater_on>0 OR Savings_energy_on>0) THEN -1 ELSE 0
UNITS: unitless
SE_DE_swift[Food_A] = 0
UNITS: unitless
SE_DE_swift[Food_B] = 0
UNITS: unitless
SE_DE_swift[Food_C] = 0
UNITS: unitless
SE_DE_swift[Health_A] = IF SE_ON>0 THEN 1 ELSE 0
UNITS: unitless
SE_DE_swift[Health_B] = IF SE_ON>0 THEN 1 ELSE 0
UNITS: unitless
SE_DE_swift[Education_A] = 0
UNITS: unitless
SE_DE_swift[Education_B] = 0
UNITS: unitless
SE_DE_swift[Income_A] = IF SE_ON>0 THEN 1 ELSE 0
UNITS: unitless
SE_DE_swift[Income_B] = IF SE_ON>0 THEN 1 ELSE 0
UNITS: unitless
SE_DE_swift[Sanitation] = 0
UNITS: unitless
SE_DE_swift[Energy_A] = IF SE_ON>0 THEN 1 ELSE 0
UNITS: unitless
SE_DE_swift[Energy_B] = IF SE_ON>0 THEN 1 ELSE 0
UNITS: unitless
SE_DE_swift[Networks] = 0
UNITS: unitless
SE_DE_swift[Housing_A] = 0
UNITS: unitless
SE_DE_swift[Housing_B] = 0
UNITS: unitless
SE_DE_swift[Gender_Equality_A] = 0
UNITS: unitless
SE_DE_swift[Gender_Equality_B] = 0
UNITS: unitless
SE_DE_swift[Social_Equity] = 0
UNITS: unitless
SE_DE_swift[Political_voice] = 0
UNITS: unitless

SE_DE_swift[Peace_and_Justice_A] = 0
UNITS: unitless
SE_DE_swift[Peace_and_Justice_B] = 0
UNITS: unitless
SE_DE_swift[Climate_Crisis] = IF SE_ON>0 THEN -1 ELSE 0
UNITS: unitless
SE_DE_swift[Ocean_Acidification] = 0
UNITS: unitless
SE_DE_swift[Chemical_Pollution] = IF SE_ON>0 THEN 1 ELSE 0
UNITS: unitless
SE_DE_swift[Nitrogen_Loading] = 0
UNITS: unitless
SE_DE_swift[Phosphorus_Loading] = 0
UNITS: unitless
SE_DE_swift[Freswater_Withdrawals] = IF SE_ON>0 THEN 1 ELSE 0
UNITS: unitless
SE_DE_swift[Land_Conversion] = IF SE_ON>0 THEN 1 ELSE 0
UNITS: unitless
SE_DE_swift[Biodiversity_Loss] = IF SE_ON>0 THEN 1 ELSE 0
UNITS: unitless
SE_DE_swift[Air_Pollution] = IF SE_ON>0 THEN -1 ELSE 0
UNITS: unitless
SE_DE_swift[Ozone_Layer_Depletion] = 0
UNITS: unitless
WE_DE_swift[Food_A] = 0
UNITS: unitless
WE_DE_swift[Food_B] = 0
UNITS: unitless
WE_DE_swift[Food_C] = 0
UNITS: unitless
WE_DE_swift[Health_A] = IF WE_ON>0 THEN 1 ELSE 0
UNITS: unitless
WE_DE_swift[Health_B] = IF WE_ON>0 THEN 1 ELSE 0
UNITS: unitless
WE_DE_swift[Education_A] = 0
UNITS: unitless
WE_DE_swift[Education_B] = 0
UNITS: unitless
WE_DE_swift[Income_A] = IF WE_ON>0 THEN 1 ELSE 0
UNITS: unitless
WE_DE_swift[Income_B] = IF WE_ON>0 THEN 1 ELSE 0
UNITS: unitless
WE_DE_swift[Sanitation] = 0
UNITS: unitless
WE_DE_swift[Energy_A] = IF WE_ON>0 THEN 1 ELSE 0
UNITS: unitless

WE_DE_swift[Energy_B] = IF WE_ON>0 THEN 1 ELSE 0
UNITS: unitless
WE_DE_swift[Networks] = 0
UNITS: unitless
WE_DE_swift[Housing_A] = 0
UNITS: unitless
WE_DE_swift[Housing_B] = 0
UNITS: unitless
WE_DE_swift[Gender_Equality_A] = 0
UNITS: unitless
WE_DE_swift[Gender_Equality_B] = 0
UNITS: unitless
WE_DE_swift[Social_Equity] = 0
UNITS: unitless
WE_DE_swift[Political_voice] = 0
UNITS: unitless
WE_DE_swift[Peace_and_Justice_A] = 0
UNITS: unitless
WE_DE_swift[Peace_and_Justice_B] = 0
UNITS: unitless
WE_DE_swift[Climate_Crisis] = IF WE_ON>0 THEN -1 ELSE 0
UNITS: unitless
WE_DE_swift[Ocean_Acidification] = 0
UNITS: unitless
WE_DE_swift[Chemical_Pollution] = IF WE_ON>0 THEN 1 ELSE 0
UNITS: unitless
WE_DE_swift[Nitrogen_Loading] = 0
UNITS: unitless
WE_DE_swift[Phosphorus_Loading] = 0
UNITS: unitless
WE_DE_swift[Freswater_Withdrawals] = IF WE_ON>0 THEN -1 ELSE 0
UNITS: unitless
WE_DE_swift[Land_Conversion] = IF WE_ON>0 THEN 1 ELSE 0
UNITS: unitless
WE_DE_swift[Biodiversity_Loss] = IF WE_ON>0 THEN 1 ELSE 0
UNITS: unitless
WE_DE_swift[Air_Pollution] = IF WE_ON>0 THEN -1 ELSE 0
UNITS: unitless
WE_DE_swift[Ozone_Layer_Depletion] = 0
UNITS: unitless

****
Doughnut_Economics:
****
Children_Food_value = Weight_Food_2* (IF Children_rate_model=1 THEN 1 ELSE Dynamic_food_sufficiency_children+ Children_rate_model)

UNITS: percentage
Children_rate_model = IF Meals_per_year > Meal_required_per_year_children THEN 1 ELSE (Meals_per_year/Meal_required_per_year_children)
UNITS: meals per year
Conventional_Farms_after_strategies = SN_Area_farms_available-Number_of_HF_acres-Number_of_RF_acres
UNITS: Acres
EA_indicator = Dynamic_accesibility*Weight
UNITS: percentage
Energy_value = EA_indicator+RN_indicator
UNITS: percentage
Food_Doughnut_Economics = Yield_food_value+Food_insecurity_value_1+Children_Food_value
UNITS: unitless
Food_insecurity_rate_model = Meals_per_year/Meal_required_per_year
UNITS: percentage
Food_insecurity_value_1 = Weight_Food_1*(Food_insecurity_rate_model-Dynamic_food_insecurity)
UNITS: percentage
HF_Productivity = 10
UNITS: USD per acre
HF_yield = Number_of_HF_acres*HF_Productivity*Average_farmland_income
UNITS: USD per acre
Meals_per_year = 0
UNITS: meals per year
NV_Doughnut_Freshwater_Withdrawal = (SN_Freshwater_withdrawal_total-Savings_freshwater-(Savings_freshwater_in_Urban_Env_GR*GR_pct_total)-(Saving_freshwater_in_Farm_Env_GR*GR_pct_total_1)-Total_water_saving_HF-Total_water_saving_RF)/Population
REPORT IN TABLE AS STOCK
UNITS: gpcd
NV_Doughnut_Renewable_Energy = (SN_Renewables+Solar_energy+Wind_energy+Geothermal_energy)/(SN_Energy_Demand-Savings_energy+Total_electricity_EV+Average_cold_storage_energy_consumption_2+Energy_demand_HF)
UNITS: percentage
Optimal_yield = 9000
UNITS: USD per acre
RF_yield_model = Number_of_RF_acres*Average_Yield_increment*Average_farmland_income
UNITS: USD per acre
RN_indicator = Weight*NV_Doughnut_Renewable_Energy
UNITS: percentage
Sustainable_goal = 9000
UNITS: USD per acre

Total_yield =
((Conventional_Farms_after_strategies*Average_farmland_income)+HF_yield+RF_yield_model)/SN_Area_farms_available
UNITS: USD per acre
Weight = 0.5
UNITS: percentage
Weight_Food_1 = .34
UNITS: percentage
Weight_Food_2 = 0.33
UNITS: percentage
Weight_Food_3 = 0.33
UNITS: percentage
Yield_food_value = Weight_Food_3*(IF Total_yield<Optimal_yield THEN (Total_yield/Optimal_yield) ELSE Average_farmland_income/Sustainable_goal)
UNITS: unitless

****
EV_Landscape_Units:
****
EV_LU_1 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
EV_LU_2 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
EV_LU_3 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
EV_LU_4 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
EV_LU_5 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
EV_option_1 = IF EV_LU_1=1 THEN EV_per_Landscape_Unit[1] ELSE 0 OR IF EV_LU_1=2 THEN EV_per_Landscape_Unit[2] ELSE 0 OR IF EV_LU_1=3 THEN EV_per_Landscape_Unit[3] ELSE 0 OR IF EV_LU_1=4 THEN EV_per_Landscape_Unit[4] ELSE 0 OR IF EV_LU_1=5 THEN EV_per_Landscape_Unit[5] ELSE 0 OR IF EV_LU_1=6 THEN EV_per_Landscape_Unit[6] ELSE 0 OR IF EV_LU_1=7 THEN EV_per_Landscape_Unit[7] ELSE 0 OR IF EV_LU_1=8 THEN EV_per_Landscape_Unit[8] ELSE 0 OR IF EV_LU_1=9 THEN EV_per_Landscape_Unit[9] ELSE 0 OR IF EV_LU_1=10 THEN EV_per_Landscape_Unit[10] ELSE 0 OR IF EV_LU_1=11 THEN EV_per_Landscape_Unit[11] ELSE 0 OR IF EV_LU_1=12 THEN EV_per_Landscape_Unit[12] ELSE 0 OR IF EV_LU_1=13 THEN EV_per_Landscape_Unit[13] ELSE 0 OR IF EV_LU_1=14 THEN EV_per_Landscape_Unit[14]ELSE 0 OR IF EV_LU_1=15 THEN EV_per_Landscape_Unit[15] ELSE 0 OR IF EV_LU_1=16 THEN EV_per_Landscape_Unit[16]

ELSE 0 OR IF EV_LU_1=17 THEN EV_per_Landscape_Unit[17] ELSE 0 OR IF EV_LU_1=18 THEN EV_per_Landscape_Unit[18] ELSE 0 OR IF EV_LU_1=19 THEN EV_per_Landscape_Unit[19] ELSE 0 OR IF EV_LU_1=20 THEN EV_per_Landscape_Unit[20]ELSE 0 OR IF EV_LU_1=21 THEN EV_per_Landscape_Unit[21] ELSE 0 OR IF EV_LU_1=22 THEN EV_per_Landscape_Unit[22]ELSE 0 OR IF EV_LU_1=23 THEN EV_per_Landscape_Unit[23] ELSE 0 OR IF EV_LU_1=24 THEN EV_per_Landscape_Unit[24] ELSE 0 OR IF EV_LU_1=25 THEN EV_per_Landscape_Unit[25]ELSE 0 OR IF EV_LU_1=26 THEN EV_per_Landscape_Unit[26] ELSE 0

UNITS: unitless

EV_option_2 = IF EV_LU_2=1 THEN EV_per_Landscape_Unit[1] ELSE 0 OR IF EV_LU_2=2 THEN EV_per_Landscape_Unit[2] ELSE 0 OR IF EV_LU_2=3 THEN EV_per_Landscape_Unit[3] ELSE 0 OR IF EV_LU_2=4 THEN EV_per_Landscape_Unit[4] ELSE 0 OR IF EV_LU_2=5 THEN EV_per_Landscape_Unit[5] ELSE 0 OR IF EV_LU_2=6 THEN EV_per_Landscape_Unit[6] ELSE 0 OR IF EV_LU_2=7 THEN EV_per_Landscape_Unit[7] ELSE 0 OR IF EV_LU_2=8 THEN EV_per_Landscape_Unit[8] ELSE 0 OR IF EV_LU_2=9 THEN EV_per_Landscape_Unit[9] ELSE 0 OR IF EV_LU_2=10 THEN EV_per_Landscape_Unit[10] ELSE 0 OR IF EV_LU_2=11 THEN EV_per_Landscape_Unit[11] ELSE 0 OR IF EV_LU_2=12 THEN EV_per_Landscape_Unit[12] ELSE 0 OR IF EV_LU_2=13 THEN EV_per_Landscape_Unit[13] ELSE 0 OR IF EV_LU_2=14 THEN EV_per_Landscape_Unit[14]ELSE 0 OR IF EV_LU_2=15 THEN EV_per_Landscape_Unit[15] ELSE 0 OR IF EV_LU_2=16 THEN EV_per_Landscape_Unit[16] ELSE 0 OR IF EV_LU_2=17 THEN EV_per_Landscape_Unit[17] ELSE 0 OR IF EV_LU_2=18 THEN EV_per_Landscape_Unit[18] ELSE 0 OR IF EV_LU_2=19 THEN EV_per_Landscape_Unit[19] ELSE 0 OR IF EV_LU_2=20 THEN EV_per_Landscape_Unit[20]ELSE 0 OR IF EV_LU_2=21 THEN EV_per_Landscape_Unit[21] ELSE 0 OR IF EV_LU_2=22 THEN EV_per_Landscape_Unit[22]ELSE 0 OR IF EV_LU_2=23 THEN EV_per_Landscape_Unit[23] ELSE 0 OR IF EV_LU_2=24 THEN EV_per_Landscape_Unit[24] ELSE 0 OR IF EV_LU_2=25 THEN EV_per_Landscape_Unit[25]ELSE 0 OR IF EV_LU_2=26 THEN EV_per_Landscape_Unit[26] ELSE 0

UNITS: unitless

EV_option_3 = IF EV_LU_3=1 THEN EV_per_Landscape_Unit[1] ELSE 0 OR IF EV_LU_3=2 THEN EV_per_Landscape_Unit[2] ELSE 0 OR IF EV_LU_3=3 THEN EV_per_Landscape_Unit[3] ELSE 0 OR IF EV_LU_3=4 THEN EV_per_Landscape_Unit[4] ELSE 0 OR IF EV_LU_3=5 THEN EV_per_Landscape_Unit[5] ELSE 0 OR IF EV_LU_3=6 THEN EV_per_Landscape_Unit[6] ELSE 0 OR IF EV_LU_3=7 THEN EV_per_Landscape_Unit[7] ELSE 0 OR IF EV_LU_3=8 THEN EV_per_Landscape_Unit[8] ELSE 0 OR IF EV_LU_3=9 THEN EV_per_Landscape_Unit[9] ELSE 0 OR IF EV_LU_3=10 THEN EV_per_Landscape_Unit[10] ELSE 0 OR IF EV_LU_3=11 THEN EV_per_Landscape_Unit[11] ELSE 0 OR IF EV_LU_3=12 THEN EV_per_Landscape_Unit[12] ELSE 0 OR IF EV_LU_3=13 THEN EV_per_Landscape_Unit[13] ELSE 0 OR IF EV_LU_3=14 THEN EV_per_Landscape_Unit[14]ELSE 0 OR IF EV_LU_3=15 THEN EV_per_Landscape_Unit[15] ELSE 0 OR IF EV_LU_3=16 THEN EV_per_Landscape_Unit[16] ELSE 0 OR IF EV_LU_3=17 THEN EV_per_Landscape_Unit[17] ELSE 0 OR IF EV_LU_3=18 THEN EV_per_Landscape_Unit[18] ELSE 0 OR IF EV_LU_3=19 THEN

EV_per_Landscape_Unit[19] ELSE 0 OR IF EV_LU_3=20 THEN EV_per_Landscape_Unit[20]ELSE 0 OR IF EV_LU_3=21 THEN EV_per_Landscape_Unit[21] ELSE 0 OR IF EV_LU_3=22 THEN EV_per_Landscape_Unit[22]ELSE 0 OR IF EV_LU_3=23 THEN EV_per_Landscape_Unit[23] ELSE 0 OR IF EV_LU_3=24 THEN EV_per_Landscape_Unit[24] ELSE 0 OR IF EV_LU_3=25 THEN EV_per_Landscape_Unit[25]ELSE 0 OR IF EV_LU_3=26 THEN EV_per_Landscape_Unit[26] ELSE 0

UNITS: unitless

EV_option_4 = IF EV_LU_4=1 THEN EV_per_Landscape_Unit[1] ELSE 0 OR IF EV_LU_4=2 THEN EV_per_Landscape_Unit[2] ELSE 0 OR IF EV_LU_4=3 THEN EV_per_Landscape_Unit[3] ELSE 0 OR IF EV_LU_4=4 THEN EV_per_Landscape_Unit[4] ELSE 0 OR IF EV_LU_4=5 THEN EV_per_Landscape_Unit[5] ELSE 0 OR IF EV_LU_4=6 THEN EV_per_Landscape_Unit[6] ELSE 0 OR IF EV_LU_4=7 THEN EV_per_Landscape_Unit[7] ELSE 0 OR IF EV_LU_4=8 THEN EV_per_Landscape_Unit[8] ELSE 0 OR IF EV_LU_4=9 THEN EV_per_Landscape_Unit[9] ELSE 0 OR IF EV_LU_4=10 THEN EV_per_Landscape_Unit[10] ELSE 0 OR IF EV_LU_4=11 THEN EV_per_Landscape_Unit[11] ELSE 0 OR IF EV_LU_4=12 THEN EV_per_Landscape_Unit[12] ELSE 0 OR IF EV_LU_4=13 THEN EV_per_Landscape_Unit[13] ELSE 0 OR IF EV_LU_4=14 THEN EV_per_Landscape_Unit[14]ELSE 0 OR IF EV_LU_4=15 THEN EV_per_Landscape_Unit[15] ELSE 0 OR IF EV_LU_4=16 THEN EV_per_Landscape_Unit[16] ELSE 0 OR IF EV_LU_4=17 THEN EV_per_Landscape_Unit[17] ELSE 0 OR IF EV_LU_4=18 THEN EV_per_Landscape_Unit[18] ELSE 0 OR IF EV_LU_4=19 THEN EV_per_Landscape_Unit[19] ELSE 0 OR IF EV_LU_4=20 THEN EV_per_Landscape_Unit[20]ELSE 0 OR IF EV_LU_4=21 THEN EV_per_Landscape_Unit[21] ELSE 0 OR IF EV_LU_4=22 THEN EV_per_Landscape_Unit[22]ELSE 0 OR IF EV_LU_4=23 THEN EV_per_Landscape_Unit[23] ELSE 0 OR IF EV_LU_4=24 THEN EV_per_Landscape_Unit[24] ELSE 0 OR IF EV_LU_4=25 THEN EV_per_Landscape_Unit[25]ELSE 0 OR IF EV_LU_4=26 THEN EV_per_Landscape_Unit[26] ELSE 0

UNITS: unitless

EV_option_5 = IF EV_LU_5=1 THEN EV_per_Landscape_Unit[1] ELSE 0 OR IF EV_LU_5=2 THEN EV_per_Landscape_Unit[2] ELSE 0 OR IF EV_LU_5=3 THEN EV_per_Landscape_Unit[3] ELSE 0 OR IF EV_LU_5=4 THEN EV_per_Landscape_Unit[4] ELSE 0 OR IF EV_LU_5=5 THEN EV_per_Landscape_Unit[5] ELSE 0 OR IF EV_LU_5=6 THEN EV_per_Landscape_Unit[6] ELSE 0 OR IF EV_LU_5=7 THEN EV_per_Landscape_Unit[7] ELSE 0 OR IF EV_LU_5=8 THEN EV_per_Landscape_Unit[8] ELSE 0 OR IF EV_LU_5=9 THEN EV_per_Landscape_Unit[9] ELSE 0 OR IF EV_LU_5=10 THEN EV_per_Landscape_Unit[10] ELSE 0 OR IF EV_LU_5=11 THEN EV_per_Landscape_Unit[11] ELSE 0 OR IF EV_LU_5=12 THEN EV_per_Landscape_Unit[12] ELSE 0 OR IF EV_LU_5=13 THEN EV_per_Landscape_Unit[13] ELSE 0 OR IF EV_LU_5=14 THEN EV_per_Landscape_Unit[14]ELSE 0 OR IF EV_LU_5=15 THEN EV_per_Landscape_Unit[15] ELSE 0 OR IF EV_LU_5=16 THEN EV_per_Landscape_Unit[16] ELSE 0 OR IF EV_LU_5=17 THEN EV_per_Landscape_Unit[17] ELSE 0 OR IF EV_LU_5=18 THEN EV_per_Landscape_Unit[18] ELSE 0 OR IF EV_LU_5=19 THEN EV_per_Landscape_Unit[19] ELSE 0 OR IF EV_LU_5=20 THEN EV_per_Landscape_Unit[20]ELSE 0 OR IF EV_LU_5=21 THEN EV_per_Landscape_Unit[21]

ELSE 0 OR IF EV_LU_5=22 THEN EV_per_Landscape_Unit[22]ELSE 0 OR IF EV_LU_5=23 THEN EV_per_Landscape_Unit[23] ELSE 0 OR IF EV_LU_5=24 THEN EV_per_Landscape_Unit[24] ELSE 0 OR IF EV_LU_5=25 THEN EV_per_Landscape_Unit[25]ELSE 0 OR IF EV_LU_5=26 THEN EV_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
EV_pct_1 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
EV_pct_2 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
EV_pct_3 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
EV_pct_4 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
EV_pct_5 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
EV_pct_total = IF (EV_pct_1+EV_pct_2+EV_pct_3+EV_pct_4+EV_pct_5)<=1 THEN EV_pct_1+EV_pct_2+EV_pct_3+EV_pct_4+EV_pct_5 ELSE 0
UNITS: percentage
EV_Suitability = IF EV_on>0 THEN ((EV_pct_1*EV_option_1)+(EV_pct_2*EV_option_2)+(EV_pct_3*EV_option_3)+(EV_pct_4*EV_option_4)+(EV_pct_5*EV_option_5)) ELSE 0
UNITS: unitless
EV_valve = IF EV_pct_total<=1 THEN EV_on ELSE 0
UNITS: EV vehicles

****
Farm_productivity:
****
Average_farm_productivity_with_inflation = Average_farmland_income*inflation_rate {UNIFLOW}
UNITS: USD/acre/Years
Average_farmland_income(t) = Average_farmland_income(t - dt) + (Average_farm_productivity_with_inflation) * dt {NON-NEGATIVE}
INIT Average_farmland_income = 129
UNITS: USD/acre
inflation_rate = 0.0238
UNITS: percentage
SN_Area_farms_available = 66257+93344+27454+1965
UNITS: acres
SN_Farm_Profit = SN_Area_farms_available*Average_farmland_income

UNITS: US/ Acre

****
FB_Landscape_Units:
****
Average_cold_storage_energy_consumption_2 =
(Energy_consumption_per_sq_foot_2*Storage_area_2)/1000
UNITS: MW per year
Energy_consumption_per_sq_foot_2 = 25
UNITS: kwh per square foot
FB_LU_1 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
FB_LU_2 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
FB_LU_3 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
FB_LU_4 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
FB_LU_5 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
FB_option_1 = IF FB_LU_1=1 THEN FB_per_Landscape_Unit[1] ELSE 0 OR IF FB_LU_1=2 THEN FB_per_Landscape_Unit[2] ELSE 0 OR IF FB_LU_1=3 THEN FB_per_Landscape_Unit[3] ELSE 0 OR IF FB_LU_1=4 THEN FB_per_Landscape_Unit[4] ELSE 0 OR IF FB_LU_1=5 THEN FB_per_Landscape_Unit[5] ELSE 0 OR IF FB_LU_1=6 THEN FB_per_Landscape_Unit[6] ELSE 0 OR IF FB_LU_1=7 THEN FB_per_Landscape_Unit[7] ELSE 0 OR IF FB_LU_1=8 THEN FB_per_Landscape_Unit[8] ELSE 0 OR IF FB_LU_1=9 THEN FB_per_Landscape_Unit[9] ELSE 0 OR IF FB_LU_1=10 THEN FB_per_Landscape_Unit[10] ELSE 0 OR IF FB_LU_1=11 THEN FB_per_Landscape_Unit[11] ELSE 0 OR IF FB_LU_1=12 THEN FB_per_Landscape_Unit[12] ELSE 0 OR IF FB_LU_1=13 THEN FB_per_Landscape_Unit[13] ELSE 0 OR IF FB_LU_1=14 THEN FB_per_Landscape_Unit[14]ELSE 0 OR IF FB_LU_1=15 THEN FB_per_Landscape_Unit[15] ELSE 0 OR IF FB_LU_1=16 THEN FB_per_Landscape_Unit[16] ELSE 0 OR IF FB_LU_1=17 THEN FB_per_Landscape_Unit[17] ELSE 0 OR IF FB_LU_1=18 THEN FB_per_Landscape_Unit[18] ELSE 0 OR IF FB_LU_1=20 THEN FB_per_Landscape_Unit[20]ELSE 0 OR IF FB_LU_1=21 THEN FB_per_Landscape_Unit[21] ELSE 0 OR IF FB_LU_1=22 THEN FB_per_Landscape_Unit[22]ELSE 0 OR IF FB_LU_1=23 THEN FB_per_Landscape_Unit[23] ELSE 0 OR IF FB_LU_1=24 THEN FB_per_Landscape_Unit[24] ELSE 0 OR IF FB_LU_1=25 THEN FB_per_Landscape_Unit[25]ELSE 0 OR IF FB_LU_1=26 THEN FB_per_Landscape_Unit[26] ELSE 0
UNITS: unitless

FB_option_2 = IF FB_LU_2=1 THEN FB_per_Landscape_Unit[1] ELSE 0 OR IF FB_LU_2=2 THEN FB_per_Landscape_Unit[2] ELSE 0 OR IF FB_LU_2=3 THEN FB_per_Landscape_Unit[3] ELSE 0 OR IF FB_LU_2=4 THEN FB_per_Landscape_Unit[4] ELSE 0 OR IF FB_LU_2=5 THEN FB_per_Landscape_Unit[5] ELSE 0 OR IF FB_LU_2=6 THEN FB_per_Landscape_Unit[6] ELSE 0 OR IF FB_LU_2=7 THEN FB_per_Landscape_Unit[7] ELSE 0 OR IF FB_LU_2=8 THEN FB_per_Landscape_Unit[8] ELSE 0 OR IF FB_LU_2=9 THEN FB_per_Landscape_Unit[9] ELSE 0 OR IF FB_LU_2=10 THEN FB_per_Landscape_Unit[10] ELSE 0 OR IF FB_LU_2=11 THEN FB_per_Landscape_Unit[11] ELSE 0 OR IF FB_LU_2=12 THEN FB_per_Landscape_Unit[12] ELSE 0 OR IF FB_LU_2=13 THEN FB_per_Landscape_Unit[13] ELSE 0 OR IF FB_LU_2=14 THEN FB_per_Landscape_Unit[14]ELSE 0 OR IF FB_LU_2=15 THEN FB_per_Landscape_Unit[15] ELSE 0 OR IF FB_LU_2=16 THEN FB_per_Landscape_Unit[16] ELSE 0 OR IF FB_LU_2=17 THEN FB_per_Landscape_Unit[17] ELSE 0 OR IF FB_LU_2=18 THEN FB_per_Landscape_Unit[18] ELSE 0 OR IF FB_LU_2=20 THEN FB_per_Landscape_Unit[20]ELSE 0 OR IF FB_LU_2=21 THEN FB_per_Landscape_Unit[21] ELSE 0 OR IF FB_LU_2=22 THEN FB_per_Landscape_Unit[22]ELSE 0 OR IF FB_LU_2=23 THEN FB_per_Landscape_Unit[23] ELSE 0 OR IF FB_LU_2=24 THEN FB_per_Landscape_Unit[24] ELSE 0 OR IF FB_LU_2=25 THEN FB_per_Landscape_Unit[25]ELSE 0 OR IF FB_LU_2=26 THEN FB_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
FB_option_3 = IF FB_LU_3=1 THEN FB_per_Landscape_Unit[1] ELSE 0 OR IF FB_LU_3=2 THEN FB_per_Landscape_Unit[2] ELSE 0 OR IF FB_LU_3=3 THEN FB_per_Landscape_Unit[3] ELSE 0 OR IF FB_LU_3=4 THEN FB_per_Landscape_Unit[4] ELSE 0 OR IF FB_LU_3=5 THEN FB_per_Landscape_Unit[5] ELSE 0 OR IF FB_LU_3=6 THEN FB_per_Landscape_Unit[6] ELSE 0 OR IF FB_LU_3=7 THEN FB_per_Landscape_Unit[7] ELSE 0 OR IF FB_LU_3=8 THEN FB_per_Landscape_Unit[8] ELSE 0 OR IF FB_LU_3=9 THEN FB_per_Landscape_Unit[9] ELSE 0 OR IF FB_LU_3=10 THEN FB_per_Landscape_Unit[10] ELSE 0 OR IF FB_LU_3=11 THEN FB_per_Landscape_Unit[11] ELSE 0 OR IF FB_LU_3=12 THEN FB_per_Landscape_Unit[12] ELSE 0 OR IF FB_LU_3=13 THEN FB_per_Landscape_Unit[13] ELSE 0 OR IF FB_LU_3=14 THEN FB_per_Landscape_Unit[14]ELSE 0 OR IF FB_LU_3=15 THEN FB_per_Landscape_Unit[15] ELSE 0 OR IF FB_LU_3=16 THEN FB_per_Landscape_Unit[16] ELSE 0 OR IF FB_LU_3=17 THEN FB_per_Landscape_Unit[17] ELSE 0 OR IF FB_LU_3=18 THEN FB_per_Landscape_Unit[18] ELSE 0 OR IF FB_LU_3=20 THEN FB_per_Landscape_Unit[20]ELSE 0 OR IF FB_LU_3=21 THEN FB_per_Landscape_Unit[21] ELSE 0 OR IF FB_LU_3=22 THEN FB_per_Landscape_Unit[22]ELSE 0 OR IF FB_LU_3=23 THEN FB_per_Landscape_Unit[23] ELSE 0 OR IF FB_LU_3=24 THEN FB_per_Landscape_Unit[24] ELSE 0 OR IF FB_LU_3=25 THEN FB_per_Landscape_Unit[25]ELSE 0 OR IF FB_LU_3=26 THEN FB_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
FB_option_4 = IF FB_LU_4=1 THEN FB_per_Landscape_Unit[1] ELSE 0 OR IF FB_LU_4=2 THEN FB_per_Landscape_Unit[2] ELSE 0 OR IF FB_LU_4=3 THEN FB_per_Landscape_Unit[3] ELSE 0 OR IF FB_LU_4=4 THEN FB_per_Landscape_Unit[4] ELSE 0 OR IF FB_LU_4=5 THEN FB_per_Landscape_Unit[5] ELSE 0 OR IF FB_LU_4=6

THEN FB_per_Landscape_Unit[6] ELSE 0 OR IF FB_LU_4=7 THEN
FB_per_Landscape_Unit[7] ELSE 0 OR IF FB_LU_4=8 THEN FB_per_Landscape_Unit[8]
ELSE 0 OR IF FB_LU_4=9 THEN FB_per_Landscape_Unit[9] ELSE 0 OR IF FB_LU_4=10
THEN FB_per_Landscape_Unit[10] ELSE 0 OR IF FB_LU_4=11 THEN
FB_per_Landscape_Unit[11] ELSE 0 OR IF FB_LU_4=12 THEN FB_per_Landscape_Unit[12]
ELSE 0 OR IF FB_LU_4=13 THEN FB_per_Landscape_Unit[13] ELSE 0 OR IF FB_LU_4=14
THEN FB_per_Landscape_Unit[14]ELSE 0 OR IF FB_LU_4=15 THEN
FB_per_Landscape_Unit[15] ELSE 0 OR IF FB_LU_4=16 THEN FB_per_Landscape_Unit[16]
ELSE 0 OR IF FB_LU_4=17 THEN FB_per_Landscape_Unit[17] ELSE 0 OR IF FB_LU_4=18
THEN FB_per_Landscape_Unit[18] ELSE 0 OR IF FB_LU_4=20 THEN
FB_per_Landscape_Unit[20]ELSE 0 OR IF FB_LU_4=21 THEN FB_per_Landscape_Unit[21]
ELSE 0 OR IF FB_LU_4=22 THEN FB_per_Landscape_Unit[22]ELSE 0 OR IF FB_LU_4=23
THEN FB_per_Landscape_Unit[23] ELSE 0 OR IF FB_LU_4=24 THEN
FB_per_Landscape_Unit[24] ELSE 0 OR IF FB_LU_4=25 THEN
FB_per_Landscape_Unit[25]ELSE 0 OR IF FB_LU_4=26 THEN FB_per_Landscape_Unit[26]
ELSE 0
UNITS: unitless
FB_option_5 = IF FB_LU_5=1 THEN FB_per_Landscape_Unit[1] ELSE 0 OR IF FB_LU_5=2
THEN FB_per_Landscape_Unit[2] ELSE 0 OR IF FB_LU_5=3 THEN
FB_per_Landscape_Unit[3] ELSE 0 OR IF FB_LU_5=4 THEN FB_per_Landscape_Unit[4]
ELSE 0 OR IF FB_LU_5=5 THEN FB_per_Landscape_Unit[5] ELSE 0 OR IF FB_LU_5=6
THEN FB_per_Landscape_Unit[6] ELSE 0 OR IF FB_LU_5=7 THEN
FB_per_Landscape_Unit[7] ELSE 0 OR IF FB_LU_5=8 THEN FB_per_Landscape_Unit[8]
ELSE 0 OR IF FB_LU_5=9 THEN FB_per_Landscape_Unit[9] ELSE 0 OR IF FB_LU_5=10
THEN FB_per_Landscape_Unit[10] ELSE 0 OR IF FB_LU_5=11 THEN
FB_per_Landscape_Unit[11] ELSE 0 OR IF FB_LU_5=12 THEN FB_per_Landscape_Unit[12]
ELSE 0 OR IF FB_LU_5=13 THEN FB_per_Landscape_Unit[13] ELSE 0 OR IF FB_LU_5=14
THEN FB_per_Landscape_Unit[14]ELSE 0 OR IF FB_LU_5=15 THEN
FB_per_Landscape_Unit[15] ELSE 0 OR IF FB_LU_5=16 THEN FB_per_Landscape_Unit[16]
ELSE 0 OR IF FB_LU_5=17 THEN FB_per_Landscape_Unit[17] ELSE 0 OR IF FB_LU_5=18
THEN FB_per_Landscape_Unit[18] ELSE 0 OR IF FB_LU_5=20 THEN
FB_per_Landscape_Unit[20]ELSE 0 OR IF FB_LU_5=21 THEN FB_per_Landscape_Unit[21]
ELSE 0 OR IF FB_LU_5=22 THEN FB_per_Landscape_Unit[22]ELSE 0 OR IF FB_LU_5=23
THEN FB_per_Landscape_Unit[23] ELSE 0 OR IF FB_LU_5=24 THEN
FB_per_Landscape_Unit[24] ELSE 0 OR IF FB_LU_5=25 THEN
FB_per_Landscape_Unit[25]ELSE 0 OR IF FB_LU_5=26 THEN FB_per_Landscape_Unit[26]
ELSE 0
UNITS: unitless
FB_pct_1 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
FB_pct_2 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
FB_pct_3 = 0
REPORT IN TABLE AS STOCK

UNITS: percentage
FB_pct_4 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
FB_pct_5 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
FB_pct_total = IF (FB_pct_1+FB_pct_2+FB_pct_3+FB_pct_4+FB_pct_5)<=1 THEN FB_pct_1+FB_pct_2+FB_pct_3+FB_pct_4+FB_pct_5 ELSE 0
UNITS: percentage
FB_Storage_area_acre_1 = Storage_area_2/43560
UNITS: Acres
FB_Suitability = IF Meals_per_year>0 THEN ((FB_pct_1*FB_option_1)+(FB_pct_2*FB_option_2)+(FB_pct_3*FB_option_3)+(FB_pct_4*FB_option_4)+(FB_pct_5*FB_option_5)) ELSE 0
UNITS: unitless
FB_valve = IF FB_pct_total<=1 THEN Meals_per_year ELSE 0
UNITS: EV vehicles
Meals_in_sqfoot2 = 12
UNITS: meals pear square foot
Storage_area_2 = (Meals_per_year/Meals_in_sqfoot2)/(365/Storage_time2)
UNITS: Square Feet
Storage_time2 = 2
UNITS: days

****
Food_Sufficiency_Children:
****
"%_Children_0-17" = 0.222
UNITS: percentage
"%_Food_sufficiency" = 0.645
UNITS: percentage
Dynamic_food_sufficiency_children = Population*"%_Children_0-17"*"%_Food_sufficiency"/(Population*"%_Children_0-17")
UNITS: percentage

****
GE_Landscape_Units:
****
GE_Carrying_capacity = 0.1
UNITS: percentage
GE_desired_land_1 = IF GE_pct_total<=1 THEN GE_pct_1*Geothermal_energy_area ELSE 0
UNITS: Square Kilometers
GE_desired_land_2 = IF GE_pct_total<=1 THEN GE_pct_2*Geothermal_energy_area ELSE 0
UNITS: MW per year
GE_desired_land_3 = IF GE_pct_total<=1 THEN GE_pct_3*Geothermal_energy_area ELSE 0

UNITS: MW per year
GE_desired_land_4 = IF GE_pct_total<=1 THEN GE_pct_4*Geothermal_energy_area ELSE 0
UNITS: MW per year
GE_desired_land_5 = IF GE_pct_total<=1 THEN GE_pct_5*Geothermal_energy_area ELSE 0
UNITS: MW per year
GE_energy_in_a_LU_1 = IF GE_desired_land_1<=GE_land_available_1 THEN Geothermal_energy*GE_pct_1 ELSE 0
UNITS: MW per year
GE_energy_in_a_LU_2 = IF GE_desired_land_2<=GE_land_available_2 THEN Geothermal_energy*GE_pct_2 ELSE 0
UNITS: MW per year
GE_energy_in_a_LU_3 = IF GE_desired_land_3<=GE_land_available_3 THEN Geothermal_energy*GE_pct_3 ELSE 0
UNITS: MW per year
GE_energy_in_a_LU_4 = IF GE_desired_land_4<=GE_land_available_4 THEN Geothermal_energy*GE_pct_4 ELSE 0
UNITS: MW per year
GE_energy_in_a_LU_5 = IF GE_desired_land_5<=GE_land_available_5 THEN Geothermal_energy*GE_pct_5 ELSE 0
UNITS: MW per year
GE_land_available_1 = IF GE_LU_1=1 THEN
Landscape_Unit_Areas[1]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=2 THEN
Landscape_Unit_Areas[2]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=3 THEN
Landscape_Unit_Areas[3]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=4 THEN
Landscape_Unit_Areas[4]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=5 THEN
Landscape_Unit_Areas[5]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=6 THEN
Landscape_Unit_Areas[6]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=7 THEN
Landscape_Unit_Areas[7]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=8 THEN
Landscape_Unit_Areas[8]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=9 THEN
Landscape_Unit_Areas[9]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=10 THEN
Landscape_Unit_Areas[10]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=11 THEN
Landscape_Unit_Areas[11]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=12 THEN
Landscape_Unit_Areas[12]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=13 THEN
Landscape_Unit_Areas[13]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=14 THEN
Landscape_Unit_Areas[14]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=15 THEN
Landscape_Unit_Areas[15]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=16 THEN
Landscape_Unit_Areas[16]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=17 THEN
Landscape_Unit_Areas[17]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=18 THEN
Landscape_Unit_Areas[18]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=19 THEN
Landscape_Unit_Areas[19]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=20 THEN
Landscape_Unit_Areas[20]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=21 THEN
Landscape_Unit_Areas[21]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=22 THEN
Landscape_Unit_Areas[22]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=23 THEN
Landscape_Unit_Areas[23]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=24 THEN
Landscape_Unit_Areas[24]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=25 THEN

Landscape_Unit_Areas[25]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_1=26 THEN
Landscape_Unit_Areas[26]*GE_Carrying_capacity ELSE 0
UNITS: Square Kilometers
GE_land_available_2 = IF GE_LU_2=1 THEN
Landscape_Unit_Areas[1]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=2 THEN
Landscape_Unit_Areas[2]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=3 THEN
Landscape_Unit_Areas[3]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=4 THEN
Landscape_Unit_Areas[4]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=5 THEN
Landscape_Unit_Areas[5]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=6 THEN
Landscape_Unit_Areas[6]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=7 THEN
Landscape_Unit_Areas[7]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=8 THEN
Landscape_Unit_Areas[8]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=9 THEN
Landscape_Unit_Areas[9]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=10 THEN
Landscape_Unit_Areas[10]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=11 THEN
Landscape_Unit_Areas[11]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=12 THEN
Landscape_Unit_Areas[12]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=13 THEN
Landscape_Unit_Areas[13]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=14 THEN
Landscape_Unit_Areas[14]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=15 THEN
Landscape_Unit_Areas[15]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=16 THEN
Landscape_Unit_Areas[16]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=17 THEN
Landscape_Unit_Areas[17]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=18 THEN
Landscape_Unit_Areas[18]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=19 THEN
Landscape_Unit_Areas[19]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=20 THEN
Landscape_Unit_Areas[20]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=21 THEN
Landscape_Unit_Areas[21]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=22 THEN
Landscape_Unit_Areas[22]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=23 THEN
Landscape_Unit_Areas[23]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=24 THEN
Landscape_Unit_Areas[24]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=25 THEN
Landscape_Unit_Areas[25]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_2=26 THEN
Landscape_Unit_Areas[26]*GE_Carrying_capacity ELSE 0
UNITS: Square Kilometers
GE_land_available_3 = IF GE_LU_3=1 THEN
Landscape_Unit_Areas[1]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=2 THEN
Landscape_Unit_Areas[2]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=3 THEN
Landscape_Unit_Areas[3]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=4 THEN
Landscape_Unit_Areas[4]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=5 THEN
Landscape_Unit_Areas[5]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=6 THEN
Landscape_Unit_Areas[6]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=7 THEN
Landscape_Unit_Areas[7]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=8 THEN
Landscape_Unit_Areas[8]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=9 THEN
Landscape_Unit_Areas[9]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=10 THEN
Landscape_Unit_Areas[10]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=11 THEN
Landscape_Unit_Areas[11]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=12 THEN
Landscape_Unit_Areas[12]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=13 THEN
Landscape_Unit_Areas[13]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=14 THEN
Landscape_Unit_Areas[14]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=15 THEN

Landscape_Unit_Areas[15]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=16 THEN
Landscape_Unit_Areas[16]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=17 THEN
Landscape_Unit_Areas[17]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=18 THEN
Landscape_Unit_Areas[18]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=19 THEN
Landscape_Unit_Areas[19]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=20 THEN
Landscape_Unit_Areas[20]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=21 THEN
Landscape_Unit_Areas[21]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=22 THEN
Landscape_Unit_Areas[22]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=23 THEN
Landscape_Unit_Areas[23]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=24 THEN
Landscape_Unit_Areas[24]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=25 THEN
Landscape_Unit_Areas[25]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_3=26 THEN
Landscape_Unit_Areas[26]*GE_Carrying_capacity ELSE 0
UNITS: Square Kilometers
GE_land_available_4 = IF GE_LU_4=1 THEN
Landscape_Unit_Areas[1]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=2 THEN
Landscape_Unit_Areas[2]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=3 THEN
Landscape_Unit_Areas[3]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=4 THEN
Landscape_Unit_Areas[4]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=5 THEN
Landscape_Unit_Areas[5]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=6 THEN
Landscape_Unit_Areas[6]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=7 THEN
Landscape_Unit_Areas[7]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=8 THEN
Landscape_Unit_Areas[8]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=9 THEN
Landscape_Unit_Areas[9]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=10 THEN
Landscape_Unit_Areas[10]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=11 THEN
Landscape_Unit_Areas[11]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=12 THEN
Landscape_Unit_Areas[12]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=13 THEN
Landscape_Unit_Areas[13]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=14 THEN
Landscape_Unit_Areas[14]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=15 THEN
Landscape_Unit_Areas[15]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=16 THEN
Landscape_Unit_Areas[16]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=17 THEN
Landscape_Unit_Areas[17]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=18 THEN
Landscape_Unit_Areas[18]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=19 THEN
Landscape_Unit_Areas[19]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=20 THEN
Landscape_Unit_Areas[20]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=21 THEN
Landscape_Unit_Areas[21]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=22 THEN
Landscape_Unit_Areas[22]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=23 THEN
Landscape_Unit_Areas[23]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=24 THEN
Landscape_Unit_Areas[24]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=25 THEN
Landscape_Unit_Areas[25]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_4=26 THEN
Landscape_Unit_Areas[26]*GE_Carrying_capacity ELSE 0
UNITS: Square Kilometers
GE_land_available_5 = IF GE_LU_5=1 THEN
Landscape_Unit_Areas[1]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=2 THEN
Landscape_Unit_Areas[2]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=3 THEN
Landscape_Unit_Areas[3]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=4 THEN
Landscape_Unit_Areas[4]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=5 THEN

Landscape_Unit_Areas[5]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=6 THEN
Landscape_Unit_Areas[6]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=7 THEN
Landscape_Unit_Areas[7]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=8 THEN
Landscape_Unit_Areas[8]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=9 THEN
Landscape_Unit_Areas[9]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=10 THEN
Landscape_Unit_Areas[10]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=11 THEN
Landscape_Unit_Areas[11]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=12 THEN
Landscape_Unit_Areas[12]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=13 THEN
Landscape_Unit_Areas[13]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=14 THEN
Landscape_Unit_Areas[14]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=15 THEN
Landscape_Unit_Areas[15]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=16 THEN
Landscape_Unit_Areas[16]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=17 THEN
Landscape_Unit_Areas[17]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=18 THEN
Landscape_Unit_Areas[18]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=19 THEN
Landscape_Unit_Areas[19]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=20 THEN
Landscape_Unit_Areas[20]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=21 THEN
Landscape_Unit_Areas[21]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=22 THEN
Landscape_Unit_Areas[22]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=23 THEN
Landscape_Unit_Areas[23]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=24 THEN
Landscape_Unit_Areas[24]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=25 THEN
Landscape_Unit_Areas[25]*GE_Carrying_capacity ELSE 0 OR IF GE_LU_5=26 THEN
Landscape_Unit_Areas[26]*GE_Carrying_capacity ELSE 0
UNITS: Square Kilometers
GE_LU_1 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
GE_LU_2 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
GE_LU_3 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
GE_LU_4 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
GE_LU_5 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
GE_option_1 = IF GE_LU_1=1 THEN GE_per_Landscape_Unit[1] ELSE 0 OR IF GE_LU_1=2 THEN GE_per_Landscape_Unit[2] ELSE 0 OR IF GE_LU_1=3 THEN GE_per_Landscape_Unit[3] ELSE 0 OR IF GE_LU_1=4 THEN GE_per_Landscape_Unit[4] ELSE 0 OR IF GE_LU_1=5 THEN GE_per_Landscape_Unit[5] ELSE 0 OR IF GE_LU_1=6 THEN GE_per_Landscape_Unit[6] ELSE 0 OR IF GE_LU_1=7 THEN GE_per_Landscape_Unit[7] ELSE 0 OR IF GE_LU_1=8 THEN GE_per_Landscape_Unit[8] ELSE 0 OR IF GE_LU_1=9 THEN GE_per_Landscape_Unit[9] ELSE 0 OR IF GE_LU_1=10 THEN GE_per_Landscape_Unit[10] ELSE 0 OR IF GE_LU_1=11 THEN

GE_per_Landscape_Unit[11] ELSE 0 OR IF GE_LU_1=12 THEN GE_per_Landscape_Unit[12] ELSE 0 OR IF GE_LU_1=13 THEN GE_per_Landscape_Unit[13] ELSE 0 OR IF GE_LU_1=14 THEN GE_per_Landscape_Unit[14]ELSE 0 OR IF GE_LU_1=15 THEN GE_per_Landscape_Unit[15] ELSE 0 OR IF GE_LU_1=16 THEN GE_per_Landscape_Unit[16] ELSE 0 OR IF GE_LU_1=17 THEN GE_per_Landscape_Unit[17] ELSE 0 OR IF GE_LU_1=18 THEN GE_per_Landscape_Unit[18] ELSE 0 OR IF GE_LU_1=19 THEN GE_per_Landscape_Unit[19] ELSE 0 OR IF GE_LU_1=20 THEN GE_per_Landscape_Unit[20]ELSE 0 OR IF GE_LU_1=21 THEN GE_per_Landscape_Unit[21] ELSE 0 OR IF GE_LU_1=22 THEN GE_per_Landscape_Unit[22]ELSE 0 OR IF GE_LU_1=23 THEN GE_per_Landscape_Unit[23] ELSE 0 OR IF GE_LU_1=24 THEN GE_per_Landscape_Unit[24] ELSE 0 OR IF GE_LU_1=25 THEN GE_per_Landscape_Unit[25]ELSE 0 OR IF GE_LU_1=26 THEN GE_per_Landscape_Unit[26] ELSE 0

UNITS: unitless

GE_option_2 = IF GE_LU_2=1 THEN GE_per_Landscape_Unit[1] ELSE 0 OR IF GE_LU_2=2 THEN GE_per_Landscape_Unit[2] ELSE 0 OR IF GE_LU_2=3 THEN GE_per_Landscape_Unit[3] ELSE 0 OR IF GE_LU_2=4 THEN GE_per_Landscape_Unit[4] ELSE 0 OR IF GE_LU_2=5 THEN GE_per_Landscape_Unit[5] ELSE 0 OR IF GE_LU_2=6 THEN GE_per_Landscape_Unit[6] ELSE 0 OR IF GE_LU_2=7 THEN GE_per_Landscape_Unit[7] ELSE 0 OR IF GE_LU_2=8 THEN GE_per_Landscape_Unit[8] ELSE 0 OR IF GE_LU_2=9 THEN GE_per_Landscape_Unit[9] ELSE 0 OR IF GE_LU_2=10 THEN GE_per_Landscape_Unit[10] ELSE 0 OR IF GE_LU_2=11 THEN GE_per_Landscape_Unit[11] ELSE 0 OR IF GE_LU_2=12 THEN GE_per_Landscape_Unit[12] ELSE 0 OR IF GE_LU_2=13 THEN GE_per_Landscape_Unit[13] ELSE 0 OR IF GE_LU_2=14 THEN GE_per_Landscape_Unit[14]ELSE 0 OR IF GE_LU_2=15 THEN GE_per_Landscape_Unit[15] ELSE 0 OR IF GE_LU_2=16 THEN GE_per_Landscape_Unit[16] ELSE 0 OR IF GE_LU_2=17 THEN GE_per_Landscape_Unit[17] ELSE 0 OR IF GE_LU_2=18 THEN GE_per_Landscape_Unit[18] ELSE 0 OR IF GE_LU_2=19 THEN GE_per_Landscape_Unit[19] ELSE 0 OR IF GE_LU_2=20 THEN GE_per_Landscape_Unit[20]ELSE 0 OR IF GE_LU_2=21 THEN GE_per_Landscape_Unit[21] ELSE 0 OR IF GE_LU_2=22 THEN GE_per_Landscape_Unit[22]ELSE 0 OR IF GE_LU_2=23 THEN GE_per_Landscape_Unit[23] ELSE 0 OR IF GE_LU_2=24 THEN GE_per_Landscape_Unit[24] ELSE 0 OR IF GE_LU_2=25 THEN GE_per_Landscape_Unit[25]ELSE 0 OR IF GE_LU_2=26 THEN GE_per_Landscape_Unit[26] ELSE 0

UNITS: unitless

GE_option_3 = IF GE_LU_3=1 THEN GE_per_Landscape_Unit[1] ELSE 0 OR IF GE_LU_3=2 THEN GE_per_Landscape_Unit[2] ELSE 0 OR IF GE_LU_3=3 THEN GE_per_Landscape_Unit[3] ELSE 0 OR IF GE_LU_3=4 THEN GE_per_Landscape_Unit[4] ELSE 0 OR IF GE_LU_3=5 THEN GE_per_Landscape_Unit[5] ELSE 0 OR IF GE_LU_3=6 THEN GE_per_Landscape_Unit[6] ELSE 0 OR IF GE_LU_3=7 THEN GE_per_Landscape_Unit[7] ELSE 0 OR IF GE_LU_3=8 THEN GE_per_Landscape_Unit[8] ELSE 0 OR IF GE_LU_3=9 THEN GE_per_Landscape_Unit[9] ELSE 0 OR IF GE_LU_3=10 THEN GE_per_Landscape_Unit[10] ELSE 0 OR IF GE_LU_3=11 THEN GE_per_Landscape_Unit[11] ELSE 0 OR IF GE_LU_3=12 THEN GE_per_Landscape_Unit[12] ELSE 0 OR IF GE_LU_3=13 THEN GE_per_Landscape_Unit[13] ELSE 0 OR IF

GE_LU_3=14 THEN GE_per_Landscape_Unit[14]ELSE 0 OR IF GE_LU_3=15 THEN GE_per_Landscape_Unit[15] ELSE 0 OR IF GE_LU_3=16 THEN GE_per_Landscape_Unit[16] ELSE 0 OR IF GE_LU_3=17 THEN GE_per_Landscape_Unit[17] ELSE 0 OR IF GE_LU_3=18 THEN GE_per_Landscape_Unit[18] ELSE 0 OR IF GE_LU_3=19 THEN GE_per_Landscape_Unit[19] ELSE 0 OR IF GE_LU_3=20 THEN GE_per_Landscape_Unit[20]ELSE 0 OR IF GE_LU_3=21 THEN GE_per_Landscape_Unit[21] ELSE 0 OR IF GE_LU_3=22 THEN GE_per_Landscape_Unit[22]ELSE 0 OR IF GE_LU_3=23 THEN GE_per_Landscape_Unit[23] ELSE 0 OR IF GE_LU_3=24 THEN GE_per_Landscape_Unit[24] ELSE 0 OR IF GE_LU_3=25 THEN GE_per_Landscape_Unit[25]ELSE 0 OR IF GE_LU_3=26 THEN GE_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
GE_option_4 = IF GE_LU_4=1 THEN GE_per_Landscape_Unit[1] ELSE 0 OR IF GE_LU_4=2 THEN GE_per_Landscape_Unit[2] ELSE 0 OR IF GE_LU_4=3 THEN GE_per_Landscape_Unit[3] ELSE 0 OR IF GE_LU_4=4 THEN GE_per_Landscape_Unit[4] ELSE 0 OR IF GE_LU_4=5 THEN GE_per_Landscape_Unit[5] ELSE 0 OR IF GE_LU_4=6 THEN GE_per_Landscape_Unit[6] ELSE 0 OR IF GE_LU_4=7 THEN GE_per_Landscape_Unit[7] ELSE 0 OR IF GE_LU_4=8 THEN GE_per_Landscape_Unit[8] ELSE 0 OR IF GE_LU_4=9 THEN GE_per_Landscape_Unit[9] ELSE 0 OR IF GE_LU_4=10 THEN GE_per_Landscape_Unit[10] ELSE 0 OR IF GE_LU_4=11 THEN GE_per_Landscape_Unit[11] ELSE 0 OR IF GE_LU_4=12 THEN GE_per_Landscape_Unit[12] ELSE 0 OR IF GE_LU_4=13 THEN GE_per_Landscape_Unit[13] ELSE 0 OR IF GE_LU_4=14 THEN GE_per_Landscape_Unit[14]ELSE 0 OR IF GE_LU_4=15 THEN GE_per_Landscape_Unit[15] ELSE 0 OR IF GE_LU_4=16 THEN GE_per_Landscape_Unit[16] ELSE 0 OR IF GE_LU_4=17 THEN GE_per_Landscape_Unit[17] ELSE 0 OR IF GE_LU_4=18 THEN GE_per_Landscape_Unit[18] ELSE 0 OR IF GE_LU_4=19 THEN GE_per_Landscape_Unit[19] ELSE 0 OR IF GE_LU_4=20 THEN GE_per_Landscape_Unit[20]ELSE 0 OR IF GE_LU_4=21 THEN GE_per_Landscape_Unit[21] ELSE 0 OR IF GE_LU_4=22 THEN GE_per_Landscape_Unit[22]ELSE 0 OR IF GE_LU_4=23 THEN GE_per_Landscape_Unit[23] ELSE 0 OR IF GE_LU_4=24 THEN GE_per_Landscape_Unit[24] ELSE 0 OR IF GE_LU_4=25 THEN GE_per_Landscape_Unit[25]ELSE 0 OR IF GE_LU_4=26 THEN GE_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
GE_option_5 = IF GE_LU_5=1 THEN GE_per_Landscape_Unit[1] ELSE 0 OR IF GE_LU_5=2 THEN GE_per_Landscape_Unit[2] ELSE 0 OR IF GE_LU_5=3 THEN GE_per_Landscape_Unit[3] ELSE 0 OR IF GE_LU_5=4 THEN GE_per_Landscape_Unit[4] ELSE 0 OR IF GE_LU_5=5 THEN GE_per_Landscape_Unit[5] ELSE 0 OR IF GE_LU_5=6 THEN GE_per_Landscape_Unit[6] ELSE 0 OR IF GE_LU_5=7 THEN GE_per_Landscape_Unit[7] ELSE 0 OR IF GE_LU_5=8 THEN GE_per_Landscape_Unit[8] ELSE 0 OR IF GE_LU_5=9 THEN GE_per_Landscape_Unit[9] ELSE 0 OR IF GE_LU_5=10 THEN GE_per_Landscape_Unit[10] ELSE 0 OR IF GE_LU_5=11 THEN GE_per_Landscape_Unit[11] ELSE 0 OR IF GE_LU_5=12 THEN GE_per_Landscape_Unit[12] ELSE 0 OR IF GE_LU_5=13 THEN GE_per_Landscape_Unit[13] ELSE 0 OR IF GE_LU_5=14 THEN GE_per_Landscape_Unit[14]ELSE 0 OR IF GE_LU_5=15 THEN GE_per_Landscape_Unit[15] ELSE 0 OR IF GE_LU_5=16 THEN GE_per_Landscape_Unit[16]

ELSE 0 OR IF GE_LU_5=17 THEN GE_per_Landscape_Unit[17] ELSE 0 OR IF GE_LU_5=18 THEN GE_per_Landscape_Unit[18] ELSE 0 OR IF GE_LU_5=19 THEN GE_per_Landscape_Unit[19] ELSE 0 OR IF GE_LU_5=20 THEN GE_per_Landscape_Unit[20]ELSE 0 OR IF GE_LU_5=21 THEN GE_per_Landscape_Unit[21] ELSE 0 OR IF GE_LU_5=22 THEN GE_per_Landscape_Unit[22]ELSE 0 OR IF GE_LU_5=23 THEN GE_per_Landscape_Unit[23] ELSE 0 OR IF GE_LU_5=24 THEN GE_per_Landscape_Unit[24] ELSE 0 OR IF GE_LU_5=25 THEN GE_per_Landscape_Unit[25]ELSE 0 OR IF GE_LU_5=26 THEN GE_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
GE_pct_1 = 0
UNITS: percentage
GE_pct_2 = 0
UNITS: percentage
GE_pct_3 = 0
UNITS: percentage
GE_pct_4 = 0
UNITS: percentage
GE_pct_5 = 0
UNITS: percentage
GE_pct_total = IF (GE_pct_1+GE_pct_2+GE_pct_3+GE_pct_4+GE_pct_5)<=1 THEN GE_pct_1+GE_pct_2+GE_pct_3+GE_pct_4+GE_pct_5 ELSE 0
UNITS: percentage
GE_suitability = IF GE_ON>0 THEN ((GE_pct_1*GE_option_1)+(GE_pct_2*GE_option_2)+(GE_pct_3*GE_option_3)+(GE_pct_4*GE_option_4)+(GE_pct_5*GE_option_5)) ELSE 0
UNITS: unitless

****
GR_Rural_Landscape_Units:
****
GR_LU_10 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
GR_LU_6 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
GR_LU_7 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
GR_LU_8 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
GR_LU_9 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless

GR_option_10 = IF GR_LU_10=1 THEN GR_per_Landscape_Unit[1] ELSE 0 OR IF GR_LU_10=2 THEN GR_per_Landscape_Unit[2] ELSE 0 OR IF GR_LU_10=3 THEN GR_per_Landscape_Unit[3] ELSE 0 OR IF GR_LU_10=4 THEN GR_per_Landscape_Unit[4] ELSE 0 OR IF GR_LU_10=5 THEN GR_per_Landscape_Unit[5] ELSE 0 OR IF GR_LU_10=6 THEN GR_per_Landscape_Unit[6] ELSE 0 OR IF GR_LU_10=7 THEN GR_per_Landscape_Unit[7] ELSE 0 OR IF GR_LU_10=8 THEN GR_per_Landscape_Unit[8] ELSE 0 OR IF GR_LU_10=9 THEN GR_per_Landscape_Unit[9] ELSE 0 OR IF GR_LU_10=10 THEN GR_per_Landscape_Unit[10] ELSE 0 OR IF GR_LU_10=11 THEN GR_per_Landscape_Unit[11] ELSE 0 OR IF GR_LU_10=12 THEN GR_per_Landscape_Unit[12] ELSE 0 OR IF GR_LU_10=13 THEN GR_per_Landscape_Unit[13] ELSE 0 OR IF GR_LU_10=14 THEN GR_per_Landscape_Unit[14] ELSE 0 OR IF GR_LU_10=15 THEN GR_per_Landscape_Unit[15] ELSE 0 OR IF GR_LU_10=16 THEN GR_per_Landscape_Unit[16] ELSE 0 OR IF GR_LU_10=17 THEN GR_per_Landscape_Unit[17] ELSE 0 OR IF GR_LU_10=18 THEN GR_per_Landscape_Unit[18] ELSE 0 OR IF GR_LU_10=19 THEN GR_per_Landscape_Unit[19] ELSE 0 OR IF GR_LU_10=20 THEN GR_per_Landscape_Unit[20] ELSE 0 OR IF GR_LU_10=21 THEN GR_per_Landscape_Unit[21] ELSE 0 OR IF GR_LU_10=22 THEN GR_per_Landscape_Unit[22] ELSE 0 OR IF GR_LU_10=23 THEN GR_per_Landscape_Unit[23] ELSE 0 OR IF GR_LU_10=24 THEN GR_per_Landscape_Unit[24] ELSE 0 OR IF GR_LU_10=25 THEN GR_per_Landscape_Unit[25] ELSE 0 OR IF GR_LU_10=26 THEN GR_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
GR_option_6 = IF GR_LU_6=1 THEN GR_per_Landscape_Unit[1] ELSE 0 OR IF GR_LU_6=2 THEN GR_per_Landscape_Unit[2] ELSE 0 OR IF GR_LU_6=3 THEN GR_per_Landscape_Unit[3] ELSE 0 OR IF GR_LU_6=4 THEN GR_per_Landscape_Unit[4] ELSE 0 OR IF GR_LU_6=5 THEN GR_per_Landscape_Unit[5] ELSE 0 OR IF GR_LU_6=6 THEN GR_per_Landscape_Unit[6] ELSE 0 OR IF GR_LU_6=7 THEN GR_per_Landscape_Unit[7] ELSE 0 OR IF GR_LU_6=8 THEN GR_per_Landscape_Unit[8] ELSE 0 OR IF GR_LU_6=9 THEN GR_per_Landscape_Unit[9] ELSE 0 OR IF GR_LU_6=10 THEN GR_per_Landscape_Unit[10] ELSE 0 OR IF GR_LU_6=11 THEN GR_per_Landscape_Unit[11] ELSE 0 OR IF GR_LU_6=12 THEN GR_per_Landscape_Unit[12] ELSE 0 OR IF GR_LU_6=13 THEN GR_per_Landscape_Unit[13] ELSE 0 OR IF GR_LU_6=14 THEN GR_per_Landscape_Unit[14] ELSE 0 OR IF GR_LU_6=15 THEN GR_per_Landscape_Unit[15] ELSE 0 OR IF GR_LU_6=16 THEN GR_per_Landscape_Unit[16] ELSE 0 OR IF GR_LU_6=17 THEN GR_per_Landscape_Unit[17] ELSE 0 OR IF GR_LU_6=18 THEN GR_per_Landscape_Unit[18] ELSE 0 OR IF GR_LU_6=19 THEN GR_per_Landscape_Unit[19] ELSE 0 OR IF GR_LU_6=20 THEN GR_per_Landscape_Unit[20] ELSE 0 OR IF GR_LU_6=21 THEN GR_per_Landscape_Unit[21] ELSE 0 OR IF GR_LU_6=22 THEN GR_per_Landscape_Unit[22] ELSE 0 OR IF GR_LU_6=23 THEN GR_per_Landscape_Unit[23] ELSE 0 OR IF GR_LU_6=24 THEN

GR_per_Landscape_Unit[24] ELSE 0 OR IF GR_LU_6=25 THEN
GR_per_Landscape_Unit[25] ELSE 0 OR IF GR_LU_6=26 THEN
GR_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
GR_option_7 = IF GR_LU_7=1 THEN GR_per_Landscape_Unit[1] ELSE 0 OR IF
GR_LU_7=2 THEN GR_per_Landscape_Unit[2] ELSE 0 OR IF GR_LU_7=3 THEN
GR_per_Landscape_Unit[3] ELSE 0 OR IF GR_LU_7=4 THEN GR_per_Landscape_Unit[4]
ELSE 0 OR IF GR_LU_7=5 THEN GR_per_Landscape_Unit[5] ELSE 0 OR IF GR_LU_7=6
THEN GR_per_Landscape_Unit[6] ELSE 0 OR IF GR_LU_7=7 THEN
GR_per_Landscape_Unit[7] ELSE 0 OR IF GR_LU_7=8 THEN GR_per_Landscape_Unit[8]
ELSE 0 OR IF GR_LU_7=9 THEN GR_per_Landscape_Unit[9] ELSE 0 OR IF GR_LU_7=10
THEN GR_per_Landscape_Unit[10] ELSE 0 OR IF GR_LU_7=11 THEN
GR_per_Landscape_Unit[11] ELSE 0 OR IF GR_LU_7=12 THEN
GR_per_Landscape_Unit[12] ELSE 0 OR IF GR_LU_7=13 THEN
GR_per_Landscape_Unit[13] ELSE 0 OR IF GR_LU_7=14 THEN
GR_per_Landscape_Unit[14] ELSE 0 OR IF GR_LU_7=15 THEN
GR_per_Landscape_Unit[15] ELSE 0 OR IF GR_LU_7=16 THEN
GR_per_Landscape_Unit[16] ELSE 0 OR IF GR_LU_7=17 THEN
GR_per_Landscape_Unit[17] ELSE 0 OR IF GR_LU_7=18 THEN
GR_per_Landscape_Unit[18] ELSE 0 OR IF GR_LU_7=19 THEN
GR_per_Landscape_Unit[19] ELSE 0 OR IF GR_LU_7=20 THEN
GR_per_Landscape_Unit[20] ELSE 0 OR IF GR_LU_7=21 THEN
GR_per_Landscape_Unit[21] ELSE 0 OR IF GR_LU_7=22 THEN
GR_per_Landscape_Unit[22] ELSE 0 OR IF GR_LU_7=23 THEN
GR_per_Landscape_Unit[23] ELSE 0 OR IF GR_LU_7=24 THEN
GR_per_Landscape_Unit[24] ELSE 0 OR IF GR_LU_7=25 THEN
GR_per_Landscape_Unit[25] ELSE 0 OR IF GR_LU_7=26 THEN
GR_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
GR_option_8 = IF GR_LU_8=1 THEN GR_per_Landscape_Unit[1] ELSE 0 OR IF
GR_LU_8=2 THEN GR_per_Landscape_Unit[2] ELSE 0 OR IF GR_LU_8=3 THEN
GR_per_Landscape_Unit[3] ELSE 0 OR IF GR_LU_8=4 THEN GR_per_Landscape_Unit[4]
ELSE 0 OR IF GR_LU_8=5 THEN GR_per_Landscape_Unit[5] ELSE 0 OR IF GR_LU_8=6
THEN GR_per_Landscape_Unit[6] ELSE 0 OR IF GR_LU_8=7 THEN
GR_per_Landscape_Unit[7] ELSE 0 OR IF GR_LU_8=8 THEN GR_per_Landscape_Unit[8]
ELSE 0 OR IF GR_LU_8=9 THEN GR_per_Landscape_Unit[9] ELSE 0 OR IF GR_LU_8=10
THEN GR_per_Landscape_Unit[10] ELSE 0 OR IF GR_LU_8=11 THEN
GR_per_Landscape_Unit[11] ELSE 0 OR IF GR_LU_8=12 THEN
GR_per_Landscape_Unit[12] ELSE 0 OR IF GR_LU_8=13 THEN
GR_per_Landscape_Unit[13] ELSE 0 OR IF GR_LU_8=14 THEN
GR_per_Landscape_Unit[14] ELSE 0 OR IF GR_LU_8=15 THEN
GR_per_Landscape_Unit[15] ELSE 0 OR IF GR_LU_8=16 THEN
GR_per_Landscape_Unit[16] ELSE 0 OR IF GR_LU_8=17 THEN
GR_per_Landscape_Unit[17] ELSE 0 OR IF GR_LU_8=18 THEN
GR_per_Landscape_Unit[18] ELSE 0 OR IF GR_LU_8=19 THEN
GR_per_Landscape_Unit[19] ELSE 0 OR IF GR_LU_8=20 THEN

GR_per_Landscape_Unit[20] ELSE 0 OR IF GR_LU_8=21 THEN
GR_per_Landscape_Unit[21] ELSE 0 OR IF GR_LU_8=22 THEN
GR_per_Landscape_Unit[22] ELSE 0 OR IF GR_LU_8=23 THEN
GR_per_Landscape_Unit[23] ELSE 0 OR IF GR_LU_8=24 THEN
GR_per_Landscape_Unit[24] ELSE 0 OR IF GR_LU_8=25 THEN
GR_per_Landscape_Unit[25] ELSE 0 OR IF GR_LU_8=26 THEN
GR_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
GR_option_9 = IF GR_LU_9=1 THEN GR_per_Landscape_Unit[1] ELSE 0 OR IF
GR_LU_9=2 THEN GR_per_Landscape_Unit[2] ELSE 0 OR IF GR_LU_9=3 THEN
GR_per_Landscape_Unit[3] ELSE 0 OR IF GR_LU_9=4 THEN GR_per_Landscape_Unit[4]
ELSE 0 OR IF GR_LU_9=5 THEN GR_per_Landscape_Unit[5] ELSE 0 OR IF GR_LU_9=6
THEN GR_per_Landscape_Unit[6] ELSE 0 OR IF GR_LU_9=7 THEN
GR_per_Landscape_Unit[7] ELSE 0 OR IF GR_LU_9=8 THEN GR_per_Landscape_Unit[8]
ELSE 0 OR IF GR_LU_9=9 THEN GR_per_Landscape_Unit[9] ELSE 0 OR IF GR_LU_9=10
THEN GR_per_Landscape_Unit[10] ELSE 0 OR IF GR_LU_9=11 THEN
GR_per_Landscape_Unit[11] ELSE 0 OR IF GR_LU_9=12 THEN
GR_per_Landscape_Unit[12] ELSE 0 OR IF GR_LU_9=13 THEN
GR_per_Landscape_Unit[13] ELSE 0 OR IF GR_LU_9=14 THEN
GR_per_Landscape_Unit[14] ELSE 0 OR IF GR_LU_9=15 THEN
GR_per_Landscape_Unit[15] ELSE 0 OR IF GR_LU_9=16 THEN
GR_per_Landscape_Unit[16] ELSE 0 OR IF GR_LU_9=17 THEN
GR_per_Landscape_Unit[17] ELSE 0 OR IF GR_LU_9=18 THEN
GR_per_Landscape_Unit[18] ELSE 0 OR IF GR_LU_9=19 THEN
GR_per_Landscape_Unit[19] ELSE 0 OR IF GR_LU_9=20 THEN
GR_per_Landscape_Unit[20] ELSE 0 OR IF GR_LU_9=21 THEN
GR_per_Landscape_Unit[21] ELSE 0 OR IF GR_LU_9=22 THEN
GR_per_Landscape_Unit[22] ELSE 0 OR IF GR_LU_9=23 THEN
GR_per_Landscape_Unit[23] ELSE 0 OR IF GR_LU_9=24 THEN
GR_per_Landscape_Unit[24] ELSE 0 OR IF GR_LU_9=25 THEN
GR_per_Landscape_Unit[25] ELSE 0 OR IF GR_LU_9=26 THEN
GR_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
GR_pct_10 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
GR_pct_6 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
GR_pct_7 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
GR_pct_8 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
GR_pct_9 = 0

REPORT IN TABLE AS STOCK
UNITS: percentage
GR_pct_total_1 = IF (GR_pct_6+GR_pct_7+GR_pct_8+GR_pct_9+GR_pct_10)<=1 THEN GR_pct_6+GR_pct_7+GR_pct_8+GR_pct_9+GR_pct_10 ELSE 0
UNITS: percentage
GR_Rural_Suitability = IF Savings_FW_Rural_GR_ON_1>0 THEN 0.5*((GR_pct_6*GR_option_6)+(GR_pct_7*GR_option_7)+(GR_pct_8*GR_option_8)+(GR_pct_9*GR_option_9)+(GR_pct_10*GR_option_10)) ELSE 0
UNITS: unitless
GR_Total_Suitability = IF (GR_Urban_Suitability+GR_Rural_Suitability)>0 THEN 1 ELSE 0
UNITS: unitless
GR_valve_1 = IF Savings_FW_Rural_GR_ON_1=1 THEN GR_pct_total_1*Saving_freshwater_in_Farm_Env_GR ELSE 0
UNITS: gpcd
Savings_FW_Rural_GR_ON_1 = 0
UNITS: unitless

****
GR_Urban_Landscape_Units:
****
GR_LU_1 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
GR_LU_2 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
GR_LU_3 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
GR_LU_4 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
GR_LU_5 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
GR_option_1 = IF GR_LU_1=1 THEN GR_per_Landscape_Unit[1] ELSE 0 OR IF GR_LU_1=2 THEN GR_per_Landscape_Unit[2] ELSE 0 OR IF GR_LU_1=3 THEN GR_per_Landscape_Unit[3] ELSE 0 OR IF GR_LU_1=4 THEN GR_per_Landscape_Unit[4] ELSE 0 OR IF GR_LU_1=5 THEN GR_per_Landscape_Unit[5] ELSE 0 OR IF GR_LU_1=6 THEN GR_per_Landscape_Unit[6] ELSE 0 OR IF GR_LU_1=7 THEN GR_per_Landscape_Unit[7] ELSE 0 OR IF GR_LU_1=8 THEN GR_per_Landscape_Unit[8] ELSE 0 OR IF GR_LU_1=9 THEN GR_per_Landscape_Unit[9] ELSE 0 OR IF GR_LU_1=10 THEN GR_per_Landscape_Unit[10] ELSE 0 OR IF GR_LU_1=11 THEN GR_per_Landscape_Unit[11] ELSE 0 OR IF GR_LU_1=12 THEN GR_per_Landscape_Unit[12] ELSE 0 OR IF GR_LU_1=13 THEN GR_per_Landscape_Unit[13] ELSE 0 OR IF GR_LU_1=14 THEN

GR_per_Landscape_Unit[14] ELSE 0 OR IF GR_LU_1=15 THEN
GR_per_Landscape_Unit[15] ELSE 0 OR IF GR_LU_1=16 THEN
GR_per_Landscape_Unit[16] ELSE 0 OR IF GR_LU_1=17 THEN
GR_per_Landscape_Unit[17] ELSE 0 OR IF GR_LU_1=18 THEN
GR_per_Landscape_Unit[18] ELSE 0 OR IF GR_LU_1=19 THEN
GR_per_Landscape_Unit[19] ELSE 0 OR IF GR_LU_1=20 THEN
GR_per_Landscape_Unit[20] ELSE 0 OR IF GR_LU_1=21 THEN
GR_per_Landscape_Unit[21] ELSE 0 OR IF GR_LU_1=22 THEN
GR_per_Landscape_Unit[22] ELSE 0 OR IF GR_LU_1=23 THEN
GR_per_Landscape_Unit[23] ELSE 0 OR IF GR_LU_1=24 THEN
GR_per_Landscape_Unit[24] ELSE 0 OR IF GR_LU_1=25 THEN
GR_per_Landscape_Unit[25] ELSE 0 OR IF GR_LU_1=26 THEN
GR_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
GR_option_2 = IF GR_LU_2=1 THEN GR_per_Landscape_Unit[1] ELSE 0 OR IF
GR_LU_2=2 THEN GR_per_Landscape_Unit[2] ELSE 0 OR IF GR_LU_2=3 THEN
GR_per_Landscape_Unit[3] ELSE 0 OR IF GR_LU_2=4 THEN GR_per_Landscape_Unit[4]
ELSE 0 OR IF GR_LU_2=5 THEN GR_per_Landscape_Unit[5] ELSE 0 OR IF GR_LU_2=6
THEN GR_per_Landscape_Unit[6] ELSE 0 OR IF GR_LU_2=7 THEN
GR_per_Landscape_Unit[7] ELSE 0 OR IF GR_LU_2=8 THEN GR_per_Landscape_Unit[8]
ELSE 0 OR IF GR_LU_2=9 THEN GR_per_Landscape_Unit[9] ELSE 0 OR IF GR_LU_2=10
THEN GR_per_Landscape_Unit[10] ELSE 0 OR IF GR_LU_2=11 THEN
GR_per_Landscape_Unit[11] ELSE 0 OR IF GR_LU_2=12 THEN
GR_per_Landscape_Unit[12] ELSE 0 OR IF GR_LU_2=13 THEN
GR_per_Landscape_Unit[13] ELSE 0 OR IF GR_LU_2=14 THEN
GR_per_Landscape_Unit[14] ELSE 0 OR IF GR_LU_2=15 THEN
GR_per_Landscape_Unit[15] ELSE 0 OR IF GR_LU_2=16 THEN
GR_per_Landscape_Unit[16] ELSE 0 OR IF GR_LU_2=17 THEN
GR_per_Landscape_Unit[17] ELSE 0 OR IF GR_LU_2=18 THEN
GR_per_Landscape_Unit[18] ELSE 0 OR IF GR_LU_2=19 THEN
GR_per_Landscape_Unit[19] ELSE 0 OR IF GR_LU_2=20 THEN
GR_per_Landscape_Unit[20] ELSE 0 OR IF GR_LU_2=21 THEN
GR_per_Landscape_Unit[21] ELSE 0 OR IF GR_LU_2=22 THEN
GR_per_Landscape_Unit[22] ELSE 0 OR IF GR_LU_2=23 THEN
GR_per_Landscape_Unit[23] ELSE 0 OR IF GR_LU_2=24 THEN
GR_per_Landscape_Unit[24] ELSE 0 OR IF GR_LU_2=25 THEN
GR_per_Landscape_Unit[25] ELSE 0 OR IF GR_LU_2=26 THEN
GR_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
GR_option_3 = IF GR_LU_3=1 THEN GR_per_Landscape_Unit[1] ELSE 0 OR IF
GR_LU_3=2 THEN GR_per_Landscape_Unit[2] ELSE 0 OR IF GR_LU_3=3 THEN
GR_per_Landscape_Unit[3] ELSE 0 OR IF GR_LU_3=4 THEN GR_per_Landscape_Unit[4]
ELSE 0 OR IF GR_LU_3=5 THEN GR_per_Landscape_Unit[5] ELSE 0 OR IF GR_LU_3=6
THEN GR_per_Landscape_Unit[6] ELSE 0 OR IF GR_LU_3=7 THEN
GR_per_Landscape_Unit[7] ELSE 0 OR IF GR_LU_3=8 THEN GR_per_Landscape_Unit[8]
ELSE 0 OR IF GR_LU_3=9 THEN GR_per_Landscape_Unit[9] ELSE 0 OR IF GR_LU_3=10

THEN GR_per_Landscape_Unit[10] ELSE 0 OR IF GR_LU_3=11 THEN
GR_per_Landscape_Unit[11] ELSE 0 OR IF GR_LU_3=12 THEN
GR_per_Landscape_Unit[12] ELSE 0 OR IF GR_LU_3=13 THEN
GR_per_Landscape_Unit[13] ELSE 0 OR IF GR_LU_3=14 THEN
GR_per_Landscape_Unit[14] ELSE 0 OR IF GR_LU_3=15 THEN
GR_per_Landscape_Unit[15] ELSE 0 OR IF GR_LU_3=16 THEN
GR_per_Landscape_Unit[16] ELSE 0 OR IF GR_LU_3=17 THEN
GR_per_Landscape_Unit[17] ELSE 0 OR IF GR_LU_3=18 THEN
GR_per_Landscape_Unit[18] ELSE 0 OR IF GR_LU_3=19 THEN
GR_per_Landscape_Unit[19] ELSE 0 OR IF GR_LU_3=20 THEN
GR_per_Landscape_Unit[20] ELSE 0 OR IF GR_LU_3=21 THEN
GR_per_Landscape_Unit[21] ELSE 0 OR IF GR_LU_3=22 THEN
GR_per_Landscape_Unit[22] ELSE 0 OR IF GR_LU_3=23 THEN
GR_per_Landscape_Unit[23] ELSE 0 OR IF GR_LU_3=24 THEN
GR_per_Landscape_Unit[24] ELSE 0 OR IF GR_LU_3=25 THEN
GR_per_Landscape_Unit[25] ELSE 0 OR IF GR_LU_3=26 THEN
GR_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
GR_option_4 = IF GR_LU_4=1 THEN GR_per_Landscape_Unit[1] ELSE 0 OR IF
GR_LU_4=2 THEN GR_per_Landscape_Unit[2] ELSE 0 OR IF GR_LU_4=3 THEN
GR_per_Landscape_Unit[3] ELSE 0 OR IF GR_LU_4=4 THEN GR_per_Landscape_Unit[4]
ELSE 0 OR IF GR_LU_4=5 THEN GR_per_Landscape_Unit[5] ELSE 0 OR IF GR_LU_4=6
THEN GR_per_Landscape_Unit[6] ELSE 0 OR IF GR_LU_4=7 THEN
GR_per_Landscape_Unit[7] ELSE 0 OR IF GR_LU_4=8 THEN GR_per_Landscape_Unit[8]
ELSE 0 OR IF GR_LU_4=9 THEN GR_per_Landscape_Unit[9] ELSE 0 OR IF GR_LU_4=10
THEN GR_per_Landscape_Unit[10] ELSE 0 OR IF GR_LU_4=11 THEN
GR_per_Landscape_Unit[11] ELSE 0 OR IF GR_LU_4=12 THEN
GR_per_Landscape_Unit[12] ELSE 0 OR IF GR_LU_4=13 THEN
GR_per_Landscape_Unit[13] ELSE 0 OR IF GR_LU_4=14 THEN
GR_per_Landscape_Unit[14] ELSE 0 OR IF GR_LU_4=15 THEN
GR_per_Landscape_Unit[15] ELSE 0 OR IF GR_LU_4=16 THEN
GR_per_Landscape_Unit[16] ELSE 0 OR IF GR_LU_4=17 THEN
GR_per_Landscape_Unit[17] ELSE 0 OR IF GR_LU_4=18 THEN
GR_per_Landscape_Unit[18] ELSE 0 OR IF GR_LU_4=19 THEN
GR_per_Landscape_Unit[19] ELSE 0 OR IF GR_LU_4=20 THEN
GR_per_Landscape_Unit[20] ELSE 0 OR IF GR_LU_4=21 THEN
GR_per_Landscape_Unit[21] ELSE 0 OR IF GR_LU_4=22 THEN
GR_per_Landscape_Unit[22] ELSE 0 OR IF GR_LU_4=23 THEN
GR_per_Landscape_Unit[23] ELSE 0 OR IF GR_LU_4=24 THEN
GR_per_Landscape_Unit[24] ELSE 0 OR IF GR_LU_4=25 THEN
GR_per_Landscape_Unit[25] ELSE 0 OR IF GR_LU_4=26 THEN
GR_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
GR_option_5 = IF GR_LU_5=1 THEN GR_per_Landscape_Unit[1] ELSE 0 OR IF
GR_LU_5=2 THEN GR_per_Landscape_Unit[2] ELSE 0 OR IF GR_LU_5=3 THEN
GR_per_Landscape_Unit[3] ELSE 0 OR IF GR_LU_5=4 THEN GR_per_Landscape_Unit[4]

ELSE 0 OR IF GR_LU_5=5 THEN GR_per_Landscape_Unit[5] ELSE 0 OR IF GR_LU_5=6
THEN GR_per_Landscape_Unit[6] ELSE 0 OR IF GR_LU_5=7 THEN
GR_per_Landscape_Unit[7] ELSE 0 OR IF GR_LU_5=8 THEN GR_per_Landscape_Unit[8]
ELSE 0 OR IF GR_LU_5=9 THEN GR_per_Landscape_Unit[9] ELSE 0 OR IF GR_LU_5=10
THEN GR_per_Landscape_Unit[10] ELSE 0 OR IF GR_LU_5=11 THEN
GR_per_Landscape_Unit[11] ELSE 0 OR IF GR_LU_5=12 THEN
GR_per_Landscape_Unit[12] ELSE 0 OR IF GR_LU_5=13 THEN
GR_per_Landscape_Unit[13] ELSE 0 OR IF GR_LU_5=14 THEN
GR_per_Landscape_Unit[14] ELSE 0 OR IF GR_LU_5=15 THEN
GR_per_Landscape_Unit[15] ELSE 0 OR IF GR_LU_5=16 THEN
GR_per_Landscape_Unit[16] ELSE 0 OR IF GR_LU_5=17 THEN
GR_per_Landscape_Unit[17] ELSE 0 OR IF GR_LU_5=18 THEN
GR_per_Landscape_Unit[18] ELSE 0 OR IF GR_LU_5=19 THEN
GR_per_Landscape_Unit[19] ELSE 0 OR IF GR_LU_5=20 THEN
GR_per_Landscape_Unit[20] ELSE 0 OR IF GR_LU_5=21 THEN
GR_per_Landscape_Unit[21] ELSE 0 OR IF GR_LU_5=22 THEN
GR_per_Landscape_Unit[22] ELSE 0 OR IF GR_LU_5=23 THEN
GR_per_Landscape_Unit[23] ELSE 0 OR IF GR_LU_5=24 THEN
GR_per_Landscape_Unit[24] ELSE 0 OR IF GR_LU_5=25 THEN
GR_per_Landscape_Unit[25] ELSE 0 OR IF GR_LU_5=26 THEN
GR_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
GR_pct_1 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
GR_pct_2 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
GR_pct_3 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
GR_pct_4 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
GR_pct_5 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
GR_pct_total = IF (GR_pct_1+GR_pct_2+GR_pct_3+GR_pct_4+GR_pct_5)<=1 THEN
GR_pct_1+GR_pct_2+GR_pct_3+GR_pct_4+GR_pct_5 ELSE 0
UNITS: percentage
GR_Urban_Suitability = IF Savings_FW_Urban_GR_ON>0 THEN
0.5*((GR_pct_1*GR_option_1)+(GR_pct_2*GR_option_2)+(GR_pct_3*GR_option_3)+(GR_option_4*GR_pct_4)+(GR_option_5*GR_pct_5)) ELSE 0
UNITS: unitless
GR_valve = IF Savings_FW_Urban_GR_ON=1 THEN
GR_pct_total*Savings_freshwater_in_Urban_Env_GR ELSE 0

UNITS: gpcd
Savings_FW_Urban_GR_ON = 0
UNITS: unitless

****
HF_Landscape_Units:
****
Carrying_capacity_HF = 0.1
UNITS: percentage
HF_desired_land_1 = IF HF_pct_total<=1 THEN HF_pct_1*Number_of_HF_acres*0.00404686 ELSE 0
UNITS: Square Kilometers
HF_desired_land_2 = IF HF_pct_total<=1 THEN HF_pct_2*Number_of_HF_acres*0.00404686 ELSE 0
UNITS: Square Kilometers
HF_desired_land_3 = IF HF_pct_total<=1 THEN HF_pct_3*Number_of_HF_acres*0.00404686 ELSE 0
UNITS: Square Kilometers
HF_desired_land_4 = IF HF_pct_total<=1 THEN HF_pct_4*Number_of_HF_acres*0.00404686 ELSE 0
UNITS: Square Kilometers
HF_desired_land_5 = IF HF_pct_total<=1 THEN HF_pct_5*Number_of_HF_acres*0.00404686 ELSE 0
UNITS: Square Kilometers
HF_land_available_1 = IF HF_LU_1=1 THEN
Landscape_Unit_Areas[1]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=2 THEN
Landscape_Unit_Areas[2]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=3 THEN
Landscape_Unit_Areas[3]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=4 THEN
Landscape_Unit_Areas[4]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=5 THEN
Landscape_Unit_Areas[5]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=6 THEN
Landscape_Unit_Areas[6]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=7 THEN
Landscape_Unit_Areas[7]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=8 THEN
Landscape_Unit_Areas[8]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=9 THEN
Landscape_Unit_Areas[9]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=10 THEN
Landscape_Unit_Areas[10]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=11 THEN
Landscape_Unit_Areas[11]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=12 THEN
Landscape_Unit_Areas[12]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=13 THEN
Landscape_Unit_Areas[13]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=14 THEN
Landscape_Unit_Areas[14]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=15 THEN
Landscape_Unit_Areas[15]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=16 THEN
Landscape_Unit_Areas[16]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=17 THEN
Landscape_Unit_Areas[17]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=18 THEN
Landscape_Unit_Areas[18]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=19 THEN
Landscape_Unit_Areas[19]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=20 THEN
Landscape_Unit_Areas[20]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=21 THEN
Landscape_Unit_Areas[21]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=22 THEN

Landscape_Unit_Areas[22]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=23 THEN
Landscape_Unit_Areas[23]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=24 THEN
Landscape_Unit_Areas[24]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=25 THEN
Landscape_Unit_Areas[25]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_1=26 THEN
Landscape_Unit_Areas[26]*Carrying_capacity_HF ELSE 0
UNITS: Square Kilometers
HF_land_available_2 = IF HF_LU_2=1 THEN
Landscape_Unit_Areas[1]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=2 THEN
Landscape_Unit_Areas[2]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=3 THEN
Landscape_Unit_Areas[3]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=4 THEN
Landscape_Unit_Areas[4]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=5 THEN
Landscape_Unit_Areas[5]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=6 THEN
Landscape_Unit_Areas[6]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=7 THEN
Landscape_Unit_Areas[7]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=8 THEN
Landscape_Unit_Areas[8]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=9 THEN
Landscape_Unit_Areas[9]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=10 THEN
Landscape_Unit_Areas[10]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=11 THEN
Landscape_Unit_Areas[11]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=12 THEN
Landscape_Unit_Areas[12]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=13 THEN
Landscape_Unit_Areas[13]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=14 THEN
Landscape_Unit_Areas[14]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=15 THEN
Landscape_Unit_Areas[15]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=16 THEN
Landscape_Unit_Areas[16]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=17 THEN
Landscape_Unit_Areas[17]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=18 THEN
Landscape_Unit_Areas[18]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=19 THEN
Landscape_Unit_Areas[19]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=20 THEN
Landscape_Unit_Areas[20]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=21 THEN
Landscape_Unit_Areas[21]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=22 THEN
Landscape_Unit_Areas[22]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=23 THEN
Landscape_Unit_Areas[23]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=24 THEN
Landscape_Unit_Areas[24]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=25 THEN
Landscape_Unit_Areas[25]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_2=26 THEN
Landscape_Unit_Areas[26]*Carrying_capacity_HF ELSE 0
UNITS: Square Kilometers
HF_land_available_3 = IF HF_LU_3=1 THEN
Landscape_Unit_Areas[1]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=2 THEN
Landscape_Unit_Areas[2]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=3 THEN
Landscape_Unit_Areas[3]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=4 THEN
Landscape_Unit_Areas[4]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=5 THEN
Landscape_Unit_Areas[5]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=6 THEN
Landscape_Unit_Areas[6]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=7 THEN
Landscape_Unit_Areas[7]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=8 THEN
Landscape_Unit_Areas[8]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=9 THEN
Landscape_Unit_Areas[9]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=10 THEN
Landscape_Unit_Areas[10]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=11 THEN
Landscape_Unit_Areas[11]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=12 THEN

Landscape_Unit_Areas[12]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=13 THEN
Landscape_Unit_Areas[13]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=14 THEN
Landscape_Unit_Areas[14]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=15 THEN
Landscape_Unit_Areas[15]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=16 THEN
Landscape_Unit_Areas[16]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=17 THEN
Landscape_Unit_Areas[17]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=18 THEN
Landscape_Unit_Areas[18]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=19 THEN
Landscape_Unit_Areas[19]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=20 THEN
Landscape_Unit_Areas[20]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=21 THEN
Landscape_Unit_Areas[21]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=22 THEN
Landscape_Unit_Areas[22]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=23 THEN
Landscape_Unit_Areas[23]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=24 THEN
Landscape_Unit_Areas[24]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=25 THEN
Landscape_Unit_Areas[25]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_3=26 THEN
Landscape_Unit_Areas[26]*Carrying_capacity_HF ELSE 0
UNITS: Square Kilometers
HF_land_available_4 = IF HF_LU_4=1 THEN
Landscape_Unit_Areas[1]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=2 THEN
Landscape_Unit_Areas[2]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=3 THEN
Landscape_Unit_Areas[3]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=4 THEN
Landscape_Unit_Areas[4]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=5 THEN
Landscape_Unit_Areas[5]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=6 THEN
Landscape_Unit_Areas[6]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=7 THEN
Landscape_Unit_Areas[7]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=8 THEN
Landscape_Unit_Areas[8]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=9 THEN
Landscape_Unit_Areas[9]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=10 THEN
Landscape_Unit_Areas[10]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=11 THEN
Landscape_Unit_Areas[11]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=12 THEN
Landscape_Unit_Areas[12]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=13 THEN
Landscape_Unit_Areas[13]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=14 THEN
Landscape_Unit_Areas[14]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=15 THEN
Landscape_Unit_Areas[15]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=16 THEN
Landscape_Unit_Areas[16]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=17 THEN
Landscape_Unit_Areas[17]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=18 THEN
Landscape_Unit_Areas[18]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=19 THEN
Landscape_Unit_Areas[19]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=20 THEN
Landscape_Unit_Areas[20]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=21 THEN
Landscape_Unit_Areas[21]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=22 THEN
Landscape_Unit_Areas[22]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=23 THEN
Landscape_Unit_Areas[23]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=24 THEN
Landscape_Unit_Areas[24]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=25 THEN
Landscape_Unit_Areas[25]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_4=26 THEN
Landscape_Unit_Areas[26]*Carrying_capacity_HF ELSE 0
UNITS: Square Kilometers
HF_land_available_5 = IF HF_LU_5=1 THEN
Landscape_Unit_Areas[1]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=2 THEN

Landscape_Unit_Areas[2]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=3 THEN
Landscape_Unit_Areas[3]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=4 THEN
Landscape_Unit_Areas[4]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=5 THEN
Landscape_Unit_Areas[5]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=6 THEN
Landscape_Unit_Areas[6]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=7 THEN
Landscape_Unit_Areas[7]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=8 THEN
Landscape_Unit_Areas[8]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=9 THEN
Landscape_Unit_Areas[9]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=10 THEN
Landscape_Unit_Areas[10]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=11 THEN
Landscape_Unit_Areas[11]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=12 THEN
Landscape_Unit_Areas[12]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=13 THEN
Landscape_Unit_Areas[13]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=14 THEN
Landscape_Unit_Areas[14]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=15 THEN
Landscape_Unit_Areas[15]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=16 THEN
Landscape_Unit_Areas[16]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=17 THEN
Landscape_Unit_Areas[17]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=18 THEN
Landscape_Unit_Areas[18]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=19 THEN
Landscape_Unit_Areas[19]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=20 THEN
Landscape_Unit_Areas[20]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=21 THEN
Landscape_Unit_Areas[21]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=22 THEN
Landscape_Unit_Areas[22]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=23 THEN
Landscape_Unit_Areas[23]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=24 THEN
Landscape_Unit_Areas[24]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=25 THEN
Landscape_Unit_Areas[25]*Carrying_capacity_HF ELSE 0 OR IF HF_LU_5=26 THEN
Landscape_Unit_Areas[26]*Carrying_capacity_HF ELSE 0
UNITS: Square Kilometers
HF_LU_1 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
HF_LU_2 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
HF_LU_3 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
HF_LU_4 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
HF_LU_5 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
HF_option_1 = IF HF_LU_1=1 THEN HF_per_Landscape_Unit[1] ELSE 0 OR IF HF_LU_1=2
THEN HF_per_Landscape_Unit[2] ELSE 0 OR IF HF_LU_1=3 THEN
HF_per_Landscape_Unit[3] ELSE 0 OR IF HF_LU_1=4 THEN HF_per_Landscape_Unit[4]
ELSE 0 OR IF HF_LU_1=5 THEN HF_per_Landscape_Unit[5] ELSE 0 OR IF HF_LU_1=6
THEN HF_per_Landscape_Unit[6] ELSE 0 OR IF HF_LU_1=7 THEN

HF_per_Landscape_Unit[7] ELSE 0 OR IF HF_LU_1=8 THEN HF_per_Landscape_Unit[8] ELSE 0 OR IF HF_LU_1=9 THEN HF_per_Landscape_Unit[9] ELSE 0 OR IF HF_LU_1=10 THEN HF_per_Landscape_Unit[10] ELSE 0 OR IF HF_LU_1=11 THEN HF_per_Landscape_Unit[11] ELSE 0 OR IF HF_LU_1=12 THEN HF_per_Landscape_Unit[12] ELSE 0 OR IF HF_LU_1=13 THEN HF_per_Landscape_Unit[13] ELSE 0 OR IF HF_LU_1=14 THEN HF_per_Landscape_Unit[14]ELSE 0 OR IF HF_LU_1=15 THEN HF_per_Landscape_Unit[15] ELSE 0 OR IF HF_LU_1=16 THEN HF_per_Landscape_Unit[16] ELSE 0 OR IF HF_LU_1=17 THEN HF_per_Landscape_Unit[17] ELSE 0 OR IF HF_LU_1=18 THEN HF_per_Landscape_Unit[18] ELSE 0 OR IF HF_LU_1=19 THEN HF_per_Landscape_Unit[19] ELSE 0 OR IF HF_LU_1=20 THEN HF_per_Landscape_Unit[20]ELSE 0 OR IF HF_LU_1=21 THEN HF_per_Landscape_Unit[21] ELSE 0 OR IF HF_LU_1=22 THEN HF_per_Landscape_Unit[22]ELSE 0 OR IF HF_LU_1=23 THEN HF_per_Landscape_Unit[23] ELSE 0 OR IF HF_LU_1=24 THEN HF_per_Landscape_Unit[24] ELSE 0 OR IF HF_LU_1=25 THEN HF_per_Landscape_Unit[25]ELSE 0 OR IF HF_LU_1=26 THEN HF_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
HF_option_2 = IF HF_LU_2=1 THEN HF_per_Landscape_Unit[1] ELSE 0 OR IF HF_LU_2=2 THEN HF_per_Landscape_Unit[2] ELSE 0 OR IF HF_LU_2=3 THEN HF_per_Landscape_Unit[3] ELSE 0 OR IF HF_LU_2=4 THEN HF_per_Landscape_Unit[4] ELSE 0 OR IF HF_LU_2=5 THEN HF_per_Landscape_Unit[5] ELSE 0 OR IF HF_LU_2=6 THEN HF_per_Landscape_Unit[6] ELSE 0 OR IF HF_LU_2=7 THEN HF_per_Landscape_Unit[7] ELSE 0 OR IF HF_LU_2=8 THEN HF_per_Landscape_Unit[8] ELSE 0 OR IF HF_LU_2=9 THEN HF_per_Landscape_Unit[9] ELSE 0 OR IF HF_LU_2=10 THEN HF_per_Landscape_Unit[10] ELSE 0 OR IF HF_LU_2=11 THEN HF_per_Landscape_Unit[11] ELSE 0 OR IF HF_LU_2=12 THEN HF_per_Landscape_Unit[12] ELSE 0 OR IF HF_LU_2=13 THEN HF_per_Landscape_Unit[13] ELSE 0 OR IF HF_LU_2=14 THEN HF_per_Landscape_Unit[14]ELSE 0 OR IF HF_LU_2=15 THEN HF_per_Landscape_Unit[15] ELSE 0 OR IF HF_LU_2=16 THEN HF_per_Landscape_Unit[16] ELSE 0 OR IF HF_LU_2=17 THEN HF_per_Landscape_Unit[17] ELSE 0 OR IF HF_LU_2=18 THEN HF_per_Landscape_Unit[18] ELSE 0 OR IF HF_LU_2=19 THEN HF_per_Landscape_Unit[19] ELSE 0 OR IF HF_LU_2=20 THEN HF_per_Landscape_Unit[20]ELSE 0 OR IF HF_LU_2=21 THEN HF_per_Landscape_Unit[21] ELSE 0 OR IF HF_LU_2=22 THEN HF_per_Landscape_Unit[22]ELSE 0 OR IF HF_LU_2=23 THEN HF_per_Landscape_Unit[23] ELSE 0 OR IF HF_LU_2=24 THEN HF_per_Landscape_Unit[24] ELSE 0 OR IF HF_LU_2=25 THEN HF_per_Landscape_Unit[25]ELSE 0 OR IF HF_LU_2=26 THEN HF_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
HF_option_3 = IF HF_LU_3=1 THEN HF_per_Landscape_Unit[1] ELSE 0 OR IF HF_LU_3=2 THEN HF_per_Landscape_Unit[2] ELSE 0 OR IF HF_LU_3=3 THEN HF_per_Landscape_Unit[3] ELSE 0 OR IF HF_LU_3=4 THEN HF_per_Landscape_Unit[4] ELSE 0 OR IF HF_LU_3=5 THEN HF_per_Landscape_Unit[5] ELSE 0 OR IF HF_LU_3=6 THEN HF_per_Landscape_Unit[6] ELSE 0 OR IF HF_LU_3=7 THEN HF_per_Landscape_Unit[7] ELSE 0 OR IF HF_LU_3=8 THEN HF_per_Landscape_Unit[8] ELSE 0 OR IF HF_LU_3=9 THEN HF_per_Landscape_Unit[9] ELSE 0 OR IF HF_LU_3=10

THEN HF_per_Landscape_Unit[10] ELSE 0 OR IF HF_LU_3=11 THEN
HF_per_Landscape_Unit[11] ELSE 0 OR IF HF_LU_3=12 THEN HF_per_Landscape_Unit[12]
ELSE 0 OR IF HF_LU_3=13 THEN HF_per_Landscape_Unit[13] ELSE 0 OR IF HF_LU_3=14
THEN HF_per_Landscape_Unit[14]ELSE 0 OR IF HF_LU_3=15 THEN
HF_per_Landscape_Unit[15] ELSE 0 OR IF HF_LU_3=16 THEN HF_per_Landscape_Unit[16]
ELSE 0 OR IF HF_LU_3=17 THEN HF_per_Landscape_Unit[17] ELSE 0 OR IF HF_LU_3=18
THEN HF_per_Landscape_Unit[18] ELSE 0 OR IF HF_LU_3=19 THEN
HF_per_Landscape_Unit[19] ELSE 0 OR IF HF_LU_3=20 THEN
HF_per_Landscape_Unit[20]ELSE 0 OR IF HF_LU_3=21 THEN HF_per_Landscape_Unit[21]
ELSE 0 OR IF HF_LU_3=22 THEN HF_per_Landscape_Unit[22]ELSE 0 OR IF HF_LU_3=23
THEN HF_per_Landscape_Unit[23] ELSE 0 OR IF HF_LU_3=24 THEN
HF_per_Landscape_Unit[24] ELSE 0 OR IF HF_LU_3=25 THEN
HF_per_Landscape_Unit[25]ELSE 0 OR IF HF_LU_3=26 THEN HF_per_Landscape_Unit[26]
ELSE 0
UNITS: unitless
HF_option_4 = IF HF_LU_4=1 THEN HF_per_Landscape_Unit[1] ELSE 0 OR IF HF_LU_4=2
THEN HF_per_Landscape_Unit[2] ELSE 0 OR IF HF_LU_4=3 THEN
HF_per_Landscape_Unit[3] ELSE 0 OR IF HF_LU_4=4 THEN HF_per_Landscape_Unit[4]
ELSE 0 OR IF HF_LU_4=5 THEN HF_per_Landscape_Unit[5] ELSE 0 OR IF HF_LU_4=6
THEN HF_per_Landscape_Unit[6] ELSE 0 OR IF HF_LU_4=7 THEN
HF_per_Landscape_Unit[7] ELSE 0 OR IF HF_LU_4=8 THEN HF_per_Landscape_Unit[8]
ELSE 0 OR IF HF_LU_4=9 THEN HF_per_Landscape_Unit[9] ELSE 0 OR IF HF_LU_4=10
THEN HF_per_Landscape_Unit[10] ELSE 0 OR IF HF_LU_4=11 THEN
HF_per_Landscape_Unit[11] ELSE 0 OR IF HF_LU_4=12 THEN HF_per_Landscape_Unit[12]
ELSE 0 OR IF HF_LU_4=13 THEN HF_per_Landscape_Unit[13] ELSE 0 OR IF HF_LU_4=14
THEN HF_per_Landscape_Unit[14]ELSE 0 OR IF HF_LU_4=15 THEN
HF_per_Landscape_Unit[15] ELSE 0 OR IF HF_LU_4=16 THEN HF_per_Landscape_Unit[16]
ELSE 0 OR IF HF_LU_4=17 THEN HF_per_Landscape_Unit[17] ELSE 0 OR IF HF_LU_4=18
THEN HF_per_Landscape_Unit[18] ELSE 0 OR IF HF_LU_4=19 THEN
HF_per_Landscape_Unit[19] ELSE 0 OR IF HF_LU_4=20 THEN
HF_per_Landscape_Unit[20]ELSE 0 OR IF HF_LU_4=21 THEN HF_per_Landscape_Unit[21]
ELSE 0 OR IF HF_LU_4=22 THEN HF_per_Landscape_Unit[22]ELSE 0 OR IF HF_LU_4=23
THEN HF_per_Landscape_Unit[23] ELSE 0 OR IF HF_LU_4=24 THEN
HF_per_Landscape_Unit[24] ELSE 0 OR IF HF_LU_4=25 THEN
HF_per_Landscape_Unit[25]ELSE 0 OR IF HF_LU_4=26 THEN HF_per_Landscape_Unit[26]
ELSE 0
UNITS: unitless
HF_option_5 = IF HF_LU_5=1 THEN HF_per_Landscape_Unit[1] ELSE 0 OR IF HF_LU_5=2
THEN HF_per_Landscape_Unit[2] ELSE 0 OR IF HF_LU_5=3 THEN
HF_per_Landscape_Unit[3] ELSE 0 OR IF HF_LU_5=4 THEN HF_per_Landscape_Unit[4]
ELSE 0 OR IF HF_LU_5=5 THEN HF_per_Landscape_Unit[5] ELSE 0 OR IF HF_LU_5=6
THEN HF_per_Landscape_Unit[6] ELSE 0 OR IF HF_LU_5=7 THEN
HF_per_Landscape_Unit[7] ELSE 0 OR IF HF_LU_5=8 THEN HF_per_Landscape_Unit[8]
ELSE 0 OR IF HF_LU_5=9 THEN HF_per_Landscape_Unit[9] ELSE 0 OR IF HF_LU_5=10
THEN HF_per_Landscape_Unit[10] ELSE 0 OR IF HF_LU_5=11 THEN
HF_per_Landscape_Unit[11] ELSE 0 OR IF HF_LU_5=12 THEN HF_per_Landscape_Unit[12]

ELSE 0 OR IF HF_LU_5=13 THEN HF_per_Landscape_Unit[13] ELSE 0 OR IF HF_LU_5=14 THEN HF_per_Landscape_Unit[14]ELSE 0 OR IF HF_LU_5=15 THEN HF_per_Landscape_Unit[15] ELSE 0 OR IF HF_LU_5=16 THEN HF_per_Landscape_Unit[16] ELSE 0 OR IF HF_LU_5=17 THEN HF_per_Landscape_Unit[17] ELSE 0 OR IF HF_LU_5=18 THEN HF_per_Landscape_Unit[18] ELSE 0 OR IF HF_LU_5=19 THEN HF_per_Landscape_Unit[19] ELSE 0 OR IF HF_LU_5=20 THEN HF_per_Landscape_Unit[20]ELSE 0 OR IF HF_LU_5=21 THEN HF_per_Landscape_Unit[21] ELSE 0 OR IF HF_LU_5=22 THEN HF_per_Landscape_Unit[22]ELSE 0 OR IF HF_LU_5=23 THEN HF_per_Landscape_Unit[23] ELSE 0 OR IF HF_LU_5=24 THEN HF_per_Landscape_Unit[24] ELSE 0 OR IF HF_LU_5=25 THEN HF_per_Landscape_Unit[25]ELSE 0 OR IF HF_LU_5=26 THEN HF_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
HF_pct_1 = 0
UNITS: percentage
HF_pct_2 = 0
UNITS: percentage
HF_pct_3 = 0
UNITS: percentage
HF_pct_4 = 0
UNITS: percentage
HF_pct_5 = 0
UNITS: percentage
HF_pct_total = IF (HF_pct_1+HF_pct_2+HF_pct_3+HF_pct_4+HF_pct_5)<=1 THEN HF_pct_1+HF_pct_2+HF_pct_3+HF_pct_4+HF_pct_5 ELSE 0
UNITS: percentage
HF_Suitability = IF Number_of_HF_acres>0 THEN ((HF_pct_1*HF_option_1)+(HF_pct_2*HF_option_2)+(HF_pct_3*HF_option_3)+(HF_pct_4*HF_option_4)+(HF_pct_5*HF_option_5)) ELSE 0
UNITS: unitless
HF_water_saving_in_a_LU_1 = IF HF_desired_land_1<=HF_land_available_1 THEN Total_water_saving_HF*HF_pct_1 ELSE 0
UNITS: MW per year
HF_water_saving_in_a_LU_2 = IF HF_desired_land_2<=HF_land_available_2 THEN Total_water_saving_HF*HF_pct_2 ELSE 0
UNITS: MW per year
HF_water_saving_in_a_LU_3 = IF HF_desired_land_3<=HF_land_available_3 THEN Total_water_saving_HF*HF_pct_3 ELSE 0
UNITS: MW per year
HF_water_saving_in_a_LU_4 = IF HF_desired_land_4<=HF_land_available_4 THEN Total_water_saving_HF*HF_pct_4 ELSE 0
UNITS: MW per year
HF_water_saving_in_a_LU_5 = IF HF_desired_land_5<=HF_land_available_5 THEN Total_water_saving_HF*HF_pct_5 ELSE 0
UNITS: MW per year

****
Planetary_ceiling:
****
DE_AIR_SWIFT =
SB_DE_swift[Air_Pollution]+GR_DE_swift[Air_Pollution]+SE_DE_swift[Air_Pollution]+WE_DE_swift[Air_Pollution]+GE_DE_swift[Air_Pollution]+FB_DE_swift[Air_Pollution]+HF_DE_swift[Air_Pollution]+RF_DE_swift[Air_Pollution]+EV_DE_swift[Air_Pollution]
UNITS: unitless
DE_BIODIVERSITY_SWIFT =
SB_DE_swift[Biodiversity_Loss]+GR_DE_swift[Biodiversity_Loss]+SE_DE_swift[Biodiversity_Loss]+WE_DE_swift[Biodiversity_Loss]+GE_DE_swift[Biodiversity_Loss]+FB_DE_swift[Biodiversity_Loss]+HF_DE_swift[Biodiversity_Loss]+RF_DE_swift[Biodiversity_Loss]+EV_DE_swift[Biodiversity_Loss]
UNITS: unitless
DE_CHEMICAL_SWIFT =
SB_DE_swift[Chemical_Pollution]+GR_DE_swift[Chemical_Pollution]+SE_DE_swift[Chemical_Pollution]+WE_DE_swift[Chemical_Pollution]+GE_DE_swift[Chemical_Pollution]+FB_DE_swift[Chemical_Pollution]+HF_DE_swift[Chemical_Pollution]+RF_DE_swift[Chemical_Pollution]+EV_DE_swift[Chemical_Pollution]
UNITS: unitless
DE_CLIMATE_CRISIS_SWIFT =
SB_DE_swift[Climate_Crisis]+GR_DE_swift[Climate_Crisis]+SE_DE_swift[Climate_Crisis]+WE_DE_swift[Climate_Crisis]+GE_DE_swift[Climate_Crisis]+FB_DE_swift[Climate_Crisis]+FB_DE_swift[Climate_Crisis]+HF_DE_swift[Climate_Crisis]+RF_DE_swift[Climate_Crisis]+EV_DE_swift[Climate_Crisis]
UNITS: unitless
DE_LAND_SWIFT =
SB_DE_swift[Land_Conversion]+GR_DE_swift[Land_Conversion]+SE_DE_swift[Land_Conversion]+WE_DE_swift[Land_Conversion]+GE_DE_swift[Land_Conversion]+FB_DE_swift[Land_Conversion]+HF_DE_swift[Land_Conversion]+RF_DE_swift[Land_Conversion]+EV_DE_swift[Land_Conversion]
UNITS: unitless
DE_Ni_P_SWIFT =
0.5*(SB_DE_swift[Nitrogen_Loading]+GR_DE_swift[Nitrogen_Loading]+SE_DE_swift[Nitrogen_Loading]+WE_DE_swift[Nitrogen_Loading]+GE_DE_swift[Nitrogen_Loading]+FB_DE_swift[Nitrogen_Loading]+HF_DE_swift[Nitrogen_Loading]+RF_DE_swift[Nitrogen_Loading]+EV_DE_swift[Nitrogen_Loading])+0.5*(SB_DE_swift[Phosphorus_Loading]+GR_DE_swift[Phosphorus_Loading]+SE_DE_swift[Phosphorus_Loading]+WE_DE_swift[Phosphorus_Loading]+GE_DE_swift[Phosphorus_Loading]+FB_DE_swift[Phosphorus_Loading]+HF_DE_swift[Phosphorus_Loading]+RF_DE_swift[Phosphorus_Loading]+EV_DE_swift[Phosphorus_Loading])
UNITS: unitless
DE_OCEAN_SWIFT =
SB_DE_swift[Ocean_Acidification]+GR_DE_swift[Ocean_Acidification]+SE_DE_swift[Ocean_Acidification]+WE_DE_swift[Ocean_Acidification]+GE_DE_swift[Ocean_Acidification]+FB_DE_swift[Ocean_Acidification]+HF_DE_swift[Ocean_Acidification]+RF_DE_swift[Ocean_Acidification]+EV_DE_swift[Ocean_Acidification]

UNITS: unitless
DE_OZONE_SWIFT =
SB_DE_swift[Ozone_Layer_Depletion]+GR_DE_swift[Ozone_Layer_Depletion]+SE_DE_swift[Ozone_Layer_Depletion]+WE_DE_swift[Ozone_Layer_Depletion]+GE_DE_swift[Ozone_Layer_Depletion]+FB_DE_swift[Ozone_Layer_Depletion]+HF_DE_swift[Ozone_Layer_Depletion]+RF_DE_swift[Ozone_Layer_Depletion]+EV_DE_swift[Ozone_Layer_Depletion]
UNITS: unitless
DE_WATER_SWIFT =
SB_DE_swift[Freswater_Withdrawals]+GR_DE_swift[Freswater_Withdrawals]+SE_DE_swift[Freswater_Withdrawals]+WE_DE_swift[Freswater_Withdrawals]+GE_DE_swift[Freswater_Withdrawals]+FB_DE_swift[Freswater_Withdrawals]+HF_DE_swift[Freswater_Withdrawals]+RF_DE_swift[Freswater_Withdrawals]+EV_DE_swift[Freswater_Withdrawals]
UNITS: unitless

****
RF_Landscape_Units:
****
Carrying_capacity_RF = 0.1
UNITS: percentage
HF_land_available_8 = IF RF_LU_3=1 THEN
Landscape_Unit_Areas[1]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=2 THEN
Landscape_Unit_Areas[2]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=3 THEN
Landscape_Unit_Areas[3]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=4 THEN
Landscape_Unit_Areas[4]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=5 THEN
Landscape_Unit_Areas[5]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=6 THEN
Landscape_Unit_Areas[6]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=7 THEN
Landscape_Unit_Areas[7]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=8 THEN
Landscape_Unit_Areas[8]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=9 THEN
Landscape_Unit_Areas[9]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=10 THEN
Landscape_Unit_Areas[10]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=11 THEN
Landscape_Unit_Areas[11]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=12 THEN
Landscape_Unit_Areas[12]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=13 THEN
Landscape_Unit_Areas[13]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=14 THEN
Landscape_Unit_Areas[14]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=15 THEN
Landscape_Unit_Areas[15]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=16 THEN
Landscape_Unit_Areas[16]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=17 THEN
Landscape_Unit_Areas[17]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=18 THEN
Landscape_Unit_Areas[18]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=19 THEN
Landscape_Unit_Areas[19]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=20 THEN
Landscape_Unit_Areas[20]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=21 THEN
Landscape_Unit_Areas[21]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=22 THEN
Landscape_Unit_Areas[22]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=23 THEN
Landscape_Unit_Areas[23]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=24 THEN
Landscape_Unit_Areas[24]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=25 THEN
Landscape_Unit_Areas[25]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_3=26 THEN
Landscape_Unit_Areas[26]*Carrying_capacity_RF ELSE 0

UNITS: Square Kilometers
HF_water_saving_in_a_LU_8 = IF RF_desired_land_3<=HF_land_available_8 THEN
Total_water_saving_RF*RF_pct_3 ELSE 0
UNITS: MW per year
RF_desired_land_1 = IF RF_pct_total<=1 THEN RF_pct_1*Number_of_RF_acres*0.00404686
ELSE 0
UNITS: Square Kilometers
RF_desired_land_2 = IF RF_pct_total<=1 THEN RF_pct_2*Number_of_RF_acres*0.00404686
ELSE 0
UNITS: Square Kilometers
RF_desired_land_3 = IF RF_pct_total<=1 THEN RF_pct_3*Number_of_RF_acres*0.00404686
ELSE 0
UNITS: Square Kilometers
RF_desired_land_4 = IF RF_pct_total<=1 THEN RF_pct_4*Number_of_RF_acres*0.00404686
ELSE 0
UNITS: Square Kilometers
RF_desired_land_5 = IF RF_pct_total<=1 THEN RF_pct_5*Number_of_RF_acres*0.00404686
ELSE 0
UNITS: Square Kilometers
RF_land_available_1 = IF RF_LU_1=1 THEN
Landscape_Unit_Areas[1]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=2 THEN
Landscape_Unit_Areas[2]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=3 THEN
Landscape_Unit_Areas[3]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=4 THEN
Landscape_Unit_Areas[4]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=5 THEN
Landscape_Unit_Areas[5]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=6 THEN
Landscape_Unit_Areas[6]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=7 THEN
Landscape_Unit_Areas[7]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=8 THEN
Landscape_Unit_Areas[8]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=9 THEN
Landscape_Unit_Areas[9]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=10 THEN
Landscape_Unit_Areas[10]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=11 THEN
Landscape_Unit_Areas[11]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=12 THEN
Landscape_Unit_Areas[12]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=13 THEN
Landscape_Unit_Areas[13]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=14 THEN
Landscape_Unit_Areas[14]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=15 THEN
Landscape_Unit_Areas[15]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=16 THEN
Landscape_Unit_Areas[16]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=17 THEN
Landscape_Unit_Areas[17]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=18 THEN
Landscape_Unit_Areas[18]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=19 THEN
Landscape_Unit_Areas[19]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=20 THEN
Landscape_Unit_Areas[20]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=21 THEN
Landscape_Unit_Areas[21]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=22 THEN
Landscape_Unit_Areas[22]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=23 THEN
Landscape_Unit_Areas[23]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=24 THEN
Landscape_Unit_Areas[24]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=25 THEN
Landscape_Unit_Areas[25]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_1=26 THEN
Landscape_Unit_Areas[26]*Carrying_capacity_RF ELSE 0

UNITS: Square Kilometers
RF_land_available_2 = IF RF_LU_2=1 THEN
Landscape_Unit_Areas[1]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=2 THEN
Landscape_Unit_Areas[2]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=3 THEN
Landscape_Unit_Areas[3]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=4 THEN
Landscape_Unit_Areas[4]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=5 THEN
Landscape_Unit_Areas[5]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=6 THEN
Landscape_Unit_Areas[6]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=7 THEN
Landscape_Unit_Areas[7]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=8 THEN
Landscape_Unit_Areas[8]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=9 THEN
Landscape_Unit_Areas[9]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=10 THEN
Landscape_Unit_Areas[10]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=11 THEN
Landscape_Unit_Areas[11]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=12 THEN
Landscape_Unit_Areas[12]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=13 THEN
Landscape_Unit_Areas[13]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=14 THEN
Landscape_Unit_Areas[14]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=15 THEN
Landscape_Unit_Areas[15]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=16 THEN
Landscape_Unit_Areas[16]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=17 THEN
Landscape_Unit_Areas[17]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=18 THEN
Landscape_Unit_Areas[18]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=19 THEN
Landscape_Unit_Areas[19]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=20 THEN
Landscape_Unit_Areas[20]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=21 THEN
Landscape_Unit_Areas[21]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=22 THEN
Landscape_Unit_Areas[22]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=23 THEN
Landscape_Unit_Areas[23]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=24 THEN
Landscape_Unit_Areas[24]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=25 THEN
Landscape_Unit_Areas[25]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_2=26 THEN
Landscape_Unit_Areas[26]*Carrying_capacity_RF ELSE 0
UNITS: Square Kilometers
RF_land_available_4 = IF RF_LU_4=1 THEN
Landscape_Unit_Areas[1]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=2 THEN
Landscape_Unit_Areas[2]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=3 THEN
Landscape_Unit_Areas[3]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=4 THEN
Landscape_Unit_Areas[4]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=5 THEN
Landscape_Unit_Areas[5]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=6 THEN
Landscape_Unit_Areas[6]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=7 THEN
Landscape_Unit_Areas[7]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=8 THEN
Landscape_Unit_Areas[8]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=9 THEN
Landscape_Unit_Areas[9]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=10 THEN
Landscape_Unit_Areas[10]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=11 THEN
Landscape_Unit_Areas[11]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=12 THEN
Landscape_Unit_Areas[12]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=13 THEN
Landscape_Unit_Areas[13]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=14 THEN
Landscape_Unit_Areas[14]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=15 THEN
Landscape_Unit_Areas[15]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=16 THEN
Landscape_Unit_Areas[16]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=17 THEN

Landscape_Unit_Areas[17]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=18 THEN
Landscape_Unit_Areas[18]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=19 THEN
Landscape_Unit_Areas[19]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=20 THEN
Landscape_Unit_Areas[20]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=21 THEN
Landscape_Unit_Areas[21]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=22 THEN
Landscape_Unit_Areas[22]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=23 THEN
Landscape_Unit_Areas[23]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=24 THEN
Landscape_Unit_Areas[24]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=25 THEN
Landscape_Unit_Areas[25]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_4=26 THEN
Landscape_Unit_Areas[26]*Carrying_capacity_RF ELSE 0
UNITS: Square Kilometers
RF_land_available_5 = IF RF_LU_5=1 THEN
Landscape_Unit_Areas[1]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=2 THEN
Landscape_Unit_Areas[2]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=3 THEN
Landscape_Unit_Areas[3]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=4 THEN
Landscape_Unit_Areas[4]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=5 THEN
Landscape_Unit_Areas[5]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=6 THEN
Landscape_Unit_Areas[6]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=7 THEN
Landscape_Unit_Areas[7]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=8 THEN
Landscape_Unit_Areas[8]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=9 THEN
Landscape_Unit_Areas[9]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=10 THEN
Landscape_Unit_Areas[10]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=11 THEN
Landscape_Unit_Areas[11]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=12 THEN
Landscape_Unit_Areas[12]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=13 THEN
Landscape_Unit_Areas[13]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=14 THEN
Landscape_Unit_Areas[14]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=15 THEN
Landscape_Unit_Areas[15]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=16 THEN
Landscape_Unit_Areas[16]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=17 THEN
Landscape_Unit_Areas[17]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=18 THEN
Landscape_Unit_Areas[18]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=19 THEN
Landscape_Unit_Areas[19]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=20 THEN
Landscape_Unit_Areas[20]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=21 THEN
Landscape_Unit_Areas[21]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=22 THEN
Landscape_Unit_Areas[22]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=23 THEN
Landscape_Unit_Areas[23]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=24 THEN
Landscape_Unit_Areas[24]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=25 THEN
Landscape_Unit_Areas[25]*Carrying_capacity_RF ELSE 0 OR IF RF_LU_5=26 THEN
Landscape_Unit_Areas[26]*Carrying_capacity_RF ELSE 0
UNITS: Square Kilometers
RF_LU_1 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
RF_LU_2 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
RF_LU_3 = 0

REPORT IN TABLE AS STOCK
UNITS: unitless
RF_LU_4 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
RF_LU_5 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
RF_option_1 = IF RF_LU_1=1 THEN RF_per_Landscape_Unit[1] ELSE 0 OR IF RF_LU_1=2 THEN RF_per_Landscape_Unit[2] ELSE 0 OR IF RF_LU_1=3 THEN RF_per_Landscape_Unit[3] ELSE 0 OR IF RF_LU_1=4 THEN RF_per_Landscape_Unit[4] ELSE 0 OR IF RF_LU_1=5 THEN RF_per_Landscape_Unit[5] ELSE 0 OR IF RF_LU_1=6 THEN RF_per_Landscape_Unit[6] ELSE 0 OR IF RF_LU_1=7 THEN RF_per_Landscape_Unit[7] ELSE 0 OR IF RF_LU_1=8 THEN RF_per_Landscape_Unit[8] ELSE 0 OR IF RF_LU_1=9 THEN RF_per_Landscape_Unit[9] ELSE 0 OR IF RF_LU_1=10 THEN RF_per_Landscape_Unit[10] ELSE 0 OR IF RF_LU_1=11 THEN RF_per_Landscape_Unit[11] ELSE 0 OR IF RF_LU_1=12 THEN RF_per_Landscape_Unit[12] ELSE 0 OR IF RF_LU_1=13 THEN RF_per_Landscape_Unit[13] ELSE 0 OR IF RF_LU_1=14 THEN RF_per_Landscape_Unit[14]ELSE 0 OR IF RF_LU_1=15 THEN RF_per_Landscape_Unit[15] ELSE 0 OR IF RF_LU_1=16 THEN RF_per_Landscape_Unit[16] ELSE 0 OR IF RF_LU_1=17 THEN RF_per_Landscape_Unit[17] ELSE 0 OR IF RF_LU_1=18 THEN RF_per_Landscape_Unit[18] ELSE 0 OR IF RF_LU_1=19 THEN RF_per_Landscape_Unit[19] ELSE 0 OR IF RF_LU_1=20 THEN RF_per_Landscape_Unit[20]ELSE 0 OR IF RF_LU_1=21 THEN RF_per_Landscape_Unit[21] ELSE 0 OR IF RF_LU_1=22 THEN RF_per_Landscape_Unit[22]ELSE 0 OR IF RF_LU_1=23 THEN RF_per_Landscape_Unit[23] ELSE 0 OR IF RF_LU_1=24 THEN RF_per_Landscape_Unit[24] ELSE 0 OR IF RF_LU_1=25 THEN RF_per_Landscape_Unit[25]ELSE 0 OR IF RF_LU_1=26 THEN RF_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
RF_option_2 = IF RF_LU_2=1 THEN RF_per_Landscape_Unit[1] ELSE 0 OR IF RF_LU_2=2 THEN RF_per_Landscape_Unit[2] ELSE 0 OR IF RF_LU_2=3 THEN RF_per_Landscape_Unit[3] ELSE 0 OR IF RF_LU_2=4 THEN RF_per_Landscape_Unit[4] ELSE 0 OR IF RF_LU_2=5 THEN RF_per_Landscape_Unit[5] ELSE 0 OR IF RF_LU_2=6 THEN RF_per_Landscape_Unit[6] ELSE 0 OR IF RF_LU_2=7 THEN RF_per_Landscape_Unit[7] ELSE 0 OR IF RF_LU_2=8 THEN RF_per_Landscape_Unit[8] ELSE 0 OR IF RF_LU_2=9 THEN RF_per_Landscape_Unit[9] ELSE 0 OR IF RF_LU_2=10 THEN RF_per_Landscape_Unit[10] ELSE 0 OR IF RF_LU_2=11 THEN RF_per_Landscape_Unit[11] ELSE 0 OR IF RF_LU_2=12 THEN RF_per_Landscape_Unit[12] ELSE 0 OR IF RF_LU_2=13 THEN RF_per_Landscape_Unit[13] ELSE 0 OR IF RF_LU_2=14 THEN RF_per_Landscape_Unit[14]ELSE 0 OR IF RF_LU_2=15 THEN RF_per_Landscape_Unit[15] ELSE 0 OR IF RF_LU_2=16 THEN RF_per_Landscape_Unit[16] ELSE 0 OR IF RF_LU_2=17 THEN RF_per_Landscape_Unit[17] ELSE 0 OR IF RF_LU_2=18 THEN RF_per_Landscape_Unit[18] ELSE 0 OR IF RF_LU_2=19 THEN RF_per_Landscape_Unit[19] ELSE 0 OR IF RF_LU_2=20 THEN RF_per_Landscape_Unit[20]ELSE 0 OR IF RF_LU_2=21 THEN RF_per_Landscape_Unit[21]

ELSE 0 OR IF RF_LU_2=22 THEN RF_per_Landscape_Unit[22]ELSE 0 OR IF RF_LU_2=23 THEN RF_per_Landscape_Unit[23] ELSE 0 OR IF RF_LU_2=24 THEN RF_per_Landscape_Unit[24] ELSE 0 OR IF RF_LU_2=25 THEN RF_per_Landscape_Unit[25]ELSE 0 OR IF RF_LU_2=26 THEN RF_per_Landscape_Unit[26] ELSE 0

UNITS: unitless

RF_option_3 = IF RF_LU_3=1 THEN RF_per_Landscape_Unit[1] ELSE 0 OR IF RF_LU_3=2 THEN RF_per_Landscape_Unit[2] ELSE 0 OR IF RF_LU_3=3 THEN RF_per_Landscape_Unit[3] ELSE 0 OR IF RF_LU_3=4 THEN RF_per_Landscape_Unit[4] ELSE 0 OR IF RF_LU_3=5 THEN RF_per_Landscape_Unit[5] ELSE 0 OR IF RF_LU_3=6 THEN RF_per_Landscape_Unit[6] ELSE 0 OR IF RF_LU_3=7 THEN RF_per_Landscape_Unit[7] ELSE 0 OR IF RF_LU_3=8 THEN RF_per_Landscape_Unit[8] ELSE 0 OR IF RF_LU_3=9 THEN RF_per_Landscape_Unit[9] ELSE 0 OR IF RF_LU_3=10 THEN RF_per_Landscape_Unit[10] ELSE 0 OR IF RF_LU_3=11 THEN RF_per_Landscape_Unit[11] ELSE 0 OR IF RF_LU_3=12 THEN RF_per_Landscape_Unit[12] ELSE 0 OR IF RF_LU_3=13 THEN RF_per_Landscape_Unit[13] ELSE 0 OR IF RF_LU_3=14 THEN RF_per_Landscape_Unit[14]ELSE 0 OR IF RF_LU_3=15 THEN RF_per_Landscape_Unit[15] ELSE 0 OR IF RF_LU_3=16 THEN RF_per_Landscape_Unit[16] ELSE 0 OR IF RF_LU_3=17 THEN RF_per_Landscape_Unit[17] ELSE 0 OR IF RF_LU_3=18 THEN RF_per_Landscape_Unit[18] ELSE 0 OR IF RF_LU_3=19 THEN RF_per_Landscape_Unit[19] ELSE 0 OR IF RF_LU_3=20 THEN RF_per_Landscape_Unit[20]ELSE 0 OR IF RF_LU_3=21 THEN RF_per_Landscape_Unit[21] ELSE 0 OR IF RF_LU_3=22 THEN RF_per_Landscape_Unit[22]ELSE 0 OR IF RF_LU_3=23 THEN RF_per_Landscape_Unit[23] ELSE 0 OR IF RF_LU_3=24 THEN RF_per_Landscape_Unit[24] ELSE 0 OR IF RF_LU_3=25 THEN RF_per_Landscape_Unit[25]ELSE 0 OR IF RF_LU_3=26 THEN RF_per_Landscape_Unit[26] ELSE 0

UNITS: unitless

RF_option_4 = IF RF_LU_4=1 THEN RF_per_Landscape_Unit[1] ELSE 0 OR IF RF_LU_4=2 THEN RF_per_Landscape_Unit[2] ELSE 0 OR IF RF_LU_4=3 THEN RF_per_Landscape_Unit[3] ELSE 0 OR IF RF_LU_4=4 THEN RF_per_Landscape_Unit[4] ELSE 0 OR IF RF_LU_4=5 THEN RF_per_Landscape_Unit[5] ELSE 0 OR IF RF_LU_4=6 THEN RF_per_Landscape_Unit[6] ELSE 0 OR IF RF_LU_4=7 THEN RF_per_Landscape_Unit[7] ELSE 0 OR IF RF_LU_4=8 THEN RF_per_Landscape_Unit[8] ELSE 0 OR IF RF_LU_4=9 THEN RF_per_Landscape_Unit[9] ELSE 0 OR IF RF_LU_4=10 THEN RF_per_Landscape_Unit[10] ELSE 0 OR IF RF_LU_4=11 THEN RF_per_Landscape_Unit[11] ELSE 0 OR IF RF_LU_4=12 THEN RF_per_Landscape_Unit[12] ELSE 0 OR IF RF_LU_4=13 THEN RF_per_Landscape_Unit[13] ELSE 0 OR IF RF_LU_4=14 THEN RF_per_Landscape_Unit[14]ELSE 0 OR IF RF_LU_4=15 THEN RF_per_Landscape_Unit[15] ELSE 0 OR IF RF_LU_4=16 THEN RF_per_Landscape_Unit[16] ELSE 0 OR IF RF_LU_4=17 THEN RF_per_Landscape_Unit[17] ELSE 0 OR IF RF_LU_4=18 THEN RF_per_Landscape_Unit[18] ELSE 0 OR IF RF_LU_4=19 THEN RF_per_Landscape_Unit[19] ELSE 0 OR IF RF_LU_4=20 THEN RF_per_Landscape_Unit[20]ELSE 0 OR IF RF_LU_4=21 THEN RF_per_Landscape_Unit[21] ELSE 0 OR IF RF_LU_4=22 THEN RF_per_Landscape_Unit[22]ELSE 0 OR IF RF_LU_4=23 THEN RF_per_Landscape_Unit[23] ELSE 0 OR IF RF_LU_4=24 THEN

RF_per_Landscape_Unit[24] ELSE 0 OR IF RF_LU_4=25 THEN
RF_per_Landscape_Unit[25]ELSE 0 OR IF RF_LU_4=26 THEN RF_per_Landscape_Unit[26]
ELSE 0
UNITS: unitless
RF_option_5 = IF RF_LU_5=1 THEN RF_per_Landscape_Unit[1] ELSE 0 OR IF RF_LU_5=2
THEN RF_per_Landscape_Unit[2] ELSE 0 OR IF RF_LU_5=3 THEN
RF_per_Landscape_Unit[3] ELSE 0 OR IF RF_LU_5=4 THEN RF_per_Landscape_Unit[4]
ELSE 0 OR IF RF_LU_5=5 THEN RF_per_Landscape_Unit[5] ELSE 0 OR IF RF_LU_5=6
THEN RF_per_Landscape_Unit[6] ELSE 0 OR IF RF_LU_5=7 THEN
RF_per_Landscape_Unit[7] ELSE 0 OR IF RF_LU_5=8 THEN RF_per_Landscape_Unit[8]
ELSE 0 OR IF RF_LU_5=9 THEN RF_per_Landscape_Unit[9] ELSE 0 OR IF RF_LU_5=10
THEN RF_per_Landscape_Unit[10] ELSE 0 OR IF RF_LU_5=11 THEN
RF_per_Landscape_Unit[11] ELSE 0 OR IF RF_LU_5=12 THEN RF_per_Landscape_Unit[12]
ELSE 0 OR IF RF_LU_5=13 THEN RF_per_Landscape_Unit[13] ELSE 0 OR IF RF_LU_5=14
THEN RF_per_Landscape_Unit[14]ELSE 0 OR IF RF_LU_5=15 THEN
RF_per_Landscape_Unit[15] ELSE 0 OR IF RF_LU_5=16 THEN RF_per_Landscape_Unit[16]
ELSE 0 OR IF RF_LU_5=17 THEN RF_per_Landscape_Unit[17] ELSE 0 OR IF RF_LU_5=18
THEN RF_per_Landscape_Unit[18] ELSE 0 OR IF RF_LU_5=19 THEN
RF_per_Landscape_Unit[19] ELSE 0 OR IF RF_LU_5=20 THEN
RF_per_Landscape_Unit[20]ELSE 0 OR IF RF_LU_5=21 THEN RF_per_Landscape_Unit[21]
ELSE 0 OR IF RF_LU_5=22 THEN RF_per_Landscape_Unit[22]ELSE 0 OR IF RF_LU_5=23
THEN RF_per_Landscape_Unit[23] ELSE 0 OR IF RF_LU_5=24 THEN
RF_per_Landscape_Unit[24] ELSE 0 OR IF RF_LU_5=25 THEN
RF_per_Landscape_Unit[25]ELSE 0 OR IF RF_LU_5=26 THEN RF_per_Landscape_Unit[26]
ELSE 0
UNITS: unitless
RF_pct_1 = 0
UNITS: percentage
RF_pct_2 = 0
UNITS: percentage
RF_pct_3 = 0
UNITS: percentage
RF_pct_4 = 0
UNITS: percentage
RF_pct_5 = 0
UNITS: percentage
RF_pct_total = IF (RF_pct_1+RF_pct_2+RF_pct_3+RF_pct_4+RF_pct_5)<=1 THEN
RF_pct_1+RF_pct_2+RF_pct_3+RF_pct_4+RF_pct_5 ELSE 0
UNITS: percentage
RF_Suitability = IF Number_of_RF_acres>0 THEN
((RF_pct_1*RF_option_1)+(RF_pct_2*RF_option_2)+(RF_pct_3*RF_option_3)+(RF_pct_4*RF_option_4)+(RF_pct_5*RF_option_5)) ELSE 0
UNITS: unitless
RF_water_saving_in_a_LU_1 = IF RF_desired_land_1<=RF_land_available_1 THEN
Total_water_saving_RF*RF_pct_1 ELSE 0
UNITS: MW per year

RF_water_saving_in_a_LU_2 = IF RF_desired_land_2<=RF_land_available_2 THEN Total_water_saving_RF*RF_pct_2 ELSE 0
UNITS: MW per year
RF_water_saving_in_a_LU_4 = IF RF_desired_land_4<=RF_land_available_4 THEN Total_water_saving_RF*RF_pct_4 ELSE 0
UNITS: MW per year
RF_water_saving_in_a_LU_5 = IF RF_desired_land_5<=RF_land_available_5 THEN Total_water_saving_RF*RF_pct_5 ELSE 0
UNITS: MW per year

****
SB_energy_Landscape_Units:
****
Savings_energy_on = 1*pcnt_of_new_SB_energy
UNITS: unitless
SB_LU_options_SB_10 = IF SB_LUE_5=1 THEN SB_per_Landscape_Unit[1] ELSE 0 OR IF SB_LUE_5=2 THEN SB_per_Landscape_Unit[2] ELSE 0 OR IF SB_LUE_5=3 THEN SB_per_Landscape_Unit[3] ELSE 0 OR IF SB_LUE_5=4 THEN SB_per_Landscape_Unit[4] ELSE 0 OR IF SB_LUE_5=5 THEN SB_per_Landscape_Unit[5] ELSE 0 OR IF SB_LUE_5=6 THEN SB_per_Landscape_Unit[6] ELSE 0 OR IF SB_LUE_5=7 THEN SB_per_Landscape_Unit[7] ELSE 0 OR IF SB_LUE_5=8 THEN SB_per_Landscape_Unit[8] ELSE 0 OR IF SB_LUE_5=9 THEN SB_per_Landscape_Unit[9] ELSE 0 OR IF SB_LUE_5=10 THEN SB_per_Landscape_Unit[10] ELSE 0 OR IF SB_LUE_5=11 THEN SB_per_Landscape_Unit[11] ELSE 0 OR IF SB_LUE_5=12 THEN SB_per_Landscape_Unit[12] ELSE 0 OR IF SB_LUE_5=13 THEN SB_per_Landscape_Unit[13] ELSE 0 OR IF SB_LUE_5=14 THEN SB_per_Landscape_Unit[14] ELSE 0 OR IF SB_LUE_5=15 THEN SB_per_Landscape_Unit[15] ELSE 0 OR IF SB_LUE_5=16 THEN SB_per_Landscape_Unit[16] ELSE 0 OR IF SB_LUE_5=17 THEN SB_per_Landscape_Unit[17] ELSE 0 OR IF SB_LUE_5=18 THEN SB_per_Landscape_Unit[18] ELSE 0 OR IF SB_LUE_5=19 THEN SB_per_Landscape_Unit[19] ELSE 0 OR IF SB_LUE_5=20 THEN SB_per_Landscape_Unit[20] ELSE 0 OR IF SB_LUE_5=21 THEN SB_per_Landscape_Unit[21] ELSE 0 OR IF SB_LUE_5=22 THEN SB_per_Landscape_Unit[22] ELSE 0 OR IF SB_LUE_5=23 THEN SB_per_Landscape_Unit[23] ELSE 0 OR IF SB_LUE_5=24 THEN SB_per_Landscape_Unit[24] ELSE 0 OR IF SB_LUE_5=25 THEN SB_per_Landscape_Unit[25] ELSE 0 OR IF SB_LUE_5=26 THEN SB_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
SB_LU_options_SB_6 = IF SB_LUE_1=1 THEN SB_per_Landscape_Unit[1] ELSE 0 OR IF SB_LUE_1=2 THEN SB_per_Landscape_Unit[2] ELSE 0 OR IF SB_LUE_1=3 THEN SB_per_Landscape_Unit[3] ELSE 0 OR IF SB_LUE_1=4 THEN SB_per_Landscape_Unit[4] ELSE 0 OR IF SB_LUE_1=5 THEN SB_per_Landscape_Unit[5] ELSE 0 OR IF SB_LUE_1=6 THEN SB_per_Landscape_Unit[6] ELSE 0 OR IF SB_LUE_1=7 THEN SB_per_Landscape_Unit[7] ELSE 0 OR IF SB_LUE_1=8 THEN SB_per_Landscape_Unit[8]

ELSE 0 OR IF SB_LUE_1=9 THEN SB_per_Landscape_Unit[9] ELSE 0 OR IF SB_LUE_1=10 THEN SB_per_Landscape_Unit[10] ELSE 0 OR IF SB_LUE_1=11 THEN SB_per_Landscape_Unit[11] ELSE 0 OR IF SB_LUE_1=12 THEN SB_per_Landscape_Unit[12] ELSE 0 OR IF SB_LUE_1=13 THEN SB_per_Landscape_Unit[13] ELSE 0 OR IF SB_LUE_1=14 THEN SB_per_Landscape_Unit[14] ELSE 0 OR IF SB_LUE_1=15 THEN SB_per_Landscape_Unit[15] ELSE 0 OR IF SB_LUE_1=16 THEN SB_per_Landscape_Unit[16] ELSE 0 OR IF SB_LUE_1=17 THEN SB_per_Landscape_Unit[17] ELSE 0 OR IF SB_LUE_1=18 THEN SB_per_Landscape_Unit[18] ELSE 0 OR IF SB_LUE_1=19 THEN SB_per_Landscape_Unit[19] ELSE 0 OR IF SB_LUE_1=20 THEN SB_per_Landscape_Unit[20] ELSE 0 OR IF SB_LUE_1=21 THEN SB_per_Landscape_Unit[21] ELSE 0 OR IF SB_LUE_1=22 THEN SB_per_Landscape_Unit[22] ELSE 0 OR IF SB_LUE_1=23 THEN SB_per_Landscape_Unit[23] ELSE 0 OR IF SB_LUE_1=24 THEN SB_per_Landscape_Unit[24] ELSE 0 OR IF SB_LUE_1=25 THEN SB_per_Landscape_Unit[25] ELSE 0 OR IF SB_LUE_1=26 THEN SB_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
SB_LU_options_SB_7 = IF SB_LUE_2=1 THEN SB_per_Landscape_Unit[1] ELSE 0 OR IF SB_LUE_2=2 THEN SB_per_Landscape_Unit[2] ELSE 0 OR IF SB_LUE_2=3 THEN SB_per_Landscape_Unit[3] ELSE 0 OR IF SB_LUE_2=4 THEN SB_per_Landscape_Unit[4] ELSE 0 OR IF SB_LUE_2=5 THEN SB_per_Landscape_Unit[5] ELSE 0 OR IF SB_LUE_2=6 THEN SB_per_Landscape_Unit[6] ELSE 0 OR IF SB_LUE_2=7 THEN SB_per_Landscape_Unit[7] ELSE 0 OR IF SB_LUE_2=8 THEN SB_per_Landscape_Unit[8] ELSE 0 OR IF SB_LUE_2=9 THEN SB_per_Landscape_Unit[9] ELSE 0 OR IF SB_LUE_2=10 THEN SB_per_Landscape_Unit[10] ELSE 0 OR IF SB_LUE_2=11 THEN SB_per_Landscape_Unit[11] ELSE 0 OR IF SB_LUE_2=12 THEN SB_per_Landscape_Unit[12] ELSE 0 OR IF SB_LUE_2=13 THEN SB_per_Landscape_Unit[13] ELSE 0 OR IF SB_LUE_2=14 THEN SB_per_Landscape_Unit[14] ELSE 0 OR IF SB_LUE_2=15 THEN SB_per_Landscape_Unit[15] ELSE 0 OR IF SB_LUE_2=16 THEN SB_per_Landscape_Unit[16] ELSE 0 OR IF SB_LUE_2=17 THEN SB_per_Landscape_Unit[17] ELSE 0 OR IF SB_LUE_2=18 THEN SB_per_Landscape_Unit[18] ELSE 0 OR IF SB_LUE_2=19 THEN SB_per_Landscape_Unit[19] ELSE 0 OR IF SB_LUE_2=20 THEN SB_per_Landscape_Unit[20] ELSE 0 OR IF SB_LUE_2=21 THEN SB_per_Landscape_Unit[21] ELSE 0 OR IF SB_LUE_2=22 THEN SB_per_Landscape_Unit[22] ELSE 0 OR IF SB_LUE_2=23 THEN SB_per_Landscape_Unit[23] ELSE 0 OR IF SB_LUE_2=24 THEN SB_per_Landscape_Unit[24] ELSE 0 OR IF SB_LUE_2=25 THEN SB_per_Landscape_Unit[25] ELSE 0 OR IF SB_LUE_2=26 THEN SB_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
SB_LU_options_SB_8 = IF SB_LUE_3=1 THEN SB_per_Landscape_Unit[1] ELSE 0 OR IF SB_LUE_3=2 THEN SB_per_Landscape_Unit[2] ELSE 0 OR IF SB_LUE_3=3 THEN

SB_per_Landscape_Unit[3] ELSE 0 OR IF SB_LUE_3=4 THEN SB_per_Landscape_Unit[4] ELSE 0 OR IF SB_LUE_3=5 THEN SB_per_Landscape_Unit[5] ELSE 0 OR IF SB_LUE_3=6 THEN SB_per_Landscape_Unit[6] ELSE 0 OR IF SB_LUE_3=7 THEN SB_per_Landscape_Unit[7] ELSE 0 OR IF SB_LUE_3=8 THEN SB_per_Landscape_Unit[8] ELSE 0 OR IF SB_LUE_3=9 THEN SB_per_Landscape_Unit[9] ELSE 0 OR IF SB_LUE_3=10 THEN SB_per_Landscape_Unit[10] ELSE 0 OR IF SB_LUE_3=11 THEN SB_per_Landscape_Unit[11] ELSE 0 OR IF SB_LUE_3=12 THEN SB_per_Landscape_Unit[12] ELSE 0 OR IF SB_LUE_3=13 THEN SB_per_Landscape_Unit[13] ELSE 0 OR IF SB_LUE_3=14 THEN SB_per_Landscape_Unit[14] ELSE 0 OR IF SB_LUE_3=15 THEN SB_per_Landscape_Unit[15] ELSE 0 OR IF SB_LUE_3=16 THEN SB_per_Landscape_Unit[16] ELSE 0 OR IF SB_LUE_3=17 THEN SB_per_Landscape_Unit[17] ELSE 0 OR IF SB_LUE_3=18 THEN SB_per_Landscape_Unit[18] ELSE 0 OR IF SB_LUE_3=19 THEN SB_per_Landscape_Unit[19] ELSE 0 OR IF SB_LUE_3=20 THEN SB_per_Landscape_Unit[20] ELSE 0 OR IF SB_LUE_3=21 THEN SB_per_Landscape_Unit[21] ELSE 0 OR IF SB_LUE_3=22 THEN SB_per_Landscape_Unit[22] ELSE 0 OR IF SB_LUE_3=23 THEN SB_per_Landscape_Unit[23] ELSE 0 OR IF SB_LUE_3=24 THEN SB_per_Landscape_Unit[24] ELSE 0 OR IF SB_LUE_3=25 THEN SB_per_Landscape_Unit[25] ELSE 0 OR IF SB_LUE_3=26 THEN SB_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
SB_LU_options_SB_9 = IF SB_LUE_4=1 THEN SB_per_Landscape_Unit[1] ELSE 0 OR IF SB_LUE_4=2 THEN SB_per_Landscape_Unit[2] ELSE 0 OR IF SB_LUE_4=3 THEN SB_per_Landscape_Unit[3] ELSE 0 OR IF SB_LUE_4=4 THEN SB_per_Landscape_Unit[4] ELSE 0 OR IF SB_LUE_4=5 THEN SB_per_Landscape_Unit[5] ELSE 0 OR IF SB_LUE_4=6 THEN SB_per_Landscape_Unit[6] ELSE 0 OR IF SB_LUE_4=7 THEN SB_per_Landscape_Unit[7] ELSE 0 OR IF SB_LUE_4=8 THEN SB_per_Landscape_Unit[8] ELSE 0 OR IF SB_LUE_4=9 THEN SB_per_Landscape_Unit[9] ELSE 0 OR IF SB_LUE_4=10 THEN SB_per_Landscape_Unit[10] ELSE 0 OR IF SB_LUE_4=11 THEN SB_per_Landscape_Unit[11] ELSE 0 OR IF SB_LUE_4=12 THEN SB_per_Landscape_Unit[12] ELSE 0 OR IF SB_LUE_4=13 THEN SB_per_Landscape_Unit[13] ELSE 0 OR IF SB_LUE_4=14 THEN SB_per_Landscape_Unit[14] ELSE 0 OR IF SB_LUE_4=15 THEN SB_per_Landscape_Unit[15] ELSE 0 OR IF SB_LUE_4=16 THEN SB_per_Landscape_Unit[16] ELSE 0 OR IF SB_LUE_4=17 THEN SB_per_Landscape_Unit[17] ELSE 0 OR IF SB_LUE_4=18 THEN SB_per_Landscape_Unit[18] ELSE 0 OR IF SB_LUE_4=19 THEN SB_per_Landscape_Unit[19] ELSE 0 OR IF SB_LUE_4=20 THEN SB_per_Landscape_Unit[20] ELSE 0 OR IF SB_LUE_4=21 THEN SB_per_Landscape_Unit[21] ELSE 0 OR IF SB_LUE_4=22 THEN SB_per_Landscape_Unit[22] ELSE 0 OR IF SB_LUE_4=23 THEN SB_per_Landscape_Unit[23] ELSE 0 OR IF SB_LUE_4=24 THEN SB_per_Landscape_Unit[24] ELSE 0 OR IF SB_LUE_4=25 THEN

SB_per_Landscape_Unit[25] ELSE 0 OR IF SB_LUE_4=26 THEN
SB_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
SB_LUE_1 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
SB_LUE_2 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
SB_LUE_3 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
SB_LUE_4 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
SB_LUE_5 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
SB_pct_10 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
SB_pct_6 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
SB_pct_7 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
SB_pct_8 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
SB_pct_9 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
SB_pct_total_1 = IF (SB_pct_6+SB_pct_7+SB_pct_8+SB_pct_9+SB_pct_10)<=1 THEN
SB_pct_6+SB_pct_7+SB_pct_8+SB_pct_9+SB_pct_10 ELSE 0
UNITS: percentage
SB_suitability_energy = IF Savings_energy_on>0 THEN
0.5*((SB_pct_6*SB_LU_options_SB_6)+(SB_pct_7*SB_LU_options_SB_7)+(SB_pct_8*SB_L
U_options_SB_8)+(SB_pct_9*SB_LU_options_SB_9)+(SB_pct_10*SB_LU_options_SB_10))
ELSE 0
UNITS: unitless
SB_total_suitability = SB_suitability_energy+SB_suitability_water
UNITS: unitless
SF_valve_1 = IF Savings_energy_on=1 THEN SB_pct_total_1*Savings_energy ELSE 0
UNITS: MW per year

****
SB_Water_Landscape_Units:
****
Savings_freshwater_on = 1*Pcnt_of_new_SB_water
UNITS: unitless
SB_LU_1 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
SB_LU_2 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
SB_LU_3 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
SB_LU_4 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
SB_LU_5 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
SB_LU_options_SB_1 = IF SB_LU_1=1 THEN SB_per_Landscape_Unit[1] ELSE 0 OR IF SB_LU_1=2 THEN SB_per_Landscape_Unit[2] ELSE 0 OR IF SB_LU_1=3 THEN SB_per_Landscape_Unit[3] ELSE 0 OR IF SB_LU_1=4 THEN SB_per_Landscape_Unit[4] ELSE 0 OR IF SB_LU_1=5 THEN SB_per_Landscape_Unit[5] ELSE 0 OR IF SB_LU_1=6 THEN SB_per_Landscape_Unit[6] ELSE 0 OR IF SB_LU_1=7 THEN SB_per_Landscape_Unit[7] ELSE 0 OR IF SB_LU_1=8 THEN SB_per_Landscape_Unit[8] ELSE 0 OR IF SB_LU_1=9 THEN SB_per_Landscape_Unit[9] ELSE 0 OR IF SB_LU_1=10 THEN SB_per_Landscape_Unit[10] ELSE 0 OR IF SB_LU_1=11 THEN SB_per_Landscape_Unit[11] ELSE 0 OR IF SB_LU_1=12 THEN SB_per_Landscape_Unit[12] ELSE 0 OR IF SB_LU_1=13 THEN SB_per_Landscape_Unit[13] ELSE 0 OR IF SB_LU_1=14 THEN SB_per_Landscape_Unit[14] ELSE 0 OR IF SB_LU_1=15 THEN SB_per_Landscape_Unit[15] ELSE 0 OR IF SB_LU_1=16 THEN SB_per_Landscape_Unit[16] ELSE 0 OR IF SB_LU_1=17 THEN SB_per_Landscape_Unit[17] ELSE 0 OR IF SB_LU_1=18 THEN SB_per_Landscape_Unit[18] ELSE 0 OR IF SB_LU_1=19 THEN SB_per_Landscape_Unit[19] ELSE 0 OR IF SB_LU_1=20 THEN SB_per_Landscape_Unit[20] ELSE 0 OR IF SB_LU_1=21 THEN SB_per_Landscape_Unit[21] ELSE 0 OR IF SB_LU_1=22 THEN SB_per_Landscape_Unit[22] ELSE 0 OR IF SB_LU_1=23 THEN SB_per_Landscape_Unit[23] ELSE 0 OR IF SB_LU_1=24 THEN SB_per_Landscape_Unit[24] ELSE 0 OR IF SB_LU_1=25 THEN SB_per_Landscape_Unit[25] ELSE 0 OR IF SB_LU_1=26 THEN SB_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
SB_LU_options_SB_2 = IF SB_LU_2=1 THEN SB_per_Landscape_Unit[1] ELSE 0 OR IF SB_LU_2=2 THEN SB_per_Landscape_Unit[2] ELSE 0 OR IF SB_LU_2=3 THEN SB_per_Landscape_Unit[3] ELSE 0 OR IF SB_LU_2=4 THEN SB_per_Landscape_Unit[4] ELSE 0 OR IF SB_LU_2=5 THEN SB_per_Landscape_Unit[5] ELSE 0 OR IF SB_LU_2=6 THEN SB_per_Landscape_Unit[6] ELSE 0 OR IF SB_LU_2=7 THEN

SB_per_Landscape_Unit[7] ELSE 0 OR IF SB_LU_2=8 THEN SB_per_Landscape_Unit[8] ELSE 0 OR IF SB_LU_2=9 THEN SB_per_Landscape_Unit[9] ELSE 0 OR IF SB_LU_2=10 THEN SB_per_Landscape_Unit[10] ELSE 0 OR IF SB_LU_2=11 THEN SB_per_Landscape_Unit[11] ELSE 0 OR IF SB_LU_2=12 THEN SB_per_Landscape_Unit[12] ELSE 0 OR IF SB_LU_2=13 THEN SB_per_Landscape_Unit[13] ELSE 0 OR IF SB_LU_2=14 THEN SB_per_Landscape_Unit[14] ELSE 0 OR IF SB_LU_2=15 THEN SB_per_Landscape_Unit[15] ELSE 0 OR IF SB_LU_2=16 THEN SB_per_Landscape_Unit[16] ELSE 0 OR IF SB_LU_2=17 THEN SB_per_Landscape_Unit[17] ELSE 0 OR IF SB_LU_2=18 THEN SB_per_Landscape_Unit[18] ELSE 0 OR IF SB_LU_2=19 THEN SB_per_Landscape_Unit[19] ELSE 0 OR IF SB_LU_2=20 THEN SB_per_Landscape_Unit[20] ELSE 0 OR IF SB_LU_2=21 THEN SB_per_Landscape_Unit[21] ELSE 0 OR IF SB_LU_2=22 THEN SB_per_Landscape_Unit[22] ELSE 0 OR IF SB_LU_2=23 THEN SB_per_Landscape_Unit[23] ELSE 0 OR IF SB_LU_2=24 THEN SB_per_Landscape_Unit[24] ELSE 0 OR IF SB_LU_2=25 THEN SB_per_Landscape_Unit[25] ELSE 0 OR IF SB_LU_2=26 THEN SB_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
SB_LU_options_SB_3 = IF SB_LU_3=1 THEN SB_per_Landscape_Unit[1] ELSE 0 OR IF SB_LU_3=2 THEN SB_per_Landscape_Unit[2] ELSE 0 OR IF SB_LU_3=3 THEN SB_per_Landscape_Unit[3] ELSE 0 OR IF SB_LU_3=4 THEN SB_per_Landscape_Unit[4] ELSE 0 OR IF SB_LU_3=5 THEN SB_per_Landscape_Unit[5] ELSE 0 OR IF SB_LU_3=6 THEN SB_per_Landscape_Unit[6] ELSE 0 OR IF SB_LU_3=7 THEN SB_per_Landscape_Unit[7] ELSE 0 OR IF SB_LU_3=8 THEN SB_per_Landscape_Unit[8] ELSE 0 OR IF SB_LU_3=9 THEN SB_per_Landscape_Unit[9] ELSE 0 OR IF SB_LU_3=10 THEN SB_per_Landscape_Unit[10] ELSE 0 OR IF SB_LU_3=11 THEN SB_per_Landscape_Unit[11] ELSE 0 OR IF SB_LU_3=12 THEN SB_per_Landscape_Unit[12] ELSE 0 OR IF SB_LU_3=13 THEN SB_per_Landscape_Unit[13] ELSE 0 OR IF SB_LU_3=14 THEN SB_per_Landscape_Unit[14] ELSE 0 OR IF SB_LU_3=15 THEN SB_per_Landscape_Unit[15] ELSE 0 OR IF SB_LU_3=16 THEN SB_per_Landscape_Unit[16] ELSE 0 OR IF SB_LU_3=17 THEN SB_per_Landscape_Unit[17] ELSE 0 OR IF SB_LU_3=18 THEN SB_per_Landscape_Unit[18] ELSE 0 OR IF SB_LU_3=19 THEN SB_per_Landscape_Unit[19] ELSE 0 OR IF SB_LU_3=20 THEN SB_per_Landscape_Unit[20] ELSE 0 OR IF SB_LU_3=21 THEN SB_per_Landscape_Unit[21] ELSE 0 OR IF SB_LU_3=22 THEN SB_per_Landscape_Unit[22] ELSE 0 OR IF SB_LU_3=23 THEN SB_per_Landscape_Unit[23] ELSE 0 OR IF SB_LU_3=24 THEN SB_per_Landscape_Unit[24] ELSE 0 OR IF SB_LU_3=25 THEN SB_per_Landscape_Unit[25] ELSE 0 OR IF SB_LU_3=26 THEN SB_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
SB_LU_options_SB_4 = IF SB_LU_4=1 THEN SB_per_Landscape_Unit[1] ELSE 0 OR IF SB_LU_4=2 THEN SB_per_Landscape_Unit[2] ELSE 0 OR IF SB_LU_4=3 THEN SB_per_Landscape_Unit[3] ELSE 0 OR IF SB_LU_4=4 THEN SB_per_Landscape_Unit[4] ELSE 0 OR IF SB_LU_4=5 THEN SB_per_Landscape_Unit[5] ELSE 0 OR IF SB_LU_4=6 THEN SB_per_Landscape_Unit[6] ELSE 0 OR IF SB_LU_4=7 THEN SB_per_Landscape_Unit[7] ELSE 0 OR IF SB_LU_4=8 THEN SB_per_Landscape_Unit[8] ELSE 0 OR IF SB_LU_4=9 THEN SB_per_Landscape_Unit[9] ELSE 0 OR IF SB_LU_4=10 THEN SB_per_Landscape_Unit[10] ELSE 0 OR IF SB_LU_4=11 THEN SB_per_Landscape_Unit[11] ELSE 0 OR IF SB_LU_4=12 THEN SB_per_Landscape_Unit[12]

ELSE 0 OR IF SB_LU_4=13 THEN SB_per_Landscape_Unit[13] ELSE 0 OR IF SB_LU_4=14 THEN SB_per_Landscape_Unit[14] ELSE 0 OR IF SB_LU_4=15 THEN SB_per_Landscape_Unit[15] ELSE 0 OR IF SB_LU_4=16 THEN SB_per_Landscape_Unit[16] ELSE 0 OR IF SB_LU_4=17 THEN SB_per_Landscape_Unit[17] ELSE 0 OR IF SB_LU_4=18 THEN SB_per_Landscape_Unit[18] ELSE 0 OR IF SB_LU_4=19 THEN SB_per_Landscape_Unit[19] ELSE 0 OR IF SB_LU_4=20 THEN SB_per_Landscape_Unit[20] ELSE 0 OR IF SB_LU_4=21 THEN SB_per_Landscape_Unit[21] ELSE 0 OR IF SB_LU_4=22 THEN SB_per_Landscape_Unit[22] ELSE 0 OR IF SB_LU_4=23 THEN SB_per_Landscape_Unit[23] ELSE 0 OR IF SB_LU_4=24 THEN SB_per_Landscape_Unit[24] ELSE 0 OR IF SB_LU_4=25 THEN SB_per_Landscape_Unit[25] ELSE 0 OR IF SB_LU_4=26 THEN SB_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
SB_LU_options_SB_5 = IF SB_LU_5=1 THEN SB_per_Landscape_Unit[1] ELSE 0 OR IF SB_LU_5=2 THEN SB_per_Landscape_Unit[2] ELSE 0 OR IF SB_LU_5=3 THEN SB_per_Landscape_Unit[3] ELSE 0 OR IF SB_LU_5=4 THEN SB_per_Landscape_Unit[4] ELSE 0 OR IF SB_LU_5=5 THEN SB_per_Landscape_Unit[5] ELSE 0 OR IF SB_LU_5=6 THEN SB_per_Landscape_Unit[6] ELSE 0 OR IF SB_LU_5=7 THEN SB_per_Landscape_Unit[7] ELSE 0 OR IF SB_LU_5=8 THEN SB_per_Landscape_Unit[8] ELSE 0 OR IF SB_LU_5=9 THEN SB_per_Landscape_Unit[9] ELSE 0 OR IF SB_LU_5=10 THEN SB_per_Landscape_Unit[10] ELSE 0 OR IF SB_LU_5=11 THEN SB_per_Landscape_Unit[11] ELSE 0 OR IF SB_LU_5=12 THEN SB_per_Landscape_Unit[12] ELSE 0 OR IF SB_LU_5=13 THEN SB_per_Landscape_Unit[13] ELSE 0 OR IF SB_LU_5=14 THEN SB_per_Landscape_Unit[14] ELSE 0 OR IF SB_LU_5=15 THEN SB_per_Landscape_Unit[15] ELSE 0 OR IF SB_LU_5=16 THEN SB_per_Landscape_Unit[16] ELSE 0 OR IF SB_LU_5=17 THEN SB_per_Landscape_Unit[17] ELSE 0 OR IF SB_LU_5=18 THEN SB_per_Landscape_Unit[18] ELSE 0 OR IF SB_LU_5=19 THEN SB_per_Landscape_Unit[19] ELSE 0 OR IF SB_LU_5=20 THEN SB_per_Landscape_Unit[20] ELSE 0 OR IF SB_LU_5=21 THEN SB_per_Landscape_Unit[21] ELSE 0 OR IF SB_LU_5=22 THEN SB_per_Landscape_Unit[22] ELSE 0 OR IF SB_LU_5=23 THEN SB_per_Landscape_Unit[23] ELSE 0 OR IF SB_LU_5=24 THEN SB_per_Landscape_Unit[24] ELSE 0 OR IF SB_LU_5=25 THEN SB_per_Landscape_Unit[25] ELSE 0 OR IF SB_LU_5=26 THEN SB_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
SB_pct_1 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
SB_pct_2 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
SB_pct_3 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
SB_pct_4 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
SB_pct_5 = 0

REPORT IN TABLE AS STOCK
UNITS: percentage
SB_pct_total = IF (SB_pct_1+SB_pct_2+SB_pct_3+SB_pct_4+SB_pct_5)<=1 THEN SB_pct_1+SB_pct_2+SB_pct_3+SB_pct_4+SB_pct_5 ELSE 0
UNITS: unitless
SB_suitability_water = IF Savings_freshwater_on>0 THEN 0.5*((SB_pct_1*SB_LU_options_SB_1)+(SB_pct_2*SB_LU_options_SB_2)+(SB_pct_3*SB_LU_options_SB_3)+(SB_pct_4*SB_LU_options_SB_4)+(SB_pct_5*SB_LU_options_SB_5)) ELSE 0
UNITS: unitless
SF_valve = IF Savings_freshwater_on=1 THEN SB_pct_total*Savings_freshwater ELSE 0
UNITS: gpcd

****
SE_Landscape_Units:
****
SE_Carrying_capacity = 0.1
UNITS: percentage
SE_desired_land_1 = IF SE_pcnt_total<=1 THEN SE_pcnt_1*Solar_energy_area ELSE 0
UNITS: Square Kilometers
SE_desired_land_2 = IF SE_pcnt_total<=1 THEN SE_pcnt_2*Solar_energy_area ELSE 0
UNITS: MW per year
SE_desired_land_3 = IF SE_pcnt_total<=1 THEN SE_pcnt_3*Solar_energy_area ELSE 0
UNITS: MW per year
SE_desired_land_4 = IF SE_pcnt_total<=1 THEN SE_pcnt_4*Solar_energy_area ELSE 0
UNITS: MW per year
SE_desired_land_5 = IF SE_pcnt_total<=1 THEN SE_pcnt_5*Solar_energy_area ELSE 0
UNITS: MW per year
SE_energy_in_a_LU_1 = IF SE_desired_land_1<=SE_land_available_1 THEN Solar_energy*SE_pcnt_1 ELSE 0
UNITS: MW per year
SE_energy_in_a_LU_2 = IF SE_desired_land_2<=SE_land_available_2 THEN Solar_energy*SE_pcnt_2 ELSE 0
UNITS: MW per year
SE_energy_in_a_LU_3 = IF SE_desired_land_3<=SE_land_available_3 THEN Solar_energy*SE_pcnt_3 ELSE 0
UNITS: MW per year
SE_energy_in_a_LU_4 = IF SE_desired_land_4<=SE_land_available_4 THEN Solar_energy*SE_pcnt_4 ELSE 0
UNITS: MW per year
SE_energy_in_a_LU_5 = IF SE_desired_land_5<=SE_land_available_5 THEN Solar_energy*SE_pcnt_5 ELSE 0
UNITS: MW per year
SE_land_available_1 = IF SE_LU_1=1 THEN Landscape_Unit_Areas[1]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=2 THEN Landscape_Unit_Areas[2]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=3 THEN

Landscape_Unit_Areas[3]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=4 THEN
Landscape_Unit_Areas[4]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=5 THEN
Landscape_Unit_Areas[5]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=6 THEN
Landscape_Unit_Areas[6]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=7 THEN
Landscape_Unit_Areas[7]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=8 THEN
Landscape_Unit_Areas[8]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=9 THEN
Landscape_Unit_Areas[9]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=10 THEN
Landscape_Unit_Areas[10]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=11 THEN
Landscape_Unit_Areas[11]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=12 THEN
Landscape_Unit_Areas[12]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=13 THEN
Landscape_Unit_Areas[13]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=14 THEN
Landscape_Unit_Areas[14]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=15 THEN
Landscape_Unit_Areas[15]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=16 THEN
Landscape_Unit_Areas[16]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=17 THEN
Landscape_Unit_Areas[17]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=18 THEN
Landscape_Unit_Areas[18]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=19 THEN
Landscape_Unit_Areas[19]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=20 THEN
Landscape_Unit_Areas[20]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=21 THEN
Landscape_Unit_Areas[21]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=22 THEN
Landscape_Unit_Areas[22]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=23 THEN
Landscape_Unit_Areas[23]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=24 THEN
Landscape_Unit_Areas[24]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=25 THEN
Landscape_Unit_Areas[25]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_1=26 THEN
Landscape_Unit_Areas[26]*SE_Carrying_capacity ELSE 0
UNITS: Square Kilometers
SE_land_available_2 = IF SE_LU_2=1 THEN
Landscape_Unit_Areas[1]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=2 THEN
Landscape_Unit_Areas[2]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=3 THEN
Landscape_Unit_Areas[3]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=4 THEN
Landscape_Unit_Areas[4]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=5 THEN
Landscape_Unit_Areas[5]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=6 THEN
Landscape_Unit_Areas[6]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=7 THEN
Landscape_Unit_Areas[7]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=8 THEN
Landscape_Unit_Areas[8]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=9 THEN
Landscape_Unit_Areas[9]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=10 THEN
Landscape_Unit_Areas[10]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=11 THEN
Landscape_Unit_Areas[11]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=12 THEN
Landscape_Unit_Areas[12]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=13 THEN
Landscape_Unit_Areas[13]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=14 THEN
Landscape_Unit_Areas[14]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=15 THEN
Landscape_Unit_Areas[15]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=16 THEN
Landscape_Unit_Areas[16]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=17 THEN
Landscape_Unit_Areas[17]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=18 THEN
Landscape_Unit_Areas[18]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=19 THEN
Landscape_Unit_Areas[19]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=20 THEN
Landscape_Unit_Areas[20]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=21 THEN

Landscape_Unit_Areas[21]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=22 THEN
Landscape_Unit_Areas[22]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=23 THEN
Landscape_Unit_Areas[23]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=24 THEN
Landscape_Unit_Areas[24]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=25 THEN
Landscape_Unit_Areas[25]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_2=26 THEN
Landscape_Unit_Areas[26]*SE_Carrying_capacity ELSE 0
UNITS: Square Kilometers
SE_land_available_3 = IF SE_LU_3=1 THEN
Landscape_Unit_Areas[1]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=2 THEN
Landscape_Unit_Areas[2]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=3 THEN
Landscape_Unit_Areas[3]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=4 THEN
Landscape_Unit_Areas[4]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=5 THEN
Landscape_Unit_Areas[5]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=6 THEN
Landscape_Unit_Areas[6]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=7 THEN
Landscape_Unit_Areas[7]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=8 THEN
Landscape_Unit_Areas[8]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=9 THEN
Landscape_Unit_Areas[9]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=10 THEN
Landscape_Unit_Areas[10]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=11 THEN
Landscape_Unit_Areas[11]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=12 THEN
Landscape_Unit_Areas[12]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=13 THEN
Landscape_Unit_Areas[13]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=14 THEN
Landscape_Unit_Areas[14]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=15 THEN
Landscape_Unit_Areas[15]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=16 THEN
Landscape_Unit_Areas[16]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=17 THEN
Landscape_Unit_Areas[17]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=18 THEN
Landscape_Unit_Areas[18]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=19 THEN
Landscape_Unit_Areas[19]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=20 THEN
Landscape_Unit_Areas[20]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=21 THEN
Landscape_Unit_Areas[21]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=22 THEN
Landscape_Unit_Areas[22]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=23 THEN
Landscape_Unit_Areas[23]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=24 THEN
Landscape_Unit_Areas[24]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=25 THEN
Landscape_Unit_Areas[25]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_3=26 THEN
Landscape_Unit_Areas[26]*SE_Carrying_capacity ELSE 0
UNITS: Square Kilometers
SE_land_available_4 = IF SE_LU_4=1 THEN
Landscape_Unit_Areas[1]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=2 THEN
Landscape_Unit_Areas[2]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=3 THEN
Landscape_Unit_Areas[3]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=4 THEN
Landscape_Unit_Areas[4]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=5 THEN
Landscape_Unit_Areas[5]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=6 THEN
Landscape_Unit_Areas[6]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=7 THEN
Landscape_Unit_Areas[7]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=8 THEN
Landscape_Unit_Areas[8]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=9 THEN
Landscape_Unit_Areas[9]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=10 THEN
Landscape_Unit_Areas[10]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=11 THEN

Landscape_Unit_Areas[11]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=12 THEN
Landscape_Unit_Areas[12]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=13 THEN
Landscape_Unit_Areas[13]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=14 THEN
Landscape_Unit_Areas[14]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=15 THEN
Landscape_Unit_Areas[15]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=16 THEN
Landscape_Unit_Areas[16]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=17 THEN
Landscape_Unit_Areas[17]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=18 THEN
Landscape_Unit_Areas[18]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=19 THEN
Landscape_Unit_Areas[19]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=20 THEN
Landscape_Unit_Areas[20]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=21 THEN
Landscape_Unit_Areas[21]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=22 THEN
Landscape_Unit_Areas[22]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=23 THEN
Landscape_Unit_Areas[23]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=24 THEN
Landscape_Unit_Areas[24]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=25 THEN
Landscape_Unit_Areas[25]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_4=26 THEN
Landscape_Unit_Areas[26]*SE_Carrying_capacity ELSE 0
UNITS: Square Kilometers
SE_land_available_5 = IF SE_LU_5=1 THEN
Landscape_Unit_Areas[1]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=2 THEN
Landscape_Unit_Areas[2]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=3 THEN
Landscape_Unit_Areas[3]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=4 THEN
Landscape_Unit_Areas[4]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=5 THEN
Landscape_Unit_Areas[5]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=6 THEN
Landscape_Unit_Areas[6]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=7 THEN
Landscape_Unit_Areas[7]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=8 THEN
Landscape_Unit_Areas[8]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=9 THEN
Landscape_Unit_Areas[9]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=10 THEN
Landscape_Unit_Areas[10]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=11 THEN
Landscape_Unit_Areas[11]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=12 THEN
Landscape_Unit_Areas[12]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=13 THEN
Landscape_Unit_Areas[13]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=14 THEN
Landscape_Unit_Areas[14]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=15 THEN
Landscape_Unit_Areas[15]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=16 THEN
Landscape_Unit_Areas[16]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=17 THEN
Landscape_Unit_Areas[17]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=18 THEN
Landscape_Unit_Areas[18]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=19 THEN
Landscape_Unit_Areas[19]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=20 THEN
Landscape_Unit_Areas[20]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=21 THEN
Landscape_Unit_Areas[21]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=22 THEN
Landscape_Unit_Areas[22]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=23 THEN
Landscape_Unit_Areas[23]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=24 THEN
Landscape_Unit_Areas[24]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=25 THEN
Landscape_Unit_Areas[25]*SE_Carrying_capacity ELSE 0 OR IF SE_LU_5=26 THEN
Landscape_Unit_Areas[26]*SE_Carrying_capacity ELSE 0
UNITS: Square Kilometers
SE_LU_1 = 0

REPORT IN TABLE AS STOCK
UNITS: unitless
SE_LU_2 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
SE_LU_3 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
SE_LU_4 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
SE_LU_5 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
SE_option_1 = IF SE_LU_1=1 THEN E_per_Landscape_Unit[1] ELSE 0 OR IF SE_LU_1=2 THEN E_per_Landscape_Unit[2] ELSE 0 OR IF SE_LU_1=3 THEN E_per_Landscape_Unit[3] ELSE 0 OR IF SE_LU_1=4 THEN E_per_Landscape_Unit[4] ELSE 0 OR IF SE_LU_1=5 THEN E_per_Landscape_Unit[5] ELSE 0 OR IF SE_LU_1=6 THEN E_per_Landscape_Unit[6] ELSE 0 OR IF SE_LU_1=7 THEN E_per_Landscape_Unit[7]ELSE 0 OR IF SE_LU_1=8 THEN E_per_Landscape_Unit[8] ELSE 0 OR IF SE_LU_1=9 THEN E_per_Landscape_Unit[9] ELSE 0 OR IF SE_LU_1=10 THEN E_per_Landscape_Unit[10] ELSE 0 OR IF SE_LU_1=11 THEN E_per_Landscape_Unit[11] ELSE 0 OR IF SE_LU_1=12 THEN E_per_Landscape_Unit[12] ELSE 0 OR IF SE_LU_1=13 THEN E_per_Landscape_Unit[13] ELSE 0 OR IF SE_LU_1=14 THEN E_per_Landscape_Unit[14]ELSE 0 OR IF SE_LU_1=15 THEN E_per_Landscape_Unit[15] ELSE 0 OR IF SE_LU_1=16 THEN E_per_Landscape_Unit[16] ELSE 0 OR IF SE_LU_1=17 THEN E_per_Landscape_Unit[17] ELSE 0 OR IF SE_LU_1=18 THEN E_per_Landscape_Unit[18] ELSE 0 OR IF SE_LU_1=19 THEN E_per_Landscape_Unit[19] ELSE 0 OR IF SE_LU_1=20 THEN E_per_Landscape_Unit[20]ELSE 0 OR IF SE_LU_1=21 THEN E_per_Landscape_Unit[21] ELSE 0 OR IF SE_LU_1=22 THEN E_per_Landscape_Unit[22]ELSE 0 OR IF SE_LU_1=23 THEN E_per_Landscape_Unit[23] ELSE 0 OR IF SE_LU_1=24 THEN E_per_Landscape_Unit[24] ELSE 0 OR IF SE_LU_1=25 THEN E_per_Landscape_Unit[25]ELSE 0 OR IF SE_LU_1=26 THEN E_per_Landscape_Unit[26] ELSE 0
REPORT IN TABLE AS STOCK
UNITS: unitless
SE_option_2 = IF SE_LU_2=1 THEN E_per_Landscape_Unit[1] ELSE 0 OR IF SE_LU_2=2 THEN E_per_Landscape_Unit[2] ELSE 0 OR IF SE_LU_2=3 THEN E_per_Landscape_Unit[3] ELSE 0 OR IF SE_LU_2=4 THEN E_per_Landscape_Unit[4] ELSE 0 OR IF SE_LU_2=5 THEN E_per_Landscape_Unit[5] ELSE 0 OR IF SE_LU_2=6 THEN E_per_Landscape_Unit[6] ELSE 0 OR IF SE_LU_2=7 THEN E_per_Landscape_Unit[7]ELSE 0 OR IF SE_LU_2=8 THEN E_per_Landscape_Unit[8] ELSE 0 OR IF SE_LU_2=9 THEN E_per_Landscape_Unit[9] ELSE 0 OR IF SE_LU_2=10 THEN E_per_Landscape_Unit[10] ELSE 0 OR IF SE_LU_2=11 THEN E_per_Landscape_Unit[11] ELSE 0 OR IF SE_LU_2=12 THEN E_per_Landscape_Unit[12] ELSE 0 OR IF SE_LU_2=13 THEN E_per_Landscape_Unit[13] ELSE 0 OR IF SE_LU_2=14 THEN E_per_Landscape_Unit[14]ELSE 0 OR IF SE_LU_2=15

THEN E_per_Landscape_Unit[15] ELSE 0 OR IF SE_LU_2=16 THEN
E_per_Landscape_Unit[16] ELSE 0 OR IF SE_LU_2=17 THEN E_per_Landscape_Unit[17]
ELSE 0 OR IF SE_LU_2=18 THEN E_per_Landscape_Unit[18] ELSE 0 OR IF SE_LU_2=19
THEN E_per_Landscape_Unit[19] ELSE 0 OR IF SE_LU_2=20 THEN
E_per_Landscape_Unit[20]ELSE 0 OR IF SE_LU_2=21 THEN E_per_Landscape_Unit[21]
ELSE 0 OR IF SE_LU_2=22 THEN E_per_Landscape_Unit[22]ELSE 0 OR IF SE_LU_2=23
THEN E_per_Landscape_Unit[23] ELSE 0 OR IF SE_LU_2=24 THEN
E_per_Landscape_Unit[24] ELSE 0 OR IF SE_LU_2=25 THEN
E_per_Landscape_Unit[25]ELSE 0 OR IF SE_LU_2=26 THEN E_per_Landscape_Unit[26]
ELSE 0
REPORT IN TABLE AS STOCK
UNITS: unitless
SE_option_3 = IF SE_LU_3=1 THEN E_per_Landscape_Unit[1] ELSE 0 OR IF SE_LU_3=2
THEN E_per_Landscape_Unit[2] ELSE 0 OR IF SE_LU_3=3 THEN E_per_Landscape_Unit[3]
ELSE 0 OR IF SE_LU_3=4 THEN E_per_Landscape_Unit[4] ELSE 0 OR IF SE_LU_3=5
THEN E_per_Landscape_Unit[5] ELSE 0 OR IF SE_LU_3=6 THEN E_per_Landscape_Unit[6]
ELSE 0 OR IF SE_LU_3=7 THEN E_per_Landscape_Unit[7]ELSE 0 OR IF SE_LU_3=8
THEN E_per_Landscape_Unit[8] ELSE 0 OR IF SE_LU_3=9 THEN E_per_Landscape_Unit[9]
ELSE 0 OR IF SE_LU_3=10 THEN E_per_Landscape_Unit[10] ELSE 0 OR IF SE_LU_3=11
THEN E_per_Landscape_Unit[11] ELSE 0 OR IF SE_LU_3=12 THEN
E_per_Landscape_Unit[12] ELSE 0 OR IF SE_LU_3=13 THEN E_per_Landscape_Unit[13]
ELSE 0 OR IF SE_LU_3=14 THEN E_per_Landscape_Unit[14]ELSE 0 OR IF SE_LU_3=15
THEN E_per_Landscape_Unit[15] ELSE 0 OR IF SE_LU_3=16 THEN
E_per_Landscape_Unit[16] ELSE 0 OR IF SE_LU_3=17 THEN E_per_Landscape_Unit[17]
ELSE 0 OR IF SE_LU_3=18 THEN E_per_Landscape_Unit[18] ELSE 0 OR IF SE_LU_3=19
THEN E_per_Landscape_Unit[19] ELSE 0 OR IF SE_LU_3=20 THEN
E_per_Landscape_Unit[20]ELSE 0 OR IF SE_LU_3=21 THEN E_per_Landscape_Unit[21]
ELSE 0 OR IF SE_LU_3=22 THEN E_per_Landscape_Unit[22]ELSE 0 OR IF SE_LU_3=23
THEN E_per_Landscape_Unit[23] ELSE 0 OR IF SE_LU_3=24 THEN
E_per_Landscape_Unit[24] ELSE 0 OR IF SE_LU_3=25 THEN
E_per_Landscape_Unit[25]ELSE 0 OR IF SE_LU_3=26 THEN E_per_Landscape_Unit[26]
ELSE 0
REPORT IN TABLE AS STOCK
UNITS: unitless
SE_option_4 = IF SE_LU_4=1 THEN E_per_Landscape_Unit[1] ELSE 0 OR IF SE_LU_4=2
THEN E_per_Landscape_Unit[2] ELSE 0 OR IF SE_LU_4=3 THEN E_per_Landscape_Unit[3]
ELSE 0 OR IF SE_LU_4=4 THEN E_per_Landscape_Unit[4] ELSE 0 OR IF SE_LU_4=5
THEN E_per_Landscape_Unit[5] ELSE 0 OR IF SE_LU_4=6 THEN E_per_Landscape_Unit[6]
ELSE 0 OR IF SE_LU_4=7 THEN E_per_Landscape_Unit[7]ELSE 0 OR IF SE_LU_4=8
THEN E_per_Landscape_Unit[8] ELSE 0 OR IF SE_LU_4=9 THEN E_per_Landscape_Unit[9]
ELSE 0 OR IF SE_LU_4=10 THEN E_per_Landscape_Unit[10] ELSE 0 OR IF SE_LU_4=11
THEN E_per_Landscape_Unit[11] ELSE 0 OR IF SE_LU_4=12 THEN
E_per_Landscape_Unit[12] ELSE 0 OR IF SE_LU_4=13 THEN E_per_Landscape_Unit[13]
ELSE 0 OR IF SE_LU_4=14 THEN E_per_Landscape_Unit[14]ELSE 0 OR IF SE_LU_4=15
THEN E_per_Landscape_Unit[15] ELSE 0 OR IF SE_LU_4=16 THEN
E_per_Landscape_Unit[16] ELSE 0 OR IF SE_LU_4=17 THEN E_per_Landscape_Unit[17]

ELSE 0 OR IF SE_LU_4=18 THEN E_per_Landscape_Unit[18] ELSE 0 OR IF SE_LU_4=19 THEN E_per_Landscape_Unit[19] ELSE 0 OR IF SE_LU_4=20 THEN E_per_Landscape_Unit[20]ELSE 0 OR IF SE_LU_4=21 THEN E_per_Landscape_Unit[21] ELSE 0 OR IF SE_LU_4=22 THEN E_per_Landscape_Unit[22]ELSE 0 OR IF SE_LU_4=23 THEN E_per_Landscape_Unit[23] ELSE 0 OR IF SE_LU_4=24 THEN E_per_Landscape_Unit[24] ELSE 0 OR IF SE_LU_4=25 THEN E_per_Landscape_Unit[25]ELSE 0 OR IF SE_LU_4=26 THEN E_per_Landscape_Unit[26] ELSE 0
REPORT IN TABLE AS STOCK
UNITS: unitless
SE_option_5 = IF SE_LU_5=1 THEN E_per_Landscape_Unit[1] ELSE 0 OR IF SE_LU_5=2 THEN E_per_Landscape_Unit[2] ELSE 0 OR IF SE_LU_5=3 THEN E_per_Landscape_Unit[3] ELSE 0 OR IF SE_LU_5=4 THEN E_per_Landscape_Unit[4] ELSE 0 OR IF SE_LU_5=5 THEN E_per_Landscape_Unit[5] ELSE 0 OR IF SE_LU_5=6 THEN E_per_Landscape_Unit[6] ELSE 0 OR IF SE_LU_5=7 THEN E_per_Landscape_Unit[7]ELSE 0 OR IF SE_LU_5=8 THEN E_per_Landscape_Unit[8] ELSE 0 OR IF SE_LU_5=9 THEN E_per_Landscape_Unit[9] ELSE 0 OR IF SE_LU_5=10 THEN E_per_Landscape_Unit[10] ELSE 0 OR IF SE_LU_5=11 THEN E_per_Landscape_Unit[11] ELSE 0 OR IF SE_LU_5=12 THEN E_per_Landscape_Unit[12] ELSE 0 OR IF SE_LU_5=13 THEN E_per_Landscape_Unit[13] ELSE 0 OR IF SE_LU_5=14 THEN E_per_Landscape_Unit[14]ELSE 0 OR IF SE_LU_5=15 THEN E_per_Landscape_Unit[15] ELSE 0 OR IF SE_LU_5=16 THEN E_per_Landscape_Unit[16] ELSE 0 OR IF SE_LU_5=17 THEN E_per_Landscape_Unit[17] ELSE 0 OR IF SE_LU_5=18 THEN E_per_Landscape_Unit[18] ELSE 0 OR IF SE_LU_5=19 THEN E_per_Landscape_Unit[19] ELSE 0 OR IF SE_LU_5=20 THEN E_per_Landscape_Unit[20]ELSE 0 OR IF SE_LU_5=21 THEN E_per_Landscape_Unit[21] ELSE 0 OR IF SE_LU_5=22 THEN E_per_Landscape_Unit[22]ELSE 0 OR IF SE_LU_5=23 THEN E_per_Landscape_Unit[23] ELSE 0 OR IF SE_LU_5=24 THEN E_per_Landscape_Unit[24] ELSE 0 OR IF SE_LU_5=25 THEN E_per_Landscape_Unit[25]ELSE 0 OR IF SE_LU_5=26 THEN E_per_Landscape_Unit[26] ELSE 0
REPORT IN TABLE AS STOCK
UNITS: unitless
SE_pcnt_1 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
SE_pcnt_2 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
SE_pcnt_3 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
SE_pcnt_4 = 0
REPORT IN TABLE AS STOCK
UNITS: percentage
SE_pcnt_5 = 0
REPORT IN TABLE AS STOCK

UNITS: percentage
SE_pcnt_total = IF (SE_pcnt_1+SE_pcnt_2+SE_pcnt_3+SE_pcnt_4+SE_pcnt_5)<=1 THEN SE_pcnt_1+SE_pcnt_2+SE_pcnt_3+SE_pcnt_4+SE_pcnt_5 ELSE 0
UNITS: percentage
SE_Suitability = IF SE_ON>0 THEN ((SE_pcnt_1*SE_option_1)+(SE_pcnt_2*SE_option_2)+(SE_pcnt_3*SE_option_3)+(SE_option_4*SE_pcnt_4)+(SE_option_5*SE_pcnt_5)) ELSE 0
UNITS: unitless

****
Social_Foundations:
****
DE_EDUCATION_Color = -1*DE_EDUCATION_SWIFT
UNITS: unitless
DE_EDUCATION_SWIFT = 0.5*SB_DE_swift[Education_A]+0.5*SB_DE_swift[Education_B]+0.5*GR_DE_swift[Education_A]+0.5*GR_DE_swift[Education_B]+0.5*SE_DE_swift[Education_A]+0.5*SE_DE_swift[Education_B]+0.5*WE_DE_swift[Education_A]+0.5*WE_DE_swift[Education_B]+0.5*GE_DE_swift[Education_A]+0.5*GE_DE_swift[Education_B]+0.5*FB_DE_swift[Education_A]+0.5*FB_DE_swift[Education_B]+0.5*HF_DE_swift[Education_A]+0.5*HF_DE_swift[Education_B]+0.5*RF_DE_swift[Education_A]+0.5*RF_DE_swift[Education_B]+0.5*EV_DE_swift[Education_A]+0.5*EV_DE_swift[Education_B]
UNITS: unitless
DE_ENERGY_Color = -1*DE_ENERGY_SWIFT
UNITS: unitless
DE_ENERGY_SWIFT = 0.5*SB_DE_swift[Energy_A]+0.5*SB_DE_swift[Energy_B]+0.5*GR_DE_swift[Energy_A]+0.5*GR_DE_swift[Energy_B]+0.5*SE_DE_swift[Energy_A]+0.5*SE_DE_swift[Energy_B]+0.5*WE_DE_swift[Energy_A]+0.5*WE_DE_swift[Energy_B]+0.5*GE_DE_swift[Energy_A]+0.5*GE_DE_swift[Energy_B]+0.5*FB_DE_swift[Energy_A]+0.5*FB_DE_swift[Energy_B]+0.5*HF_DE_swift[Energy_A]+0.5*HF_DE_swift[Energy_B]+0.5*RF_DE_swift[Energy_A]+0.5*RF_DE_swift[Energy_B]+0.5*EV_DE_swift[Energy_A]+0.5*EV_DE_swift[Energy_B]
UNITS: unitless
DE_FOOD_Color = -1*DE_FOOD_SWIFT
UNITS: unitless
DE_FOOD_SWIFT = 0.33*(SB_DE_swift[Food_A])+0.33*(SB_DE_swift[Food_B])+0.34*(SB_DE_swift[Food_C])+0.33*(GR_DE_swift[Food_A])+0.33*(GR_DE_swift[Food_B])+0.34*(GR_DE_swift[Food_C])+0.33*(SE_DE_swift[Food_A])+0.33*(SE_DE_swift[Food_B])+0.34*(SE_DE_swift[Food_C])+0.33*(WE_DE_swift[Food_A])+0.33*(WE_DE_swift[Food_B])+0.34*(WE_DE_swift[Food_C])+0.33*(GE_DE_swift[Food_A])+0.33*(GE_DE_swift[Food_B])+0.34*(GE_DE_swift[Food_C])+0.33*(FB_DE_swift[Food_A])+0.33*(FB_DE_swift[Food_B])+0.34*(FB_DE_swift[Food_C])+0.33*(HF_DE_swift[Food_A])+0.33*(HF_DE_swift[Food_B])+0.34*(HF_DE_swift[Food_C])+0.33*(RF_DE_swift[Food_A])+0.33*(RF_DE_swift[Food_B])+0.34*(RF_DE_swift[Food_C])+0.33*(EV_DE_swift[Food_A])+0.33*(EV_DE_swift[Food_B])+0.34*(EV_DE_swift[Food_C])

UNITS: unitless
DE_GENDER_Color = -1*DE_GENDER_SWIFT
UNITS: unitless
DE_GENDER_SWIFT = 0.5*SB_DE_swift[Gender_Equality_A]
+0.5*SB_DE_swift[Gender_Equality_B]+0.5*GR_DE_swift[Gender_Equality_A]+0.5*GR_DE_swift[Gender_Equality_B]+0.5*SE_DE_swift[Gender_Equality_A]+0.5*SE_DE_swift[Gender_Equality_B]+0.5*WE_DE_swift[Gender_Equality_A]+0.5*WE_DE_swift[Gender_Equality_B]+0.5*GE_DE_swift[Gender_Equality_A]+0.5*GE_DE_swift[Gender_Equality_B]+0.5*FB_DE_swift[Gender_Equality_A]+0.5*FB_DE_swift[Gender_Equality_B]+0.5*HF_DE_swift[Gender_Equality_A]+0.5*HF_DE_swift[Gender_Equality_B]+0.5*RF_DE_swift[Gender_Equality_A]+0.5*RF_DE_swift[Gender_Equality_B]+0.5*EV_DE_swift[Gender_Equality_A]+0.5*EV_DE_swift[Gender_Equality_B]
UNITS: unitless
DE_HEALTH_Color = -1*DE_HEALTH_SWIFT
UNITS: unitless
DE_HEALTH_SWIFT =
0.5*SB_DE_swift[Health_A]+0.5*SB_DE_swift[Health_B]+0.5*GR_DE_swift[Health_A]+0.5*GR_DE_swift[Health_B]+0.5*SE_DE_swift[Health_A]+0.5*SE_DE_swift[Health_B]+0.5*WE_DE_swift[Health_A]+0.5*WE_DE_swift[Health_B]+0.5*GE_DE_swift[Health_A]+0.5*GE_DE_swift[Health_B]+0.5*FB_DE_swift[Health_A]+0.5*FB_DE_swift[Health_B]+0.5*HF_DE_swift[Health_A]+0.5*HF_DE_swift[Health_B]+0.5*RF_DE_swift[Health_A]+0.5*RF_DE_swift[Health_B]+0.5*EV_DE_swift[Health_A]+0.5*EV_DE_swift[Health_B]
UNITS: unitless
DE_HOUSING_Color = -1*DE_HOUSING_SWIFT
UNITS: unitless
DE_HOUSING_SWIFT =
0.5*SB_DE_swift[Housing_A]+0.5*SB_DE_swift[Housing_B]+0.5*GR_DE_swift[Housing_A]+0.5*GR_DE_swift[Housing_B]+0.5*SE_DE_swift[Housing_A]+0.5*SE_DE_swift[Housing_B]+0.5*WE_DE_swift[Housing_A]+0.5*WE_DE_swift[Housing_B]+0.5*GE_DE_swift[Housing_A]+0.5*GE_DE_swift[Housing_B]+0.5*FB_DE_swift[Housing_B]+0.5*FB_DE_swift[Housing_A]+0.5*HF_DE_swift[Housing_A]+0.5*HF_DE_swift[Housing_B]+0.5*RF_DE_swift[Housing_A]+0.5*RF_DE_swift[Housing_B]+0.5*EV_DE_swift[Housing_A]+0.5*EV_DE_swift[Housing_B]
UNITS: unitless
DE_INCOME_Color = -1*DE_INCOME_SWIFT
UNITS: unitless
DE_INCOME_SWIFT =
0.5*SB_DE_swift[Income_A]+0.5*SB_DE_swift[Income_B]+0.5*GR_DE_swift[Income_A]+0.5*GR_DE_swift[Income_B]+0.5*SE_DE_swift[Income_A]+0.5*SE_DE_swift[Income_B]+0.5*WE_DE_swift[Income_A]+0.5*WE_DE_swift[Income_B]+0.5*GE_DE_swift[Income_A]+0.5*GE_DE_swift[Income_B]+0.5*FB_DE_swift[Income_A]+0.5*FB_DE_swift[Income_B]+0.5*HF_DE_swift[Income_A]+0.5*HF_DE_swift[Income_B]+0.5*RF_DE_swift[Income_A]+0.5*RF_DE_swift[Income_B]+0.5*EV_DE_swift[Income_A]+0.5*EV_DE_swift[Income_B]
UNITS: unitless
DE_NETWORKS_Color = -1*DE_NETWORKS_SWIFT
UNITS: unitless

DE_NETWORKS_SWIFT =
SB_DE_swift[Networks]+GR_DE_swift[Networks]+SE_DE_swift[Networks]+WE_DE_swift[Networks]+GE_DE_swift[Networks]+FB_DE_swift[Networks]+HF_DE_swift[Networks]+RF_DE_swift[Networks]+EV_DE_swift[Networks]
UNITS: unitless
DE_PEACE_Color = -1*DE_PEACE_SWIFT
UNITS: unitless
DE_PEACE_SWIFT =
0.5*SB_DE_swift[Peace_and_Justice_A]+0.5*SB_DE_swift[Peace_and_Justice_B]+0.5*GR_DE_swift[Peace_and_Justice_A]+0.5*GR_DE_swift[Peace_and_Justice_B]+0.5*SE_DE_swift[Peace_and_Justice_A]+0.5*SE_DE_swift[Peace_and_Justice_B]+0.5*WE_DE_swift[Peace_and_Justice_A]+0.5*WE_DE_swift[Peace_and_Justice_B]+0.5*GE_DE_swift[Peace_and_Justice_A]+0.5*GE_DE_swift[Peace_and_Justice_B]+0.5*FB_DE_swift[Peace_and_Justice_A]+FB_DE_swift[Peace_and_Justice_B]+0.5*HF_DE_swift[Peace_and_Justice_A]+0.5*HF_DE_swift[Peace_and_Justice_B]+0.5*RF_DE_swift[Peace_and_Justice_A]+0.5*RF_DE_swift[Peace_and_Justice_B]+0.5*EV_DE_swift[Peace_and_Justice_A]+0.5*EV_DE_swift[Peace_and_Justice_B]
UNITS: unitless
DE_POLITICAL_Color = -1*DE_POLITICAL_SWIFT
UNITS: unitless
DE_POLITICAL_SWIFT =
SB_DE_swift[Political_voice]+GR_DE_swift[Political_voice]+SE_DE_swift[Political_voice]+WE_DE_swift[Political_voice]+GE_DE_swift[Political_voice]+FB_DE_swift[Political_voice]+HF_DE_swift[Political_voice]+RF_DE_swift[Political_voice]+EV_DE_swift[Political_voice]
UNITS: unitless
DE_SANITATION_Color = -1*DE_SANITATION_SWIFT
UNITS: unitless
DE_SANITATION_SWIFT =
SB_DE_swift[Sanitation]+GR_DE_swift[Sanitation]+SE_DE_swift[Sanitation]+WE_DE_swift[Sanitation]+GE_DE_swift[Sanitation]+FB_DE_swift[Sanitation]+HF_DE_swift[Sanitation]+RF_DE_swift[Sanitation]+EV_DE_swift[Sanitation]
UNITS: unitless
DE_SOCIAL_Color = -1*DE_SOCIAL_SWIFT
UNITS: unitless
DE_SOCIAL_SWIFT =
SB_DE_swift[Social_Equity]+GR_DE_swift[Social_Equity]+SE_DE_swift[Social_Equity]+WE_DE_swift[Social_Equity]+GE_DE_swift[Social_Equity]+FB_DE_swift[Social_Equity]+HF_DE_swift[Social_Equity]+RF_DE_swift[Social_Equity]+EV_DE_swift[Social_Equity]
UNITS: unitless

****
Southern_Nevada_Energy_Accesibility:
****
"%_Accesibility" = 1
UNITS: percentage
Dynamic_accesibility = INIT(Population)*"%_Accesibility"/Population
UNITS: percentage

****
Southern_Nevada_Energy_Demand:
****
"%SN_renewables" = 0.28
UNITS: percentage
"Energy/year_per_capita" = 67
UNITS: MWh
MWh_to_MW_per_year = 24*365
UNITS: hours per year
SN_Energy_Demand = Population*"Energy/year_per_capita"/MWh_to_MW_per_year
UNITS: MW per year
SN_Renewables = INIT(SN_Energy_Demand)*"%SN_renewables"
UNITS: MW per year

****
Southern_Nevada_Food_Insecurity:
****
"%_Food_insecurity" = 0.12
UNITS: percentage
Dynamic_food_insecurity = Population*"%_Food_insecurity"/Population
UNITS: percentage

****
Southern_Nevada_Freshwater_Withdrawals:
****
SN_Freshwater_withdrawal_total = Water_per_capita*Population
UNITS: gpcd
Water_per_capita = 126
UNITS: gpcd

****
Southern_Nevada_Population:
****
Growth = Growth_Rate*Population {UNIFLOW}
UNITS: People/Years
Growth_Rate = 0.01
UNITS: Per Year
Population(t) = Population(t - dt) + (Growth) * dt {NON-NEGATIVE}
INIT Population = 2324740
UNITS: People

****
WE_Landscape_Units:
****
WE_Carrying_capacity = 0.1

UNITS: percentage
WE_desired_land_1 = IF WE_pct_total<=1 THEN WE_pct_1*Wind_energy_area ELSE 0
UNITS: Square Kilometers
WE_desired_land_2 = IF WE_pct_total<=1 THEN WE_pct_2*Wind_energy_area ELSE 0
UNITS: MW per year
WE_desired_land_3 = IF WE_pct_total<=1 THEN WE_pct_3*Wind_energy_area ELSE 0
UNITS: MW per year
WE_desired_land_4 = IF WE_pct_total<=1 THEN WE_pct_4*Wind_energy_area ELSE 0
UNITS: MW per year
WE_desired_land_5 = IF WE_pct_total<=1 THEN WE_pct_5*Wind_energy_area ELSE 0
UNITS: MW per year
WE_energy_in_a_LU_1 = IF WE_desired_land_1<=WE_land_available_1 THEN
Wind_energy*WE_pct_1 ELSE 0
UNITS: MW per year
WE_energy_in_a_LU_2 = IF WE_desired_land_2<=WE_land_available_2 THEN
Wind_energy*WE_pct_2 ELSE 0
UNITS: MW per year
WE_energy_in_a_LU_3 = IF WE_desired_land_3<=WE_land_available_3 THEN
Wind_energy*WE_pct_3 ELSE 0
UNITS: MW per year
WE_energy_in_a_LU_4 = IF WE_desired_land_4<=WE_land_available_4 THEN
Wind_energy*WE_pct_4 ELSE 0
UNITS: MW per year
WE_energy_in_a_LU_5 = IF WE_desired_land_5<=WE_land_available_5 THEN
Wind_energy*WE_pct_5 ELSE 0
UNITS: MW per year
WE_land_available_1 = IF WE_LU_1=1 THEN
Landscape_Unit_Areas[1]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=2 THEN
Landscape_Unit_Areas[2]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=3 THEN
Landscape_Unit_Areas[3]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=4 THEN
Landscape_Unit_Areas[4]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=5 THEN
Landscape_Unit_Areas[5]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=6 THEN
Landscape_Unit_Areas[6]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=7 THEN
Landscape_Unit_Areas[7]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=8 THEN
Landscape_Unit_Areas[8]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=9 THEN
Landscape_Unit_Areas[9]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=10 THEN
Landscape_Unit_Areas[10]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=11 THEN
Landscape_Unit_Areas[11]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=12 THEN
Landscape_Unit_Areas[12]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=13 THEN
Landscape_Unit_Areas[13]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=14 THEN
Landscape_Unit_Areas[14]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=15 THEN
Landscape_Unit_Areas[15]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=16 THEN
Landscape_Unit_Areas[16]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=17 THEN
Landscape_Unit_Areas[17]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=18 THEN
Landscape_Unit_Areas[18]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=19 THEN
Landscape_Unit_Areas[19]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=20 THEN

Landscape_Unit_Areas[20]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=21 THEN
Landscape_Unit_Areas[21]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=22 THEN
Landscape_Unit_Areas[22]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=23 THEN
Landscape_Unit_Areas[23]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=24 THEN
Landscape_Unit_Areas[24]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=25 THEN
Landscape_Unit_Areas[25]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_1=26 THEN
Landscape_Unit_Areas[26]*WE_Carrying_capacity ELSE 0
UNITS: Square Kilometers
WE_land_available_2 = IF WE_LU_2=1 THEN
Landscape_Unit_Areas[1]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=2 THEN
Landscape_Unit_Areas[2]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=3 THEN
Landscape_Unit_Areas[3]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=4 THEN
Landscape_Unit_Areas[4]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=5 THEN
Landscape_Unit_Areas[5]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=6 THEN
Landscape_Unit_Areas[6]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=7 THEN
Landscape_Unit_Areas[7]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=8 THEN
Landscape_Unit_Areas[8]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=9 THEN
Landscape_Unit_Areas[9]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=10 THEN
Landscape_Unit_Areas[10]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=11 THEN
Landscape_Unit_Areas[11]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=12 THEN
Landscape_Unit_Areas[12]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=13 THEN
Landscape_Unit_Areas[13]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=14 THEN
Landscape_Unit_Areas[14]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=15 THEN
Landscape_Unit_Areas[15]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=16 THEN
Landscape_Unit_Areas[16]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=17 THEN
Landscape_Unit_Areas[17]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=18 THEN
Landscape_Unit_Areas[18]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=19 THEN
Landscape_Unit_Areas[19]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=20 THEN
Landscape_Unit_Areas[20]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=21 THEN
Landscape_Unit_Areas[21]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=22 THEN
Landscape_Unit_Areas[22]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=23 THEN
Landscape_Unit_Areas[23]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=24 THEN
Landscape_Unit_Areas[24]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=25 THEN
Landscape_Unit_Areas[25]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_2=26 THEN
Landscape_Unit_Areas[26]*WE_Carrying_capacity ELSE 0
UNITS: Square Kilometers
WE_land_available_3 = IF WE_LU_3=1 THEN
Landscape_Unit_Areas[1]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=2 THEN
Landscape_Unit_Areas[2]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=3 THEN
Landscape_Unit_Areas[3]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=4 THEN
Landscape_Unit_Areas[4]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=5 THEN
Landscape_Unit_Areas[5]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=6 THEN
Landscape_Unit_Areas[6]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=7 THEN
Landscape_Unit_Areas[7]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=8 THEN
Landscape_Unit_Areas[8]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=9 THEN
Landscape_Unit_Areas[9]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=10 THEN

Landscape_Unit_Areas[10]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=11 THEN
Landscape_Unit_Areas[11]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=12 THEN
Landscape_Unit_Areas[12]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=13 THEN
Landscape_Unit_Areas[13]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=14 THEN
Landscape_Unit_Areas[14]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=15 THEN
Landscape_Unit_Areas[15]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=16 THEN
Landscape_Unit_Areas[16]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=17 THEN
Landscape_Unit_Areas[17]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=18 THEN
Landscape_Unit_Areas[18]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=19 THEN
Landscape_Unit_Areas[19]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=20 THEN
Landscape_Unit_Areas[20]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=21 THEN
Landscape_Unit_Areas[21]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=22 THEN
Landscape_Unit_Areas[22]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=23 THEN
Landscape_Unit_Areas[23]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=24 THEN
Landscape_Unit_Areas[24]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=25 THEN
Landscape_Unit_Areas[25]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_3=26 THEN
Landscape_Unit_Areas[26]*WE_Carrying_capacity ELSE 0
UNITS: Square Kilometers
WE_land_available_4 = IF WE_LU_4=1 THEN
Landscape_Unit_Areas[1]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=2 THEN
Landscape_Unit_Areas[2]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=3 THEN
Landscape_Unit_Areas[3]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=4 THEN
Landscape_Unit_Areas[4]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=5 THEN
Landscape_Unit_Areas[5]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=6 THEN
Landscape_Unit_Areas[6]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=7 THEN
Landscape_Unit_Areas[7]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=8 THEN
Landscape_Unit_Areas[8]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=9 THEN
Landscape_Unit_Areas[9]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=10 THEN
Landscape_Unit_Areas[10]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=11 THEN
Landscape_Unit_Areas[11]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=12 THEN
Landscape_Unit_Areas[12]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=13 THEN
Landscape_Unit_Areas[13]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=14 THEN
Landscape_Unit_Areas[14]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=15 THEN
Landscape_Unit_Areas[15]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=16 THEN
Landscape_Unit_Areas[16]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=17 THEN
Landscape_Unit_Areas[17]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=18 THEN
Landscape_Unit_Areas[18]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=19 THEN
Landscape_Unit_Areas[19]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=20 THEN
Landscape_Unit_Areas[20]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=21 THEN
Landscape_Unit_Areas[21]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=22 THEN
Landscape_Unit_Areas[22]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=23 THEN
Landscape_Unit_Areas[23]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=24 THEN
Landscape_Unit_Areas[24]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=25 THEN
Landscape_Unit_Areas[25]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_4=26 THEN
Landscape_Unit_Areas[26]*WE_Carrying_capacity ELSE 0
UNITS: Square Kilometers

WE_land_available_5 = IF WE_LU_5=1 THEN
Landscape_Unit_Areas[1]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=2 THEN
Landscape_Unit_Areas[2]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=3 THEN
Landscape_Unit_Areas[3]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=4 THEN
Landscape_Unit_Areas[4]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=5 THEN
Landscape_Unit_Areas[5]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=6 THEN
Landscape_Unit_Areas[6]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=7 THEN
Landscape_Unit_Areas[7]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=8 THEN
Landscape_Unit_Areas[8]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=9 THEN
Landscape_Unit_Areas[9]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=10 THEN
Landscape_Unit_Areas[10]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=11 THEN
Landscape_Unit_Areas[11]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=12 THEN
Landscape_Unit_Areas[12]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=13 THEN
Landscape_Unit_Areas[13]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=14 THEN
Landscape_Unit_Areas[14]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=15 THEN
Landscape_Unit_Areas[15]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=16 THEN
Landscape_Unit_Areas[16]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=17 THEN
Landscape_Unit_Areas[17]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=18 THEN
Landscape_Unit_Areas[18]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=19 THEN
Landscape_Unit_Areas[19]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=20 THEN
Landscape_Unit_Areas[20]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=21 THEN
Landscape_Unit_Areas[21]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=22 THEN
Landscape_Unit_Areas[22]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=23 THEN
Landscape_Unit_Areas[23]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=24 THEN
Landscape_Unit_Areas[24]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=25 THEN
Landscape_Unit_Areas[25]*WE_Carrying_capacity ELSE 0 OR IF WE_LU_5=26 THEN
Landscape_Unit_Areas[26]*WE_Carrying_capacity ELSE 0
UNITS: Square Kilometers
WE_LU_1 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
WE_LU_2 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
WE_LU_3 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
WE_LU_4 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
WE_LU_5 = 0
REPORT IN TABLE AS STOCK
UNITS: unitless
WE_option_1 = IF WE_LU_1=1 THEN WE_per_Landscape_Unit[1] ELSE 0 OR IF
WE_LU_1=2 THEN WE_per_Landscape_Unit[2] ELSE 0 OR IF WE_LU_1=3 THEN
WE_per_Landscape_Unit[3] ELSE 0 OR IF WE_LU_1=4 THEN WE_per_Landscape_Unit[4]

ELSE 0 OR IF WE_LU_1=5 THEN WE_per_Landscape_Unit[5] ELSE 0 OR IF WE_LU_1=6 THEN WE_per_Landscape_Unit[6] ELSE 0 OR IF WE_LU_1=7 THEN WE_per_Landscape_Unit[7] ELSE 0 OR IF WE_LU_1=8 THEN WE_per_Landscape_Unit[8] ELSE 0 OR IF WE_LU_1=9 THEN WE_per_Landscape_Unit[9] ELSE 0 OR IF WE_LU_1=10 THEN WE_per_Landscape_Unit[10] ELSE 0 OR IF WE_LU_1=11 THEN WE_per_Landscape_Unit[11] ELSE 0 OR IF WE_LU_1=12 THEN WE_per_Landscape_Unit[12] ELSE 0 OR IF WE_LU_1=13 THEN WE_per_Landscape_Unit[13] ELSE 0 OR IF WE_LU_1=14 THEN WE_per_Landscape_Unit[14]ELSE 0 OR IF WE_LU_1=15 THEN WE_per_Landscape_Unit[15] ELSE 0 OR IF WE_LU_1=16 THEN WE_per_Landscape_Unit[16] ELSE 0 OR IF WE_LU_1=17 THEN WE_per_Landscape_Unit[17] ELSE 0 OR IF WE_LU_1=18 THEN WE_per_Landscape_Unit[18] ELSE 0 OR IF WE_LU_1=19 THEN WE_per_Landscape_Unit[19] ELSE 0 OR IF WE_LU_1=20 THEN WE_per_Landscape_Unit[20]ELSE 0 OR IF WE_LU_1=21 THEN WE_per_Landscape_Unit[21] ELSE 0 OR IF WE_LU_1=22 THEN WE_per_Landscape_Unit[22]ELSE 0 OR IF WE_LU_1=23 THEN WE_per_Landscape_Unit[23] ELSE 0 OR IF WE_LU_1=24 THEN WE_per_Landscape_Unit[24] ELSE 0 OR IF WE_LU_1=25 THEN WE_per_Landscape_Unit[25]ELSE 0 OR IF WE_LU_1=26 THEN WE_per_Landscape_Unit[26] ELSE 0

UNITS: unitless

WE_option_2 = IF WE_LU_2=1 THEN WE_per_Landscape_Unit[1] ELSE 0 OR IF WE_LU_2=2 THEN WE_per_Landscape_Unit[2] ELSE 0 OR IF WE_LU_2=3 THEN WE_per_Landscape_Unit[3] ELSE 0 OR IF WE_LU_2=4 THEN WE_per_Landscape_Unit[4] ELSE 0 OR IF WE_LU_2=5 THEN WE_per_Landscape_Unit[5] ELSE 0 OR IF WE_LU_2=6 THEN WE_per_Landscape_Unit[6] ELSE 0 OR IF WE_LU_2=7 THEN WE_per_Landscape_Unit[7] ELSE 0 OR IF WE_LU_2=8 THEN WE_per_Landscape_Unit[8] ELSE 0 OR IF WE_LU_2=9 THEN WE_per_Landscape_Unit[9] ELSE 0 OR IF WE_LU_2=10 THEN WE_per_Landscape_Unit[10] ELSE 0 OR IF WE_LU_2=11 THEN WE_per_Landscape_Unit[11] ELSE 0 OR IF WE_LU_2=12 THEN WE_per_Landscape_Unit[12] ELSE 0 OR IF WE_LU_2=13 THEN WE_per_Landscape_Unit[13] ELSE 0 OR IF WE_LU_2=14 THEN WE_per_Landscape_Unit[14]ELSE 0 OR IF WE_LU_2=15 THEN WE_per_Landscape_Unit[15] ELSE 0 OR IF WE_LU_2=16 THEN WE_per_Landscape_Unit[16] ELSE 0 OR IF WE_LU_2=17 THEN WE_per_Landscape_Unit[17] ELSE 0 OR IF WE_LU_2=18 THEN WE_per_Landscape_Unit[18] ELSE 0 OR IF WE_LU_2=19 THEN WE_per_Landscape_Unit[19] ELSE 0 OR IF WE_LU_2=20 THEN WE_per_Landscape_Unit[20]ELSE 0 OR IF WE_LU_2=21 THEN WE_per_Landscape_Unit[21] ELSE 0 OR IF WE_LU_2=22 THEN WE_per_Landscape_Unit[22]ELSE 0 OR IF WE_LU_2=23 THEN WE_per_Landscape_Unit[23] ELSE 0 OR IF WE_LU_2=24 THEN WE_per_Landscape_Unit[24] ELSE 0 OR IF WE_LU_2=25 THEN WE_per_Landscape_Unit[25]ELSE 0 OR IF WE_LU_2=26 THEN WE_per_Landscape_Unit[26] ELSE 0

UNITS: unitless
WE_option_3 = IF WE_LU_3=1 THEN WE_per_Landscape_Unit[1] ELSE 0 OR IF WE_LU_3=2 THEN WE_per_Landscape_Unit[2] ELSE 0 OR IF WE_LU_3=3 THEN WE_per_Landscape_Unit[3] ELSE 0 OR IF WE_LU_3=4 THEN WE_per_Landscape_Unit[4] ELSE 0 OR IF WE_LU_3=5 THEN WE_per_Landscape_Unit[5] ELSE 0 OR IF WE_LU_3=6 THEN WE_per_Landscape_Unit[6] ELSE 0 OR IF WE_LU_3=7 THEN WE_per_Landscape_Unit[7] ELSE 0 OR IF WE_LU_3=8 THEN WE_per_Landscape_Unit[8] ELSE 0 OR IF WE_LU_3=9 THEN WE_per_Landscape_Unit[9] ELSE 0 OR IF WE_LU_3=10 THEN WE_per_Landscape_Unit[10] ELSE 0 OR IF WE_LU_3=11 THEN WE_per_Landscape_Unit[11] ELSE 0 OR IF WE_LU_3=12 THEN WE_per_Landscape_Unit[12] ELSE 0 OR IF WE_LU_3=13 THEN WE_per_Landscape_Unit[13] ELSE 0 OR IF WE_LU_3=14 THEN WE_per_Landscape_Unit[14]ELSE 0 OR IF WE_LU_3=15 THEN WE_per_Landscape_Unit[15] ELSE 0 OR IF WE_LU_3=16 THEN WE_per_Landscape_Unit[16] ELSE 0 OR IF WE_LU_3=17 THEN WE_per_Landscape_Unit[17] ELSE 0 OR IF WE_LU_3=18 THEN WE_per_Landscape_Unit[18] ELSE 0 OR IF WE_LU_3=19 THEN WE_per_Landscape_Unit[19] ELSE 0 OR IF WE_LU_3=20 THEN WE_per_Landscape_Unit[20]ELSE 0 OR IF WE_LU_3=21 THEN WE_per_Landscape_Unit[21] ELSE 0 OR IF WE_LU_3=22 THEN WE_per_Landscape_Unit[22]ELSE 0 OR IF WE_LU_3=23 THEN WE_per_Landscape_Unit[23] ELSE 0 OR IF WE_LU_3=24 THEN WE_per_Landscape_Unit[24] ELSE 0 OR IF WE_LU_3=25 THEN WE_per_Landscape_Unit[25]ELSE 0 OR IF WE_LU_3=26 THEN WE_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
WE_option_4 = IF WE_LU_4=1 THEN WE_per_Landscape_Unit[1] ELSE 0 OR IF WE_LU_4=2 THEN WE_per_Landscape_Unit[2] ELSE 0 OR IF WE_LU_4=3 THEN WE_per_Landscape_Unit[3] ELSE 0 OR IF WE_LU_4=4 THEN WE_per_Landscape_Unit[4] ELSE 0 OR IF WE_LU_4=5 THEN WE_per_Landscape_Unit[5] ELSE 0 OR IF WE_LU_4=6 THEN WE_per_Landscape_Unit[6] ELSE 0 OR IF WE_LU_4=7 THEN WE_per_Landscape_Unit[7] ELSE 0 OR IF WE_LU_4=8 THEN WE_per_Landscape_Unit[8] ELSE 0 OR IF WE_LU_4=9 THEN WE_per_Landscape_Unit[9] ELSE 0 OR IF WE_LU_4=10 THEN WE_per_Landscape_Unit[10] ELSE 0 OR IF WE_LU_4=11 THEN WE_per_Landscape_Unit[11] ELSE 0 OR IF WE_LU_4=12 THEN WE_per_Landscape_Unit[12] ELSE 0 OR IF WE_LU_4=13 THEN WE_per_Landscape_Unit[13] ELSE 0 OR IF WE_LU_4=14 THEN WE_per_Landscape_Unit[14]ELSE 0 OR IF WE_LU_4=15 THEN WE_per_Landscape_Unit[15] ELSE 0 OR IF WE_LU_4=16 THEN WE_per_Landscape_Unit[16] ELSE 0 OR IF WE_LU_4=17 THEN WE_per_Landscape_Unit[17] ELSE 0 OR IF WE_LU_4=18 THEN WE_per_Landscape_Unit[18] ELSE 0 OR IF WE_LU_4=19 THEN WE_per_Landscape_Unit[19] ELSE 0 OR IF WE_LU_4=20 THEN WE_per_Landscape_Unit[20]ELSE 0 OR IF WE_LU_4=21 THEN WE_per_Landscape_Unit[21] ELSE 0 OR IF WE_LU_4=22 THEN WE_per_Landscape_Unit[22]ELSE 0 OR IF WE_LU_4=23 THEN

WE_per_Landscape_Unit[23] ELSE 0 OR IF WE_LU_4=24 THEN
WE_per_Landscape_Unit[24] ELSE 0 OR IF WE_LU_4=25 THEN
WE_per_Landscape_Unit[25]ELSE 0 OR IF WE_LU_4=26 THEN
WE_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
WE_option_5 = IF WE_LU_5=1 THEN WE_per_Landscape_Unit[1] ELSE 0 OR IF WE_LU_5=2 THEN WE_per_Landscape_Unit[2] ELSE 0 OR IF WE_LU_5=3 THEN WE_per_Landscape_Unit[3] ELSE 0 OR IF WE_LU_5=4 THEN WE_per_Landscape_Unit[4] ELSE 0 OR IF WE_LU_5=5 THEN WE_per_Landscape_Unit[5] ELSE 0 OR IF WE_LU_5=6 THEN WE_per_Landscape_Unit[6] ELSE 0 OR IF WE_LU_5=7 THEN WE_per_Landscape_Unit[7] ELSE 0 OR IF WE_LU_5=8 THEN WE_per_Landscape_Unit[8] ELSE 0 OR IF WE_LU_5=9 THEN WE_per_Landscape_Unit[9] ELSE 0 OR IF WE_LU_5=10 THEN WE_per_Landscape_Unit[10] ELSE 0 OR IF WE_LU_5=11 THEN
WE_per_Landscape_Unit[11] ELSE 0 OR IF WE_LU_5=12 THEN
WE_per_Landscape_Unit[12] ELSE 0 OR IF WE_LU_5=13 THEN
WE_per_Landscape_Unit[13] ELSE 0 OR IF WE_LU_5=14 THEN
WE_per_Landscape_Unit[14]ELSE 0 OR IF WE_LU_5=15 THEN
WE_per_Landscape_Unit[15] ELSE 0 OR IF WE_LU_5=16 THEN
WE_per_Landscape_Unit[16] ELSE 0 OR IF WE_LU_5=17 THEN
WE_per_Landscape_Unit[17] ELSE 0 OR IF WE_LU_5=18 THEN
WE_per_Landscape_Unit[18] ELSE 0 OR IF WE_LU_5=19 THEN
WE_per_Landscape_Unit[19] ELSE 0 OR IF WE_LU_5=20 THEN
WE_per_Landscape_Unit[20]ELSE 0 OR IF WE_LU_5=21 THEN
WE_per_Landscape_Unit[21] ELSE 0 OR IF WE_LU_5=22 THEN
WE_per_Landscape_Unit[22]ELSE 0 OR IF WE_LU_5=23 THEN
WE_per_Landscape_Unit[23] ELSE 0 OR IF WE_LU_5=24 THEN
WE_per_Landscape_Unit[24] ELSE 0 OR IF WE_LU_5=25 THEN
WE_per_Landscape_Unit[25]ELSE 0 OR IF WE_LU_5=26 THEN
WE_per_Landscape_Unit[26] ELSE 0
UNITS: unitless
WE_pct_1 = 0
UNITS: percentage
WE_pct_2 = 0
UNITS: percentage
WE_pct_3 = 0
UNITS: percentage
WE_pct_4 = 0
UNITS: percentage
WE_pct_5 = 0
UNITS: percentage
WE_pct_total = IF (WE_pct_1+WE_pct_2+WE_pct_3+WE_pct_4+WE_pct_5)<=1 THEN WE_pct_1+WE_pct_2+WE_pct_3+WE_pct_4+WE_pct_5 ELSE 0
UNITS: percentage
WE_Suitability = IF WE_ON>0 THEN (WE_pct_1*WE_option_1)+(WE_pct_2*WE_option_2)+(WE_pct_3*WE_option_3)+(WE_pct_4*WE_option_4)+(WE_pct_5*WE_option_5)ELSE 0

UNITS: unitless

****
WEF_Strategies:
****
Average_cold_storage_energy_consumption =
Energy_consumption_per_sq_foot*Storage_area*0.001
UNITS: MW per year
Average_cold_storage_energy_consumption_1 =
(Energy_consumption_per_sq_foot_1*Storage_area_1)/1000
UNITS: kwh
Average_Electricity_per_car_per_year = 2.841
UNITS: MWh per year
Average_freshwater_per_acre =
(SN_Freshwater_withdrawal_total*Pct_Farm_consumption)/SN_Area_farms_available
UNITS: gpcd per acre
Average_freshwater_per_acre_1 =
(SN_Freshwater_withdrawal_total*Pct_Farm_consumption_1)/SN_Area_farms_available
UNITS: gpcd per acre
Average_Yield_increment = 0.9
UNITS: percentage
Average_yield_per_acre = 129
UNITS: USD/acre
Cars_per_capita = 0.85
UNITS: percentage
Domestic_sector = 0.22
UNITS: percentage
"Energy_consumption_MW/_year_1" =
(Average_cold_storage_energy_consumption_1/1000)*(365*24)
UNITS: MW per year
Energy_consumption_per_sq_foot = 25
UNITS: kwh per square foot
Energy_consumption_per_sq_foot_1 = 25
UNITS: kwh per square foot
Energy_demand_HF =
(Number_of_HF_acres*Energy_increment*Total_electricity_per_acre_per_year)/1000
UNITS: MW per year
Energy_increment = 82
UNITS: times
Energy_savings_in_new_housing = 0.5*pcnt_of_new_SB_energy
REPORT IN TABLE AS FLOW
UNITS: percentage
Estimated_installation_time_GE = 7
UNITS: Years
Estimated_installation_time_GR = 0.0383562
UNITS: Years

Estimated_installation_time_HF = 0.153425
UNITS: Years
Estimated_installation_time_RF_1 = 3
UNITS: Years
Estimated_installation_time_SE = 5
UNITS: Years
Estimated_installation_time_WE = 0.5
UNITS: Years
EV_growth = INIT(EV_Vehicles_1)+(EV_Vehicles_1*EV_Rate) {UNIFLOW}
UNITS: cars/Years
EV_on = 0
UNITS: cars
EV_Rate = (17162/Existing_cars)*0.66
UNITS: percentage
EV_Vehicles_1(t) = EV_Vehicles_1(t - dt) + (EV_growth) * dt {NON-NEGATIVE}
INIT EV_Vehicles_1 = 11300
UNITS: cars
EV_Vehicles_Total = IF EV_on>0 THEN (17162+EV_on+EV_Vehicles_1-INIT(11300)) ELSE 0
UNITS: cars
Existing_cars = Population*Cars_per_capita
UNITS: cars
FB_Storage_area_acre = Storage_area/43560
UNITS: Acres
Food_insecurity_rate = 0.12
UNITS: percentage
Food_sufficiency_children_1 = 0.645
UNITS: percentage
GE_ON = 0
UNITS: MW per year
Geothermal_energy = DELAY(GE_ON, Estimated_installation_time_GE, 0)
INIT Geothermal_energy = 1
REPORT IN TABLE AS FLOW
UNITS: MW per year
Geothermal_energy_area = Geothermal_energy*0.00036421708
UNITS: Square Kilometers
HF_Average_water = DELAY((1-Pct_water_reduction)*Average_freshwater_per_acre, Estimated_installation_time_HF, 0)
REPORT IN TABLE AS FLOW
UNITS: gpcd per acre
Meal_required_per_year = Population*Food_insecurity_rate*Meals_per_day*365
UNITS: meals/year
Meal_required_per_year_children = Population*(1-Food_sufficiency_children_1)*Meals_per_day_1*365*"%_Children_0-17"
UNITS: meals/year
"Meals_in_sq/foot" = 12

UNITS: meals pear square foot
"Meals_in_sq/foot_1" = 12
UNITS: meals pear square foot
Meals_per_day = 3
UNITS: meals per day
Meals_per_day_1 = 3
UNITS: meals per day
Number_of_HF_acres = 0
REPORT IN TABLE AS STOCK
UNITS: Acres
Number_of_RF_acres = 0
REPORT IN TABLE AS STOCK
UNITS: Acres
pcnt_of_new_SB_energy = 0
UNITS: percentage
Pcnt_of_new_SB_water = 0
UNITS: percentage
Pct_Farm_consumption = 0.7
UNITS: percentage
Pct_Farm_consumption_1 = 0.7
UNITS: percentage
Pct_water_reduction = 0.7
UNITS: percentage
Pct_water_reduction_RF = 0.6
UNITS: percentage
Return_Flow_in_Farmlands = DELAY(0.15, Estimated_installation_time_GR, 0)
REPORT IN TABLE AS FLOW
UNITS: percentage
Return_Flow_in_Urban_Areas = DELAY(0.37, Estimated_installation_time_GR, 0)
REPORT IN TABLE AS FLOW
UNITS: percentage
RF_Average_water = DELAY((1-Pct_water_reduction_RF)*Average_freshwater_per_acre_1, Estimated_installation_time_RF_1, 0)
REPORT IN TABLE AS FLOW
UNITS: gpcd per acre
RF_yield =
((Number_of_RF_acres*Average_yield_per_acre)+(Number_of_RF_acres*Average_yield_per_acre*Average_Yield_increment))
UNITS: USD
Saving_freshwater_in_Farm_Env_GR = IF GR_pct_total>0 THEN Water_per_capita*Population*Return_Flow_in_Farmlands ELSE 0
UNITS: gpcd
Savings_energy = (((Population-INIT(Population))*"Energy/year_per_capita"*Energy_savings_in_new_housing)*Domestic_sector)/1000
UNITS: MW per year

Savings_freshwater = IF SB_pct_total>0 THEN (Population-INIT(Population))*Water_reduction_in_new_housing*Water_per_capita ELSE 0
REPORT IN TABLE AS STOCK
UNITS: gpcd
Savings_freshwater_in_Urban_Env_GR = IF GR_pct_total>0 THEN Population*Water_per_capita*Return_Flow_in_Urban_Areas ELSE 0
UNITS: gpcd
SE_ON = 0
REPORT IN TABLE AS STOCK
UNITS: MW per year
Solar_energy = DELAY(SE_ON, Estimated_installation_time_SE, 0)
INIT Solar_energy = 1
REPORT IN TABLE AS STOCK
UNITS: MW per year
Solar_energy_area = Solar_energy*0.0404686
UNITS: Square Kilometers
Storage_area = (Meal_required_per_year/"Meals_in_sq/foot")/(365/Storage_time)
UNITS: Square Feet
Storage_area_1 = (Meal_required_per_year_children/"Meals_in_sq/foot_1")/(365/Storage_time_1)
UNITS: Square Feet
Storage_area_acre_1 = Storage_area_1/43560
UNITS: Acres
Storage_time = 2
UNITS: days
Storage_time_1 = 2
UNITS: days
Total_electricity_EV = (Average_Electricity_per_car_per_year*EV_Vehicles_Total)/MWh_to_MW_per_year
UNITS: MW per year
Total_electricity_per_acre_per_year = 5
UNITS: kwh
Total_water_saving_HF = Number_of_HF_acres*Water_savings_per_acre
UNITS: gpcd
Total_water_saving_RF = Number_of_RF_acres*Water_savings_per_acre_1
UNITS: gpcd
Water_reduction_in_new_housing = 0.4*Pcnt_of_new_SB_water
REPORT IN TABLE AS FLOW
UNITS: percentage
Water_savings_per_acre = Average_freshwater_per_acre-HF_Average_water
UNITS: gpcd per acre
Water_savings_per_acre_1 = Average_freshwater_per_acre_1-RF_Average_water
UNITS: gpcd per acre
WE_ON = 0
UNITS: MW per year
Wind_energy = DELAY(WE_ON, Estimated_installation_time_WE, 0)

INIT Wind_energy = 1
REPORT IN TABLE AS STOCK
UNITS: MW per year
Wind_energy_area = Wind_energy*0.00202343
UNITS: Square Kilometers

****
WEF_Strategies_spatial_Compatibility:
****
Landscape_Unit_Areas[1] = 1571.91
UNITS: Square Kilometers
Landscape_Unit_Areas[2] = 1303.64
UNITS: Square Kilometers
Landscape_Unit_Areas[3] = 966.66
UNITS: Square Kilometers
Landscape_Unit_Areas[4] = 205.44
UNITS: Square Kilometers
Landscape_Unit_Areas[5] = 3337.74
UNITS: Square Kilometers
Landscape_Unit_Areas[6] = 4735.9
UNITS: Square Kilometers
Landscape_Unit_Areas[7] = 2859.98
UNITS: Square Kilometers
Landscape_Unit_Areas[8] = 4642.64
UNITS: Square Kilometers
Landscape_Unit_Areas[9] = 9150.46
UNITS: Square Kilometers
Landscape_Unit_Areas[10] = 6034.23
UNITS: Square Kilometers
Landscape_Unit_Areas[11] = 3462.67
UNITS: Square Kilometers
Landscape_Unit_Areas[12] = 1530.56
UNITS: Square Kilometers
Landscape_Unit_Areas[13] = 1577.54
UNITS: Square Kilometers
Landscape_Unit_Areas[14] = 724.55
UNITS: Square Kilometers
Landscape_Unit_Areas[15] = 1338.6
UNITS: Square Kilometers
Landscape_Unit_Areas[16] = 3161.69
UNITS: Square Kilometers
Landscape_Unit_Areas[17] = 749.62
UNITS: Square Kilometers
Landscape_Unit_Areas[18] = 693.77
UNITS: Square Kilometers
Landscape_Unit_Areas[19] = 3568.54

UNITS: Square Kilometers
Landscape_Unit_Areas[20] = 3689
UNITS: Square Kilometers
Landscape_Unit_Areas[21] = 2903.2
UNITS: Square Kilometers
Landscape_Unit_Areas[22] = 3750.49
UNITS: Square Kilometers
Landscape_Unit_Areas[23] = 5451.69
UNITS: Square Kilometers
Landscape_Unit_Areas[24] = 7145.42
UNITS: Square Kilometers
Landscape_Unit_Areas[25] = 12085.5
UNITS: Square Kilometers
Landscape_Unit_Areas[26] = 18213.54
UNITS: Square Kilometers
Spatial_compatibility = IF(Geothermal_energy_area AND Number_of_HF_acres>0)OR(Geothermal_energy_area AND Number_of_RF_acres>0)OR(Number_of_RF_acres AND FB_Storage_area_acre>0)OR(Number_of_HF_acres AND Number_of_RF_acres>0) THEN -1 ELSE 1
UNITS: unitless

****
WEF_Strategies_Suitability:
****
E_per_Landscape_Unit[1] = (IF Solar_energy>0 THEN 4 ELSE 0)/SE_Criteria_Total
UNITS: percentage
E_per_Landscape_Unit[2] = (IF Solar_energy>0 THEN 2 ELSE 0)/SE_Criteria_Total
UNITS: percentage
E_per_Landscape_Unit[3] = (IF Solar_energy>0 THEN 3 ELSE 0)/SE_Criteria_Total
UNITS: percentage
E_per_Landscape_Unit[4] = (IF Solar_energy>0 THEN 3 ELSE 0)/SE_Criteria_Total
UNITS: percentage
E_per_Landscape_Unit[5] = (IF Solar_energy>0 THEN 2 ELSE 0)/SE_Criteria_Total
UNITS: percentage
E_per_Landscape_Unit[6] = (IF Solar_energy>0 THEN 3 ELSE 0)/SE_Criteria_Total
UNITS: percentage
E_per_Landscape_Unit[7] = (IF Solar_energy>0 THEN 2 ELSE 0)/SE_Criteria_Total
UNITS: percentage
E_per_Landscape_Unit[8] = (IF Solar_energy>0 THEN 2 ELSE 0)/SE_Criteria_Total
UNITS: percentage
E_per_Landscape_Unit[9] = (IF Solar_energy>0 THEN 2 ELSE 0)/SE_Criteria_Total
UNITS: percentage
E_per_Landscape_Unit[10] = (IF Solar_energy>0 THEN 1 ELSE 0)/SE_Criteria_Total
UNITS: percentage
E_per_Landscape_Unit[11] = 0

UNITS: percentage
E_per_Landscape_Unit[12] = (IF Solar_energy>0 THEN 1 ELSE 0)/SE_Criteria_Total
UNITS: percentage
E_per_Landscape_Unit[13] = (IF Solar_energy>0 THEN 2 ELSE 0)/SE_Criteria_Total
UNITS: percentage
E_per_Landscape_Unit[14] = (IF Solar_energy>0 THEN 2 ELSE 0)/SE_Criteria_Total
UNITS: percentage
E_per_Landscape_Unit[15] = (IF Solar_energy>0 THEN 1 ELSE 0)/SE_Criteria_Total
UNITS: percentage
E_per_Landscape_Unit[16] = (IF Solar_energy>0 THEN 1 ELSE 0)/SE_Criteria_Total
UNITS: percentage
E_per_Landscape_Unit[17] = (IF Solar_energy>0 THEN 3 ELSE 0)/SE_Criteria_Total
UNITS: percentage
E_per_Landscape_Unit[18] = 0
UNITS: percentage
E_per_Landscape_Unit[19] = 0
UNITS: percentage
E_per_Landscape_Unit[20] = 0
UNITS: percentage
E_per_Landscape_Unit[21] = (IF Solar_energy>0 THEN 2 ELSE 0)/SE_Criteria_Total
UNITS: percentage
E_per_Landscape_Unit[22] = (IF Solar_energy>0 THEN 2 ELSE 0)/SE_Criteria_Total
UNITS: percentage
E_per_Landscape_Unit[23] = 0
UNITS: percentage
E_per_Landscape_Unit[24] = 0
UNITS: percentage
E_per_Landscape_Unit[25] = (IF Solar_energy>0 THEN 2 ELSE 0)/SE_Criteria_Total
UNITS: percentage
E_per_Landscape_Unit[26] = 0
UNITS: percentage
EV_per_Landscape_Unit[1] = IF Total_electricity_EV>0 THEN 1 ELSE 0
UNITS: percentage
EV_per_Landscape_Unit[2] = IF Total_electricity_EV>0 THEN 1 ELSE 0
UNITS: percentage
EV_per_Landscape_Unit[3] = IF Total_electricity_EV>0 THEN 1 ELSE 0
UNITS: percentage
EV_per_Landscape_Unit[4] = IF Total_electricity_EV>0 THEN 1 ELSE 0
UNITS: percentage
EV_per_Landscape_Unit[5] = IF Total_electricity_EV>0 THEN 1 ELSE 0
UNITS: percentage
EV_per_Landscape_Unit[6] = IF Total_electricity_EV>0 THEN 1 ELSE 0
UNITS: percentage
EV_per_Landscape_Unit[7] = IF Total_electricity_EV>0 THEN 1 ELSE 0
UNITS: percentage
EV_per_Landscape_Unit[8] = IF Total_electricity_EV>0 THEN 1 ELSE 0

UNITS: percentage
EV_per_Landscape_Unit[9] = 0
UNITS: percentage
EV_per_Landscape_Unit[10] = 0
UNITS: percentage
EV_per_Landscape_Unit[11] = 0
UNITS: percentage
EV_per_Landscape_Unit[12] = 0
UNITS: percentage
EV_per_Landscape_Unit[13] = 0
UNITS: percentage
EV_per_Landscape_Unit[14] = 0
UNITS: percentage
EV_per_Landscape_Unit[15] = 0
UNITS: percentage
EV_per_Landscape_Unit[16] = 0
UNITS: percentage
EV_per_Landscape_Unit[17] = 0
UNITS: percentage
EV_per_Landscape_Unit[18] = 0
UNITS: percentage
EV_per_Landscape_Unit[19] = 0
UNITS: percentage
EV_per_Landscape_Unit[20] = 0
UNITS: percentage
EV_per_Landscape_Unit[21] = IF Total_electricity_EV>0 THEN 1 ELSE 0
UNITS: percentage
EV_per_Landscape_Unit[22] = 0
UNITS: percentage
EV_per_Landscape_Unit[23] = 0
UNITS: percentage
EV_per_Landscape_Unit[24] = 0
UNITS: percentage
EV_per_Landscape_Unit[25] = IF Total_electricity_EV>0 THEN 1 ELSE 0
UNITS: percentage
EV_per_Landscape_Unit[26] = 0
UNITS: percentage
FB_per_Landscape_Unit[1] = IF (Meal_required_per_year OR
Meal_required_per_year_children)>0 THEN 1 ELSE 0
UNITS: percentage
FB_per_Landscape_Unit[2] = IF (Meal_required_per_year OR
Meal_required_per_year_children)>0 THEN 1 ELSE 0
UNITS: percentage
FB_per_Landscape_Unit[3] = IF (Meal_required_per_year OR
Meal_required_per_year_children)>0 THEN 1 ELSE 0
UNITS: percentage

FB_per_Landscape_Unit[4] = IF (Meal_required_per_year OR Meal_required_per_year_children)>0 THEN 1 ELSE 0
UNITS: percentage
FB_per_Landscape_Unit[5] = IF (Meal_required_per_year OR Meal_required_per_year_children)>0 THEN 1 ELSE 0
UNITS: percentage
FB_per_Landscape_Unit[6] = IF (Meal_required_per_year OR Meal_required_per_year_children)>0 THEN 1 ELSE 0
UNITS: percentage
FB_per_Landscape_Unit[7] = IF (Meal_required_per_year OR Meal_required_per_year_children)>0 THEN 1 ELSE 0
UNITS: percentage
FB_per_Landscape_Unit[8] = IF (Meal_required_per_year OR Meal_required_per_year_children)>0 THEN 1 ELSE 0
UNITS: percentage
FB_per_Landscape_Unit[9] = 0
UNITS: percentage
FB_per_Landscape_Unit[10] = 0
UNITS: percentage
FB_per_Landscape_Unit[11] = 0
UNITS: percentage
FB_per_Landscape_Unit[12] = 0
UNITS: percentage
FB_per_Landscape_Unit[13] = 0
UNITS: percentage
FB_per_Landscape_Unit[14] = 0
UNITS: percentage
FB_per_Landscape_Unit[15] = 0
UNITS: percentage
FB_per_Landscape_Unit[16] = 0
UNITS: percentage
FB_per_Landscape_Unit[17] = 0
UNITS: percentage
FB_per_Landscape_Unit[18] = 0
UNITS: percentage
FB_per_Landscape_Unit[19] = 0
UNITS: percentage
FB_per_Landscape_Unit[20] = 0
UNITS: percentage
FB_per_Landscape_Unit[21] = IF (Meal_required_per_year OR Meal_required_per_year_children)>0 THEN 1 ELSE 0
UNITS: percentage
FB_per_Landscape_Unit[22] = 0
UNITS: percentage
FB_per_Landscape_Unit[23] = 0
UNITS: percentage

FB_per_Landscape_Unit[24] = 0
UNITS: percentage
FB_per_Landscape_Unit[25] = IF (Meal_required_per_year OR
Meal_required_per_year_children)>0 THEN 1 ELSE 0
UNITS: percentage
FB_per_Landscape_Unit[26] = 0
UNITS: percentage
GE_Criteria_Total = 2
UNITS: Number of criterias
GE_per_Landscape_Unit[1] = (IF Geothermal_energy>0 THEN 2 ELSE 0)/GE_Criteria_Total
UNITS: percentage
GE_per_Landscape_Unit[2] = (IF Geothermal_energy>0 THEN 1 ELSE 0)/GE_Criteria_Total
UNITS: percentage
GE_per_Landscape_Unit[3] = (IF Geothermal_energy>0 THEN 1 ELSE 0)/GE_Criteria_Total
UNITS: percentage
GE_per_Landscape_Unit[4] = (IF Geothermal_energy>0 THEN 1 ELSE 0)/GE_Criteria_Total
UNITS: percentage
GE_per_Landscape_Unit[5] = (IF Geothermal_energy>0 THEN 2 ELSE 0)/GE_Criteria_Total
UNITS: percentage
GE_per_Landscape_Unit[6] = (IF Geothermal_energy>0 THEN 2 ELSE 0)/GE_Criteria_Total
UNITS: percentage
GE_per_Landscape_Unit[7] = (IF Geothermal_energy>0 THEN 2 ELSE 0)/GE_Criteria_Total
UNITS: percentage
GE_per_Landscape_Unit[8] = (IF Geothermal_energy>0 THEN 1 ELSE 0)/GE_Criteria_Total
UNITS: percentage
GE_per_Landscape_Unit[9] = (IF Geothermal_energy>0 THEN 1 ELSE 0)/GE_Criteria_Total
UNITS: percentage
GE_per_Landscape_Unit[10] = (IF Geothermal_energy>0 THEN 1 ELSE 0)/GE_Criteria_Total
UNITS: percentage
GE_per_Landscape_Unit[11] = (IF Geothermal_energy>0 THEN 1 ELSE 0)/GE_Criteria_Total
UNITS: percentage
GE_per_Landscape_Unit[12] = (IF Geothermal_energy>0 THEN 1 ELSE 0)/GE_Criteria_Total
UNITS: percentage
GE_per_Landscape_Unit[13] = (IF Geothermal_energy>0 THEN 1 ELSE 0)/GE_Criteria_Total
UNITS: percentage
GE_per_Landscape_Unit[14] = 0
UNITS: percentage
GE_per_Landscape_Unit[15] = 0
UNITS: percentage
GE_per_Landscape_Unit[16] = 0
UNITS: percentage
GE_per_Landscape_Unit[17] = (IF Geothermal_energy>0 THEN 1 ELSE 0)/GE_Criteria_Total
UNITS: percentage
GE_per_Landscape_Unit[18] = 0
UNITS: percentage
GE_per_Landscape_Unit[19] = 0

UNITS: percentage
GE_per_Landscape_Unit[20] = 0
UNITS: percentage
GE_per_Landscape_Unit[21] = (IF Geothermal_energy>0 THEN 1 ELSE 0)/GE_Criteria_Total
UNITS: percentage
GE_per_Landscape_Unit[22] = (IF Geothermal_energy>0 THEN 1 ELSE 0)/GE_Criteria_Total
UNITS: percentage
GE_per_Landscape_Unit[23] = 0
UNITS: percentage
GE_per_Landscape_Unit[24] = 0
UNITS: percentage
GE_per_Landscape_Unit[25] = (IF Geothermal_energy>0 THEN 2 ELSE 0)/GE_Criteria_Total
UNITS: percentage
GE_per_Landscape_Unit[26] = (IF Geothermal_energy>0 THEN 1 ELSE 0)/GE_Criteria_Total
UNITS: percentage
GR_Criteria_Total = 4
UNITS: Number of criterias
GR_per_Landscape_Unit[1] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 4 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[2] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 4 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[3] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 4 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[4] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 3 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[5] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 4 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[6] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 4 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[7] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 4 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[8] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 3 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[9] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 2 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[10] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 2 ELSE 0)/GR_Criteria_Total

UNITS: percentage
GR_per_Landscape_Unit[11] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 2 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[12] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 1 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[13] = 0
UNITS: percentage
GR_per_Landscape_Unit[14] = 0
UNITS: percentage
GR_per_Landscape_Unit[15] = 0
UNITS: percentage
GR_per_Landscape_Unit[16] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 1 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[17] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 3 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[18] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 1 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[19] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 2 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[20] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 2 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[21] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 3 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[22] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 2 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[23] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 1 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[24] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 2 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[25] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 3 ELSE 0)/GR_Criteria_Total
UNITS: percentage
GR_per_Landscape_Unit[26] = (IF Savings_freshwater_in_Urban_Env_GR>0 OR Saving_freshwater_in_Farm_Env_GR>0 THEN 2 ELSE 0)/GR_Criteria_Total
UNITS: percentage

HF_Criteria_Total = 4
UNITS: Number of criterias
HF_per_Landscape_Unit[1] = (IF Number_of_HF_acres>0 THEN 3 ELSE 0)/HF_Criteria_Total
UNITS: percentage
HF_per_Landscape_Unit[2] = (IF Number_of_HF_acres>0 THEN 4 ELSE 0)/HF_Criteria_Total
UNITS: percentage
HF_per_Landscape_Unit[3] = (IF Number_of_HF_acres>0 THEN 4 ELSE 0)/HF_Criteria_Total
UNITS: percentage
HF_per_Landscape_Unit[4] = (IF Number_of_HF_acres>0 THEN 3 ELSE 0)/HF_Criteria_Total
UNITS: percentage
HF_per_Landscape_Unit[5] = (IF Number_of_HF_acres>0 THEN 4 ELSE 0)/HF_Criteria_Total
UNITS: percentage
HF_per_Landscape_Unit[6] = (IF Number_of_HF_acres>0 THEN 4 ELSE 0)/HF_Criteria_Total
UNITS: percentage
HF_per_Landscape_Unit[7] = (IF Number_of_HF_acres>0 THEN 3 ELSE 0)/HF_Criteria_Total
UNITS: percentage
HF_per_Landscape_Unit[8] = (IF Number_of_HF_acres>0 THEN 2 ELSE 0)/HF_Criteria_Total
UNITS: percentage
HF_per_Landscape_Unit[9] = (IF Number_of_HF_acres>0 THEN 2 ELSE 0)/HF_Criteria_Total
UNITS: percentage
HF_per_Landscape_Unit[10] = (IF Number_of_HF_acres>0 THEN 2 ELSE 0)/HF_Criteria_Total
UNITS: percentage
HF_per_Landscape_Unit[11] = 0
UNITS: percentage
HF_per_Landscape_Unit[12] = 0
UNITS: percentage
HF_per_Landscape_Unit[13] = (IF Number_of_HF_acres>0 THEN 1 ELSE 0)/HF_Criteria_Total
UNITS: percentage
HF_per_Landscape_Unit[14] = (IF Number_of_HF_acres>0 THEN 1 ELSE 0)/HF_Criteria_Total
UNITS: percentage
HF_per_Landscape_Unit[15] = (IF Number_of_HF_acres>0 THEN 1 ELSE 0)/HF_Criteria_Total
UNITS: percentage
HF_per_Landscape_Unit[16] = (IF Number_of_HF_acres>0 THEN 1 ELSE 0)/HF_Criteria_Total
UNITS: percentage
HF_per_Landscape_Unit[17] = (IF Number_of_HF_acres>0 THEN 1 ELSE 0)/HF_Criteria_Total
UNITS: percentage
HF_per_Landscape_Unit[18] = 0
UNITS: percentage
HF_per_Landscape_Unit[19] = 0
UNITS: percentage

HF_per_Landscape_Unit[20] = 0
UNITS: percentage
HF_per_Landscape_Unit[21] = (IF Number_of_HF_acres>0 THEN 2 ELSE 0)/HF_Criteria_Total
UNITS: percentage
HF_per_Landscape_Unit[22] = (IF Number_of_HF_acres>0 THEN 2 ELSE 0)/HF_Criteria_Total
UNITS: percentage
HF_per_Landscape_Unit[23] = 0
UNITS: percentage
HF_per_Landscape_Unit[24] = 0
UNITS: percentage
HF_per_Landscape_Unit[25] = (IF Number_of_HF_acres>0 THEN 1 ELSE 0)/HF_Criteria_Total
UNITS: percentage
HF_per_Landscape_Unit[26] = 0
UNITS: percentage
RF_Criteria_Total = 4
UNITS: Number of criterias
RF_per_Landscape_Unit[1] = (IF Number_of_RF_acres>0 THEN 3 ELSE 0)/RF_Criteria_Total
UNITS: percentage
RF_per_Landscape_Unit[2] = (IF Number_of_RF_acres>0 THEN 4 ELSE 0)/RF_Criteria_Total
UNITS: percentage
RF_per_Landscape_Unit[3] = (IF Number_of_RF_acres>0 THEN 4 ELSE 0)/RF_Criteria_Total
UNITS: percentage
RF_per_Landscape_Unit[4] = (IF Number_of_RF_acres>0 THEN 3 ELSE 0)/RF_Criteria_Total
UNITS: percentage
RF_per_Landscape_Unit[5] = (IF Number_of_RF_acres>0 THEN 4 ELSE 0)/RF_Criteria_Total
UNITS: percentage
RF_per_Landscape_Unit[6] = (IF Number_of_RF_acres>0 THEN 4 ELSE 0)/RF_Criteria_Total
UNITS: percentage
RF_per_Landscape_Unit[7] = (IF Number_of_RF_acres>0 THEN 3 ELSE 0)/RF_Criteria_Total
UNITS: percentage
RF_per_Landscape_Unit[8] = (IF Number_of_RF_acres>0 THEN 2 ELSE 0)/RF_Criteria_Total
UNITS: percentage
RF_per_Landscape_Unit[9] = (IF Number_of_RF_acres>0 THEN 2 ELSE 0)/RF_Criteria_Total
UNITS: percentage

RF_per_Landscape_Unit[10] = (IF Number_of_RF_acres>0 THEN 2 ELSE 0)/
RF_Criteria_Total
UNITS: percentage
RF_per_Landscape_Unit[11] = 0
UNITS: percentage
RF_per_Landscape_Unit[12] = 0
UNITS: percentage
RF_per_Landscape_Unit[13] = (IF Number_of_RF_acres>0 THEN 1 ELSE 0)/
RF_Criteria_Total
UNITS: percentage
RF_per_Landscape_Unit[14] = (IF Number_of_RF_acres>0 THEN 1 ELSE 0)/
RF_Criteria_Total
UNITS: percentage
RF_per_Landscape_Unit[15] = (IF Number_of_RF_acres>0 THEN 1 ELSE 0)/
RF_Criteria_Total
UNITS: percentage
RF_per_Landscape_Unit[16] = (IF Number_of_RF_acres>0 THEN 1 ELSE 0)/
RF_Criteria_Total
UNITS: percentage
RF_per_Landscape_Unit[17] = (IF Number_of_RF_acres>0 THEN 1 ELSE 0)/
RF_Criteria_Total
UNITS: percentage
RF_per_Landscape_Unit[18] = 0
UNITS: percentage
RF_per_Landscape_Unit[19] = 0
UNITS: percentage
RF_per_Landscape_Unit[20] = 0
UNITS: percentage
RF_per_Landscape_Unit[21] = (IF Number_of_RF_acres>0 THEN 2 ELSE 0)/
RF_Criteria_Total
UNITS: percentage
RF_per_Landscape_Unit[22] = (IF Number_of_RF_acres>0 THEN 2 ELSE 0)/
RF_Criteria_Total
UNITS: percentage
RF_per_Landscape_Unit[23] = 0
UNITS: percentage
RF_per_Landscape_Unit[24] = 0
UNITS: percentage
RF_per_Landscape_Unit[25] = (IF Number_of_RF_acres>0 THEN 1 ELSE 0)/
RF_Criteria_Total
UNITS: percentage
RF_per_Landscape_Unit[26] = 0
UNITS: percentage
SB_Criteria_Total = 2
UNITS: Number of criterias

SB_per_Landscape_Unit[1] = (IF Savings_freshwater>0 OR Savings_energy>0 THEN 2 ELSE 0)/SB_Criteria_Total
UNITS: percentage
SB_per_Landscape_Unit[2] = (IF Savings_freshwater>0 OR Savings_energy>0 THEN 2 ELSE 0)/SB_Criteria_Total
UNITS: percentage
SB_per_Landscape_Unit[3] = (IF Savings_freshwater>0 OR Savings_energy>0 THEN 2 ELSE 0)/SB_Criteria_Total
UNITS: percentage
SB_per_Landscape_Unit[4] = (IF Savings_freshwater>0 OR Savings_energy>0 THEN 2 ELSE 0)/SB_Criteria_Total
UNITS: percentage
SB_per_Landscape_Unit[5] = (IF Savings_freshwater>0 OR Savings_energy>0 THEN 1 ELSE 0)/SB_Criteria_Total
UNITS: percentage
SB_per_Landscape_Unit[6] = (IF Savings_freshwater>0 OR Savings_energy>0 THEN 1 ELSE 0)/SB_Criteria_Total
UNITS: percentage
SB_per_Landscape_Unit[7] = (IF Savings_freshwater>0 OR Savings_energy>0 THEN 1 ELSE 0)/SB_Criteria_Total
UNITS: percentage
SB_per_Landscape_Unit[8] = (IF Savings_freshwater>0 OR Savings_energy>0 THEN 1 ELSE 0)/SB_Criteria_Total
UNITS: percentage
SB_per_Landscape_Unit[9] = 0
UNITS: percentage
SB_per_Landscape_Unit[10] = 0
UNITS: percentage
SB_per_Landscape_Unit[11] = 0
UNITS: percentage
SB_per_Landscape_Unit[12] = 0
UNITS: percentage
SB_per_Landscape_Unit[13] = 0
UNITS: percentage
SB_per_Landscape_Unit[14] = 0
UNITS: percentage
SB_per_Landscape_Unit[15] = 0
UNITS: percentage
SB_per_Landscape_Unit[16] = 0
UNITS: percentage
SB_per_Landscape_Unit[17] = 0
UNITS: percentage
SB_per_Landscape_Unit[18] = 0
UNITS: percentage
SB_per_Landscape_Unit[19] = 0
UNITS: percentage

SB_per_Landscape_Unit[20] = 0
UNITS: percentage
SB_per_Landscape_Unit[21] = (IF Savings_freshwater>0 OR Savings_energy>0 THEN 1 ELSE 0)/SB_Criteria_Total
UNITS: percentage
SB_per_Landscape_Unit[22] = 0
UNITS: percentage
SB_per_Landscape_Unit[23] = 0
UNITS: percentage
SB_per_Landscape_Unit[24] = 0
UNITS: percentage
SB_per_Landscape_Unit[25] = (IF Savings_freshwater>0 OR Savings_energy>0 THEN 1 ELSE 0)/SB_Criteria_Total
UNITS: percentage
SB_per_Landscape_Unit[26] = 0
UNITS: percentage
SE_Criteria_Total = 4
UNITS: Number of criterias
WE_Criteria_Total = 4
UNITS: Number of criterias
WE_per_Landscape_Unit[1] = (IF Wind_energy>0 THEN 3 ELSE 0)/WE_Criteria_Total
UNITS: percentage
WE_per_Landscape_Unit[2] = (IF Wind_energy>0 THEN 3 ELSE 0)/WE_Criteria_Total
UNITS: percentage
WE_per_Landscape_Unit[3] = (IF Wind_energy>0 THEN 2 ELSE 0)/WE_Criteria_Total
UNITS: percentage
WE_per_Landscape_Unit[4] = (IF Wind_energy>0 THEN 2 ELSE 0)/WE_Criteria_Total
UNITS: percentage
WE_per_Landscape_Unit[5] = (IF Wind_energy>0 THEN 3 ELSE 0)/WE_Criteria_Total
UNITS: percentage
WE_per_Landscape_Unit[6] = (IF Wind_energy>0 THEN 2 ELSE 0)/WE_Criteria_Total
UNITS: percentage
WE_per_Landscape_Unit[7] = (IF Wind_energy>0 THEN 1 ELSE 0)/WE_Criteria_Total
UNITS: percentage
WE_per_Landscape_Unit[8] = (IF Wind_energy>0 THEN 2 ELSE 0)/WE_Criteria_Total
UNITS: percentage
WE_per_Landscape_Unit[9] = (IF Wind_energy>0 THEN 2 ELSE 0)/WE_Criteria_Total
UNITS: percentage
WE_per_Landscape_Unit[10] = (IF Wind_energy>0 THEN 2 ELSE 0)/WE_Criteria_Total
UNITS: percentage
WE_per_Landscape_Unit[11] = 0
UNITS: percentage
WE_per_Landscape_Unit[12] = 0
UNITS: percentage
WE_per_Landscape_Unit[13] = (IF Wind_energy>0 THEN 1 ELSE 0)/WE_Criteria_Total
UNITS: percentage

WE_per_Landscape_Unit[14] = (IF Wind_energy>0 THEN 1 ELSE 0)/WE_Criteria_Total
UNITS: percentage
WE_per_Landscape_Unit[15] = (IF Wind_energy>0 THEN 1 ELSE 0)/WE_Criteria_Total
UNITS: percentage
WE_per_Landscape_Unit[16] = (IF Wind_energy>0 THEN 1 ELSE 0)/WE_Criteria_Total
UNITS: percentage
WE_per_Landscape_Unit[17] = (IF Wind_energy>0 THEN 2 ELSE 0)/WE_Criteria_Total
UNITS: percentage
WE_per_Landscape_Unit[18] = 0
UNITS: percentage
WE_per_Landscape_Unit[19] = 0
UNITS: percentage
WE_per_Landscape_Unit[20] = 0
UNITS: percentage
WE_per_Landscape_Unit[21] = (IF Wind_energy>0 THEN 2 ELSE 0)/WE_Criteria_Total
UNITS: percentage
WE_per_Landscape_Unit[22] = (IF Wind_energy>0 THEN 1 ELSE 0)/WE_Criteria_Total
UNITS: percentage
WE_per_Landscape_Unit[23] = 0
UNITS: percentage
WE_per_Landscape_Unit[24] = 0
UNITS: percentage
WE_per_Landscape_Unit[25] = (IF Wind_energy>0 THEN 2 ELSE 0)/WE_Criteria_Total
UNITS: percentage
WE_per_Landscape_Unit[26] = (IF Wind_energy>0 THEN 1 ELSE 0)/WE_Criteria_Total
UNITS: percentage
****
WEF_Strategies_Total_Sutability:
****
Counting_Suitability = (IF SB_total_suitability>0 THEN 1 ELSE 0)+(IF GR_Total_Suitability>0 THEN 1 ELSE 0)+ (IF SE_Suitability>0 THEN 1 ELSE 0) +(IF WE_Suitability>0 THEN 1 ELSE 0)+(IF GE_suitability>0 THEN 1 ELSE 0)+(IF EV_Suitability>0 THEN 1 ELSE 0)+(IF FB_Suitability>0 THEN 1 ELSE 0)+(IF HF_Suitability>0 THEN 1 ELSE 0)+(IF RF_Suitability>0 THEN 1 ELSE 0)
UNITS: unitless
Suitability = SB_total_suitability+GR_Total_Suitability+SE_Suitability+WE_Suitability+GE_suitability+EV_Suitability+FB_Suitability+HF_Suitability+RF_Suitability
UNITS: unitless
Total_suitability = IF Counting_Suitability>0 THEN (Suitability/Counting_Suitability*100) ELSE 0
UNITS: percentage
{ The model has 467 (987) variables (array expansion in parens).
In root model and 0 additional modules with 26 sectors.
Stocks: 3 (3) Flows: 3 (3) Converters: 461 (981)
Constants: 182 (207) Equations: 282 (777) Graphicals: 0 (0) }

Bibliography

Akers, M. (2022, February 7). Going Green: Nevada sees jump in electric vehicle registrations. *Review Journal*.

Alänge, S., & Holmberg, J. (n.d.). *Backcasting - What is a sustainable future and how do we reach it?* http://publications.lib.chalmers.se/records/fulltext/207783/local_207783.pdf

Albrecht, T. R., Crootof, A., & Scott, C. A. (2018). The Water-Energy-Food Nexus: A systematic review of methods for nexus assessment. *Environmental Research Letters*, *13*(4). https://doi.org/10.1088/1748-9326/aaa9c6

Allouche, J. (2019). *The water-food-energy nexus: power, politics and justice* (C. Middleton, D. Gyawali, & P. (Firm), Eds.). Abingdon, Oxon.

Amadei, B. (2019). *Systems approach to modeling the water-energy-land-food nexus. Volume II : system dynamics modeling and dynamic scenario planning*. New York, New York : Momentum Press.

Andrews-Speed, C. P. (2015). *Want, waste or war? The global resource nexus and the struggle for land, energy, food, water and minerals* (P. (Firm), Ed.). Abingdon, Oxon.

AWS Truepower. (2022). *Nevada 80-Meter Wind Resource Map*. National Renewable Energy Laboratory.

Barbosa, G., Gadelha, F., Kublik, N., Proctor, A., Reichelm, L., Weissinger, E., Wohlleb, G., & Halden, R. (2015). Comparison of Land, Water, and Energy Requirements of Lettuce Grown Using Hydroponic vs. Conventional Agricultural Methods. *International Journal of Environmental Research and Public Health*, *12*(6), 6879–6891. https://doi.org/10.3390/ijerph120606879

Bazilian, M., Rogner, H., Howells, M., Hermann, S., Arent, D., Gielen, D., Steduto, P., Mueller, A., Komor, P., Tol, R. S. J., & Yumkella, K. K. (2011). Considering the energy, water and food nexus: Towards an integrated modelling approach. *Energy Policy*, *39*(12). https://doi.org/10.1016/j.enpol.2011.09.039

Beamer, L., & Steinbaum, M. (2019, December 18). *Unequal and Uneven: The Geography of Higher Education Access*. Jain Family Institute.

Beh Lih Yi. (2021, June 14). *25 million people in Africa and Asia cannot afford electricity due to the COVID-19 pandemic*. World Economic Forum.

Bieber, N., Ker, J. H., Wang, X., Triantafyllidis, C., van Dam, K. H., Koppelaar, R. H. E. M., & Shah, N. (2018). Sustainable planning of the energy-water-food nexus using decision making tools. *Energy Policy*, *113*. https://doi.org/10.1016/j.enpol.2017.11.037

Borrelli, N., & Mela, A. (2018). Food, city and territory: some reflections from a socio-spatial point of view. *City, Territory and Architecture*, *5*(1), 7. https://doi.org/10.1186/s40410-018-0083-7

Botan, C. H. (2018). *Strategic Communication Theory and Practice: The Cocreational Model* (1st ed.). Wiley, Blackwell.

Bradshaw, B. S., & Frisbie, W. P. (1983). Potential Labor Force Supply and Replacement in Mexico and the States of the Mexican Cession and Texas: 1980–2000. *International Migration Review*, *17*(3), 394–409. https://doi.org/10.1177/019791838301700301

Brears, R. C. (2018). *The Green Economy and the Water-Energy-Food Nexus* (1st ed. 2018). London: Palgrave Macmillan UK : Imprint: Palgrave Macmillan.

Brenner, N. J. (Ed.). (2014). *Implosions/Explosions: Towards a Study of Planetary Urbanization* (1st ed.). Jovis.

Burbridge, M. (2017). If Living Labs are the Answer – What's the Question? A Review of the Literature. *Procedia Engineering*, *180*. https://doi.org/10.1016/j.proeng.2017.04.335

Bureau of Economic Analysis. (2021). *Real value added to the Gross Domestic Product (GDP) of Nevada in 2020, by industry*.

Bürgi, M., Ali, P., Chowdhury, A., Heinimann, A., Hett, C., Kienast, F., Mondal, M. K., Upreti, B. R., & Verburg, P. H. (2017). Integrated Landscape Approach: Closing the Gap between Theory and Application. *Sustainability*, *9*(8), 1371. https://doi.org/10.3390/su9081371

Capone, D., Cumming, O., Nichols, D., & Brown, J. (2020). Water and Sanitation in Urban America, 2017–2019. *AJPH Open-Themed Research*, *110*(10).

Cardinale, B. J., Duffy, J. E., Gonzalez, A., Hooper, D. U., Perrings, C., Venail, P., Narwani, A., Mace, G. M., Tilman, D., Wardle, D. A., Kinzig, A. P., Daily, G. C., Loreau, M., Grace, J. B., Larigauderie, A., Srivastava, D. S., & Naeem, S. (2012). Biodiversity loss and its impact on humanity. *Nature*, *486*(7401). https://doi.org/10.1038/nature11148

Carrington, D. (2022, January 18). Chemical pollution has passed safe limit for humanity, say scientist. *The Guardian*.

Center for Business and Economic Research. (2021). *2021-2060 Population Forecasts, Long-term Projections for Clark County, Nevada*.

Center for Crop Diversification. (2014). *Blueberry Cost and Return Estimates*.

Centers for Disease, C. and P. (2021). *Nevada's Health Statistics*.

Chen, I.-C., Wang, Y.-H., Lin, W., & Ma, H. (2020). Assessing the risk of the food-energy-water nexus of urban metabolism: A case study of Kinmen Island, Taiwan. *Ecological Indicators*, *110*. https://doi.org/10.1016/j.ecolind.2019.105861

Chiodo, G., & Polvani, L. M. (2022). New Insights on the Radiative Impacts of Ozone-Depleting Substances. *Geophysical Research Letters*, *49*(10). https://doi.org/10.1029/2021GL096783

Cho, S.-Y. (2016). Does Gender Equality Promote Social Trust? An Empirical Analysis. *World Development*, *88*, 175–187. https://doi.org/10.1016/j.worlddev.2016.07.019

Chu, J. (2017, April 19). Watering the world. *MIT News*.

Cilliers, P. (2016). *Critical complexity: collected essays* (R. Preiser, Ed.). Berlin, Germany.

Congressional Research Service. (2021). *Management of the Colorado River: Water Allocations, Drought, and the Federal Role*.

Correa Ayram, C. A., Mendoza, M. E., Etter, A., & Salicrup, D. R. P. (2016). Habitat connectivity in biodiversity conservation. *Progress in Physical Geography: Earth and Environment*, *40*(1). https://doi.org/10.1177/0309133315598713

Cortes Arevalo, V. J., Verbrugge, L. N. H., Sools, A., Brugnach, M., Wolterink, R., van Denderen, R. P., Candel, J. H. J., & Hulscher, S. J. M. H. (2020). Storylines for practice: a visual storytelling approach to strengthen the science-practice interface. *Sustainability Science*, *15*(4), 1013–1032. https://doi.org/10.1007/s11625-020-00793-y

Council of Europe Landscape Convention. (2000). *The European Landscape Convention*.

Creative Commons. (2021). *Active Mines and Energy Producers*.

Creative Commons. (2022, April 12). *Open Street Map*.

Cumming, G. S., Cumming, D. H. M., & Redman, C. L. (2006). Scale Mismatches in Social-Ecological Systems: Causes, Consequences, and Solutions. *Ecology and Society*, *11*(1). https://doi.org/10.5751/ES-01569-110114

Dale, V. H., Efroymson, R. A., & Kline, K. L. (2011). The land use–climate change–energy nexus. *Landscape Ecology*, *26*(6). https://doi.org/10.1007/s10980-011-9606-2

de Leon, C., & Schwartz, J. (2020, August 17). Death Valley Just Recorded the Hottest Temperature on Earth. *The New York Times*.

di Baldassarre, G., Wanders, N., AghaKouchak, A., Kuil, L., Rangecroft, S., Veldkamp, T. I. E., Garcia, M., van Oel, P. R., Breinl, K., & van Loon, A. F. (2018). Water shortages worsened by reservoir effects. *Nature Sustainability*, *1*(11), 617–622. https://doi.org/10.1038/s41893-018-0159-0

Dow-Fleisner, S. J., Seaton, C. L., Li, E., Plamondon, K., Oelke, N., Kurtz, D., Jones, C., Currie, L. M., Pesut, B., Hasan, K., & Rush, K. L. (2022). Internet access is a necessity: a latent class analysis of COVID-19 related challenges and the role of technology use among rural community residents. *BMC Public Health*, *22*(1), 845. https://doi.org/10.1186/s12889-022-13254-1

Earth's Endangered Creatures. (2022). *Endangered Species in Nevada*.

el Haj Assad, M., Bani-Hani, E., & Khalil, M. (2017). Performance of geothermal power plants (single, dual, and binary) to compensate for LHC-CERN power consumption: comparative study. *Geothermal Energy*, *5*(1), 17. https://doi.org/10.1186/s40517-017-0074-z

Electric Vehicle Database. (2022). *Energy consumption of full electric vehicles*. Electric Vehicle Database.

Elfversson, E. (2016). Peace from below: Governance and peacebuilding in Kerio Valley, Kenya. *The Journal of Modern African Studies*, *54*(3), 469–493. https://doi.org/10.1017/S0022278X16000227

Ellen McArthur Foundation. (2013). *Towards the Circular Economy*.

Endo, A., Yamada, M., Miyashita, Y., Sugimoto, R., Ishii, A., Nishijima, J., Fujii, M., Kato, T., Hamamoto, H., Kimura, M., Kumazawa, T., & Qi, J. (2020). Dynamics of water–energy–food nexus methodology, methods, and tools. *Current Opinion in Environmental Science & Health*, *13*. https://doi.org/10.1016/j.coesh.2019.10.004

European Union. (2020). *Circular Economy Action Plan*.

FAO, I. U. W. and W. (2021). *The State of Food Security and Nutrition in the World 2021*. FAO, IFAD, UNICEF, WFP and WHO. https://doi.org/10.4060/cb4474en

FAO, IFAD, UNICEF, WFP, & WHO. (2021). *The State of Food Security and Nutrition in the World 2021*. FAO, IFAD, UNICEF, WFP and WHO. https://doi.org/10.4060/cb4474en

Farming Base. (2022). *Is Hydroponic Farming Profitable?*

Foran, T. (2015). Node and Regime: Interdisciplinary Analysis of Water-Energy-Food Nexus in the Mekong Region. *Water Alternatives*, *8*(1), 655–674.

Foster, T. B., & Kleit, R. G. (2015). The Changing Relationship Between Housing and Inequality, 1980–2010. *Housing Policy Debate*, *25*(1), 16–40. https://doi.org/10.1080/10511482.2014.933118

Frank, A., & Marsden, T. (2016). *Regional Spatial Planning, Government and Governance as Recipe for Sustainable Development?* https://doi.org/10.1108/S1057-192220160000023011

Future Earth. (2021). *Water-Energy-Food Nexus*.

García, A. M., Santé, I., Loureiro, X., & Miranda, D. (2020). Green infrastructure spatial planning considering ecosystem services assessment and trade-off analysis. Application at landscape scale in Galicia region (NW Spain). *Ecosystem Services*, *43*, 101115. https://doi.org/10.1016/j.ecoser.2020.101115

Garcia, D. J., Lovett, B. M., & You, F. (2019). Considering agricultural wastes and ecosystem services in Food-Energy-Water-Waste Nexus system design. *Journal of Cleaner Production*, *228*. https://doi.org/10.1016/j.jclepro.2019.04.314

Garfin, G. M., Gonzalez, P., Breshears, D., Brooks, K., Brown, H. E., Elias, E., Gunasekara, A., Huntly, N., Maldonado, J. K., Mantua, N. J., Margolis, H. G., McAfee, S., Middleton, B. R., & Udall, B. (2018). *Chapter 25: Southwest. Impacts, Risks, and Adaptation in the United States: The Fourth National Climate Assessment, Volume II*. https://doi.org/10.7930/NCA4.2018.CH25

Ghazalian, P. L., & Hammoud, M. (2021). The Peace Level of Nations: An Empirical Investigation into the Determining Factors. *Defense and Peace Economics*, *32*(5), 509–532. https://doi.org/10.1080/10242694.2020.1743957

Ghodsvali, M., Krishnamurthy, S., & de Vries, B. (2019). Review of transdisciplinary approaches to food-water-energy nexus: A guide towards sustainable development. *Environmental Science & Policy*, *101*. https://doi.org/10.1016/j.envsci.2019.09.003

Giampietro, M., Aspinall, R., Ramos-Martin, J., & Bukkens, S. G. F. (2014). *Resource Accounting for Sustainability Assessment* (M. Giampietro, R. J. Aspinall, J. Ramos-Martin, & S. G. F. Bukkens, Eds.). Routledge. https://doi.org/10.4324/9781315866895

Grebner, D. L., Bettinger, P., & Siry, J. (2012). *Introduction to Forestry and Natural Resources* (1st ed.). Academic Press.

Groundwater Governance. (2022, March 19). *How Long Does It Take Well Water to Build Up?* Groundwater Governance.

Geothermal Project Timelines, (November 2, 2016).

Hancock, J. (2010). The case for an ecosystem service approach to decision-making: an overview. *Bioscience Horizons*, *3*(2). https://doi.org/10.1093/biohorizons/hzq013

Hansen, J. T., Mahak, M., & Tzanakis, I. (2021). Numerical modelling and optimization of vertical axis wind turbine pairs: A scale up approach. *Renewable Energy*, *171*, 1371–1381. https://doi.org/10.1016/j.renene.2021.03.001

Harmáčková, Z. v., & Vačkář, D. (2018). Future uncertainty in scenarios of ecosystem services provision: Linking differences among narratives and outcomes. *Ecosystem Services*, *33*. https://doi.org/10.1016/j.ecoser.2018.06.005

Hartmann, R. (2020). Heritage and Economy. In *International Encyclopedia of Human Geography*. Elsevier. https://doi.org/10.1016/B978-0-08-102295-5.10469-X

Hassing, J., Ipsen Niels, Jonch Clausen, T., Jonch Larsen, H., & Lindgaard Jorgensen, P. (2009). *Integrated Water Resources Management in Action*.

H.-O. Pörtner, D.C. Roberts, E.S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, & v. Möller. (2022). *IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* .

Holt, A. R., Alix, A., Thompson, A., & Maltby, L. (2016). Food production, ecosystem services and biodiversity: We can't have it all everywhere. *Science of The Total Environment*, *573*. https://doi.org/10.1016/j.scitotenv.2016.07.139

Hoolohan, C., Larkin, A., McLachlan, C., Falconer, R., Soutar, I., Suckling, J., Varga, L., Haltas, I., Druckman, A., Lumbroso, D., Scott, M., Gilmour, D., Ledbetter, R., McGrane, S., Mitchell, C., & Yu, D. (2018). Engaging stakeholders in research to address water–energy–food (WEF) nexus challenges. *Sustainability Science*, *13*(5). https://doi.org/10.1007/s11625-018-0552-7

Hoolohan, C., McLachlan, C., & Larkin, A. (2019). 'Aha' moments in the water-energy-food nexus: A new morphological scenario method to accelerate sustainable transformation. *Technological Forecasting and Social Change*, *148*. https://doi.org/10.1016/j.techfore.2019.119712

Houet, T., Loveland, T. R., Hubert-Moy, L., Gaucherel, C., Napton, D., Barnes, C. A., & Sayler, K. (2010). Exploring subtle land use and land cover changes: a framework for future landscape studies. *Landscape Ecology*, *25*(2). https://doi.org/10.1007/s10980-009-9362-8

Howarth, C., & Monasterolo, I. (2016). Understanding barriers to decision making in the UK energy-food-water nexus: The added value of interdisciplinary approaches. *Environmental Science & Policy*, *61*. https://doi.org/10.1016/j.envsci.2016.03.014

Huber, L. (2019). When Civilians Are Attacked: Gender Equality and Terrorist Targeting. *Journal of Conflict Resolution*, *63*(10), 2289–2318. https://doi.org/10.1177/0022002719835601

Huckleberry, J. K., & Potts, M. D. (2019). Constraints to implementing the food-energy-water nexus concept: Governance in the Lower Colorado River Basin. *Environmental Science & Policy*, *92*. https://doi.org/10.1016/j.envsci.2018.11.027

Hulse, J. (2010). *Nevada's Environmental Legacy: Progress or Plunder* (Vol. 41). https://doi.org/10.2307/westhistquar.41.3.0389a

Itayi, C. L., Mohan, G., & Saito, O. (2021). Understanding the conceptual frameworks and methods of the food–energy–water nexus at the household level for development-oriented policy support: a systematic review. *Environmental Research Letters*, *16*(3). https://doi.org/10.1088/1748-9326/abd660

IUCN. (2022). *Post-2020 Global Biodiversity Framework*.

Jamil, B., Yaping, S., Ud Din, N., & Nazneen, S. (2022). Do effective public governance and gender (in)equality matter for poverty? *Economic Research-Ekonomska Istraživanja*, *35*(1), 158–174. https://doi.org/10.1080/1331677X.2021.1889391

Joint Programming Initiative Urban Europe. (2018, February 7). *The 15 projects that will take on the food-water-energy nexus*. Https://Jpi-Urbaneurope.Eu/News/the-15-Projects-That-Will-Take-on-the-Food-Water-Energy-Nexus/.

Kabisch, N., Korn, H., Stadler, J., & Bonn, A. (2017). *Nature-Based Solutions to Climate Change Adaptation in Urban Areas* (N. Kabisch, H. Korn, J. Stadler, & A. Bonn, Eds.). Springer International Publishing. https://doi.org/10.1007/978-3-319-56091-5

Kamila, Z., Kaya, E., & Zarrouk, S. J. (2021). Reinjection in geothermal fields: An updated worldwide review 2020. *Geothermics*, *89*, 101970. https://doi.org/10.1016/j.geothermics.2020.101970

Kester, L., Griffin, A., Hultink, E. J., & Lauche, K. (2011). Exploring Portfolio Decision-Making Processes*. *Journal of Product Innovation Management*. https://doi.org/10.1111/j.1540-5885.2011.00832.x

Keyhanpour, M. J., Musavi Jahromi, S. H., & Ebrahimi, H. (2021). System dynamics model of sustainable water resources management using the Nexus Water-Food-Energy approach. *Ain Shams Engineering Journal*, *12*(2), 1267–1281. https://doi.org/10.1016/j.asej.2020.07.029

Kim, K.-H., & Pauleit, S. (2007). Landscape character, biodiversity and land use planning: The case of Kwangju City Region, South Korea. *Land Use Policy*, *24*(1). https://doi.org/10.1016/j.landusepol.2005.12.001

Kopec, D., & Bliss, A. (Eds.). (2020). *Place Meaning and Attachment*. Routledge. https://doi.org/10.4324/9780367232689

Landrigan, P. J., Stegeman, J. J., Fleming, L. E., Allemand, D., Anderson, D. M., Backer, L. C., Brucker-Davis, F., Chevalier, N., Corra, L., Czerucka, D., Bottein, M.-Y. D., Demeneix, B., Depledge, M., Deheyn, D. D., Dorman, C. J., Fénichel, P., Fisher, S., Gaill, F., Galgani, F., … Rampal, P. (2020). Human Health and Ocean Pollution. *Annals of Global Health*, *86*(1), 151. https://doi.org/10.5334/aogh.2831

Leck, H., Conway, D., Bradshaw, M., & Rees, J. (2015). Tracing the Water–Energy–Food Nexus: Description, Theory and Practice. *Geography Compass*, *9*(8). https://doi.org/10.1111/gec3.12222

Legatum Institute Foundation. (2021). *The United States Prosperity Index 2021*.

Lehmann, S. (2018, November 16). *Crunch, The Food-Water-Energy Nexus*. Http://Www.Fwe-Nexus.Eu .

Lehmann, S. (2019a). Activating the Food-Water-Energy Nexus. In *Urban Regeneration*. Springer International Publishing. https://doi.org/10.1007/978-3-030-04711-5_4

Lehmann, S. (2019b). *Urban regeneration. A manifesto for transforming UK cities in the age of climate change* (Vol. 12). https://doi.org/10.1080/17535069.2019.1639380

Lin, Y.-C., Lin, C.-C., Lee, M., Chiueh, P.-T., Lo, S.-L., & Liou, M.-L. (2019). Comprehensive assessment of regional food-energy-water nexus with GIS-based tool. *Resources, Conservation and Recycling*, *151*. https://doi.org/10.1016/j.resconrec.2019.104457

Liu, Q. (2016). Interlinking climate change with water-energy-food nexus and related ecosystem processes in California case studies. *Ecological Processes*, *5*(1). https://doi.org/10.1186/s13717-016-0058-0

Lustgarten, A. (2021, August 31). 40 million people rely on the Colorado River. It's drying up fast. *ProPublica*.

Malaney, J. L., Feldman, C. R., Cox, M., Wolff, P., Wehausen, J. D., & Matocq, M. D. (2015). Translocated to the fringe: genetic and niche variation in bighorn sheep of the Great Basin and northern Mojave deserts. *Diversity and Distributions*, *21*(9), 1063–1074. https://doi.org/10.1111/ddi.12329

Martinez-Hernandez, E., Leach, M., & Yang, A. (2017). Understanding water-energy-food and ecosystem interactions using the nexus simulation tool NexSym. *Applied Energy*, *206*. https://doi.org/10.1016/j.apenergy.2017.09.022

Masson-Delmotte, V., P. Z. A. P. S. L. C. C. P. S. B. N. C. Y. C. L. G. M. I. G. M. H. K. L. E. L. J. B. R. M. T. K. M. T. W. O. Y. R. Y. and B. Z. (eds.). (2021). *IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Summary for Policy Makers*.

Maurer, D. K., Lopes, T. J., Medina, R. L., & Smith, J. L. (2004). *Map showing areas of similar soil permeability and hardpan in Nevada*. USGS.

McHarg, I. L. (1969). *Design with nature* (Natural History Press, Ed.; 1st ed.). American Museum of Natural History.

Medina-Santana, A. A., Flores-Tlacuahuac, A., Cárdenas-Barrón, L. E., & Fuentes-Cortés, L. F. (2020). Optimal design of the water-energy-food nexus for rural communities. *Computers & Chemical Engineering*, *143*. https://doi.org/10.1016/j.compchemeng.2020.107120

Meerow, S., Newell, J. P., & Stults, M. (2016). Defining urban resilience: A review. *Landscape and Urban Planning*, *147*. https://doi.org/10.1016/j.landurbplan.2015.11.011

Milner, A., Kavanagh, A., Scovelle, A. J., O'Neil, A., Kalb, G., Hewitt, B., & King, T. L. (2021). Gender Equality and Health in High-Income Countries: A Systematic Review of Within-Country Indicators of Gender Equality in Relation to Health Outcomes. *Women's Health Reports*, *2*(1), 113–123. https://doi.org/10.1089/whr.2020.0114

Mohtar, R. H., & Daher, B. (2010). Water, Energy, and Food: The Ultimate Nexus. In *Encyclopedia of Agricultural, Food, and Biological Engineering, Second Edition*. CRC Press. https://doi.org/10.1081/E-EAFE2-120048376

Molin, E., & Martin, M. (2018). *Reviewing the energy and environmental performance of vertical farming systems in urban*.

Morrison, R., Barker, A., & Handley, J. (2018). Systems, habitats or places: evaluating the potential role of landscape character assessment in operationalising the ecosystem approach. *Landscape Research*, *43*(7). https://doi.org/10.1080/01426397.2017.1415314

Mroue, A. M., Mohtar, R. H., Pistikopoulos, E. N., & Holtzapple, M. T. (2019). Energy Portfolio Assessment Tool (EPAT): Sustainable energy planning using the WEF nexus approach – Texas case. *Science of The Total Environment*, *648*. https://doi.org/10.1016/j.scitotenv.2018.08.135

Muratovski, G. (2016). *Research for designers: a guide to methods and practice*. London: Sage Publications.

Muthu, S. S. (2021). *The Water–Energy–Food Nexus Concept and Assessments* (1st ed. 2021). Singapore: Springer Singapore : Imprint: Springer.

National Alliance to End Homelessness. (2021). *State of Homelessness: 2021 Edition*. National Alliance to End Homelessness.

National Center for Access to Justice. (2021). *Justice Index*.

National Park Service. (2021). *Great Basin National Park*.

National Park Service. (2022). *Mojave National Preserve*.

National Research Council, & Environment, and R. C. on G. (2000). *Clean Coastal Waters: Understanding and Reducing the Effects of Nutrient Pollution*.

Nature. (2018). *Climate Change*. Https://Www.Nature.Com/Subjects/Climate-Change.

Nature. (2021). *Renewable Energy*. Https://Www.Nature.Com/Subjects/Renewable-Energy.

Naya Energy. (2018, May 24). *Cold Storage Case Study: Increasing Energy Efficiency*. Naya Energy.

Neal, A. G., & Youngelson-Neal, H. (2017). *Core Values in American Life*. Routledge. https://doi.org/10.4324/9781315080321

Nederhoff, E. M., & Stanghellini, C. (2010). Water use efficiency of tomatoes - in greenhouses and hydroponics. *Practical Hydroponics & Greenhouses*, *2010*(115), 52–59.

Nevada Department of Agriculture. (2021). *Economic Analysis of the Food and Agriculture Sector in Nevada 2021*.

Nevada Division of Environmental Protection. (2020). *Nevada Statewide Greenhouse Gas Emissions Inventory and Projections, 1990-2040*.

Nevada Division of Environmental Protection, & Bureau of Water Quality Planning. (2022). *Nevada 2020-2022 Water Quality Integrated Report*.

Nevada Division of Forestry. (2020). *Nevada Forest, Range & Watershed Action Plan*. http://forestry.nv.gov/natural-resource-management/state-frwap

Nevada Division of Natural Heritage. (2008). *Nevada Vegetation Project Index*.

Nevada Energy. (22 C.E., April 28). *NV Energy Exceeds Nevada's Renewable Energy Requirement for 12th Straight Year*.

Nevada State. (21 C.E.). *State of Nevada Joint Information Center*. State of Nevada.

Nussear, K. E., Esque, T. C., Inman, R., & Gass, L. (2009). *Modeling habitat of desert tortoise (Gopherus agassizii) in the Mojave and parts of the Sonoran deserts, California, Nevada, Utah, and Arizona*.

Office of Disease Prevention and Health Promotion. (2022, February 6). *Water conservation (per capita daily gallons of domestic water usage)*.

Oxfam. (2021, November 5). *Carbon emissions of richest 1% set to be 30 times the 1.5°C limit in 2030*.

Pahl-Wostl, C. (2019). Governance of the water-energy-food security nexus: A multi-level coordination challenge. *Environmental Science & Policy*, *92*, 356–367. https://doi.org/10.1016/j.envsci.2017.07.017

Parkinson, S., Krey, V., Huppmann, D., Kahil, T., McCollum, D., Fricko, O., Byers, E., Gidden, M. J., Mayor, B., Khan, Z., Raptis, C., Rao, N. D., Johnson, N., Wada, Y., Djilali, N., & Riahi, K. (2019). Balancing clean water-climate change mitigation trade-offs. *Environmental Research Letters, 14*(1), 014009. https://doi.org/10.1088/1748-9326/aaf2a3

Payet-Burin, R., Kromann, M., Pereira-Cardenal, S., Strzepek, K. M., & Bauer-Gottwein, P. (2019). WHAT-IF: an open-source decision support tool for water infrastructure investment planning within the water–energy–food–climate nexus. *Hydrology and Earth System Sciences*, *23*(10). https://doi.org/10.5194/hess-23-4129-2019

Pezzoli, K., Hibbard, M., & Huntoon, L. (2009). Introduction to Symposium: Is Progressive Regionalism an Actionable Framework for Critical Planning Theory and Practice? *Journal of Planning Education and Research*, *28*(3). https://doi.org/10.1177/0739456X08329711

Potschin, M., & Haines-Young, R. (2013a). Landscapes, sustainability, and the place-based analysis of ecosystem services. *Landscape Ecology*, *28*(6). https://doi.org/10.1007/s10980-012-9756-x

Potschin, M., & Haines-Young, R. (2013b). Landscapes, sustainability, and the place-based analysis of ecosystem services. *Landscape Ecology*, *28*(6), 1053–1065. https://doi.org/10.1007/s10980-012-9756-x

Potteiger, M. (1998). *Landscape narratives: design practices for telling stories* (J. Purinton, Ed.). New York: J. Wiley.

Primdahl, J., & Kristensen, L. S. (2016). Landscape strategy making and landscape characterisation—experiences from Danish experimental planning processes. *Landscape Research*, *41*(2). https://doi.org/10.1080/01426397.2015.1135322

Proctor, K., Tabatabaie, S. M. H., & Murthy, G. S. (2021). Gateway to the perspectives of the Food-Energy-Water nexus. *Science of The Total Environment, 764*. https://doi.org/10.1016/j.scitotenv.2020.142852

Quist, J., Rammelt, C., Overschie, M., & de Werk, G. (2006). Backcasting for sustainability in engineering education: the case of Delft University of Technology. *Journal of Cleaner Production, 14*(9–11). https://doi.org/10.1016/j.jclepro.2005.11.032

Radmehr, R., Ghorbani, M., & Ziaei, A. N. (2021). Quantifying and managing the water-energy-food nexus in dry regions food insecurity: New methods and evidence. *Agricultural Water Management, 245*. https://doi.org/10.1016/j.agwat.2020.106588

Raghupathi, V., & Raghupathi, W. (2020). The influence of education on health: an empirical assessment of OECD countries for the period 1995–2015. *Archives of Public Health*, *78*(1), 20. https://doi.org/10.1186/s13690-020-00402-5

Raworth, K. (2017). *Doughnut economics: seven ways to think like a 21st century economist* (P. (Firm), Ed.). White River Junction, Vermont: Chelsea Green Publishing.

Raworth, K. (2022). *Doughnut Economics Action Lab*. Https://Doughnuteconomics.Org/.

Renewables Now. (2022, March 30). *SeaTwirl gets concession for 1-MW floating vertical-axis wind turbine in Norway*. Renewables Now.

Ritchie, H., & Roser, M. (2018, June). *Ozone Layer*. Our World in Data.

Ronchi, S. (2018). *Ecosystem Services for Spatial Planning: Innovative Approaches and Challenges for Practical Applications (Green Energy and Technology)* (1st ed.). Springer.

RSPB. (2009). Royal Society for the Protection of Birds (RSPB) releases report. *International Journal of Sustainability in Higher Education*, *10*(1). https://doi.org/10.1108/ijshe.2009.24910aab.005

Rural Health Information Hub. (2021). *Nevada Rural Healthcare Facilities*.

Santonen, T., Creazzo, L., Griffon, A., Bodi, Z., & Aversano, P. (2017). *Cities as Living Labs : Increasing the impact of investment in the circular economy for sustainable cities*.

Sarni, W. (2015). *Beyond the energy-water-food nexus: new strategies for 21st-century growth* (P. (Firm), Ed.). Oxford, UK: Dō Sustainability.

Scanlon, B. R., Ruddell, B. L., Reed, P. M., Hook, R. I., Zheng, C., Tidwell, V. C., & Siebert, S. (2017). The food-energy-water nexus: Transforming science for society. *Water Resources Research*, *53*(5). https://doi.org/10.1002/2017WR020889

Sisolak, S. (2021, July 27). *Hunger Action Month in Nevada*. A Proclamation by the Governor.

Southern Nevada Water Authority. (2020). *2020 Water Resource Plan*.

Spotlight on Poverty & Opportunity. (2022). *Nevada's Spotlight on Poverty & Opportunity*.

Steen, K., & van Bueren, E. (2017). The Defining Characteristics of Urban Living Labs. *Technology Innovation Management Review*, *7*(7). https://doi.org/10.22215/timreview/1088

Stoy, P. C., Ahmed, S., Jarchow, M., Rashford, B., Swanson, D., Albeke, S., Bromley, G., Brookshire, E. N. J., Dixon, M. D., Haggerty, J., Miller, P., Peyton, B., Royem, A., Spangler, L., Straub, C., & Poulter, B. (2018). Opportunities and Trade-offs among BECCS and the Food, Water, Energy, Biodiversity, and Social Systems Nexus at Regional Scales. *BioScience*, *68*(2). https://doi.org/10.1093/biosci/bix145

Subedi, R., Karki, M., & Panday, D. (2020). Food System and Water-Energy-Biodiversity Nexus in Nepal: A Review. *Agronomy (Basel)*, *10*(8), 1.

Sustainable Agriculture Research and Education. (2004). *Diverse Crops Bring Diverse Benefits*.

Swanwick, C. (2002). *Landscape Character Assessment, Guidance for England and Scotland*.

Swatuk, L. A., Cash, C., & (Firm), P. (2018). *Water, energy, food and people across the global south: "the Nexus" in an era of climate change*. Cham, Switzerland : Palgrave Macmillan.

Taylor, B. (2002). *Celebrating Nevada Indians*. Nevada Native American Education Association.

Tengberg, A., Fredholm, S., Eliasson, I., Knez, I., Saltzman, K., & Wetterberg, O. (2012). Cultural ecosystem services provided by landscapes: Assessment of heritage values and identity. *Ecosystem Services*, *2*, 14–26. https://doi.org/10.1016/j.ecoser.2012.07.006

The Ecological Sequestration Trust. (2016). *Roadmap 2030, Financing and Implementing the Global Goals in Human Settlements and City-Regions*.

The European Wind Energy Association. (2016). *Wind Energy FAQ*. The European Wind Energy Association.

The Nature Conservancy. (2022, September 14). *Mojave Desert Animals and Plants, Connect with Nature in Southern Nevada*.

The Prosperity Now Scorecard. (2022). *Unemployment Rate*.

The Water & Tribes Initiative. (2021). *The Status of Tribal Water Rights in the Colorado River Basin*.

Thomollari, X., Bahadir, Ü., Toğan, V., & Tokdemir, O. B. (2017). Reducing water consumption with sustainable building design a case study. *The Turkish Journal of Occupational/Environmental Medicine and Safety*, *2*(3).

Thompson, A. (2022, April 22). How Conserving 30 Percent of U.S. Land by 2030 Could Work. *Scientific American*.

Three Square. (2022). *Mapping hunger at a local level*. Three Square.

Treftz, C., & Omaye, S. T. (2016). Hydroponics: potential for augmenting sustainable food production in non-arable regions. *Nutrition & Food Science, 46*(5), 672–684. https://doi.org/10.1108/NFS-10-2015-0118

Tschudi, R. (2021, June 30). *How Much Does A Greenhouse Cost?* Home Advisor.

Tudor, C. (2014). *An Approach to Landscape Character Assessment*.

U. S. Environmental Protection Agency. (2022, September). *How We Use Water*. United States Environmental Protection Agency. https://www.epa.gov/watersense/how-we-use-water

U. S. Geological Survey. (2022). *Highest and Lowest Elevations*.

U.N. Economic Development. (2019, September 4). *'Digital divide' will worsen inequalities, without better global cooperation*. UN News.

UNISDR. (2015). *Sensai Framework for Disaster Risk Reduction 2015-2030*.

United Health Foundation. (2021a). *College Graduate-Women*.

United Health Foundation. (2021b). *Gender Pay Gap*.

United Health Foundation. (2021c). *Severe Housing Problems*. America's Health Rankings.

United Health Foundation. (2022). *America's Health Rankings*.

U.S. Energy Information Administration. (2020). *Nevada, State Profile and Energy Estimates*.

U.S. Census Bureau. (2021). *Nevada: 2020 Census*.

U.S. Drive. (2019). *Summary Report on EVs at Scale and the U.S. Electric Power System*.

U.S. Energy Information Administration. (2021). *Energy-Related CO2 Emission Data Tables*.

U.S. Environmental Protection Agency. (2003). *Ecoregions of Nevada*.

U.S. Environmental Protection Agency. (2016a). *Hidrology, Landscape Ecology: Nevada Geospatial*.

U.S. Environmental Protection Agency. (2016b). *Nevada GIS Data*.

U.S. Environmental Protection Agency. (2017). *Nevada Water Quality Assessment Report*.

U.S. Environmental Protection Agency. (2018). *ODS Destruction in the United States and Abroad*.

U.S. Environmental Protection Agency. (2021). *Toxic Realease Inventory National Analysis*.

U.S. Environmental Protection Agency. (2022, May 16). *Greenhouse Gas Emissions*.

U.S. Fish & Wildlife Service. (2021). *Listed species believed to or known to occur in Nevada*. https://ecos.fws.gov/ecp/report/species-listings-by-state-totals?statusCategory=Listed

U.S. Global Change Program. (2018). *Fourth National Climate Assessment. Volume II — Impacts, Risks, and Adaptation in the United States.*

USDA. (2012, March 1). *Animals Habitat Degradation*. Https://Www.Nrcs.Usda.Gov/Internet/FSE_DOCUMENTS/Stelprdb1187302.Pdf.

van den Heuvel, L., Blicharska, M., Masia, S., Sušnik, J., & Teutschbein, C. (2020). Ecosystem services in the Swedish water-energy-food-land-climate nexus: Anthropogenic pressures and physical interactions. *Ecosystem Services*, *44*. https://doi.org/10.1016/j.ecoser.2020.101141

Venghaus, S., Märker, C., Dieken, S., & Siekmann, F. (2019). Linking Environmental Policy Integration and the Water-Energy-Land-(Food-)Nexus: A Review of the European Union's Energy, Water, and Agricultural Policies. *Energies*, *12*(23). https://doi.org/10.3390/en12234446

von Haaren, C., Lovett, A., & Albert, C. (Eds.). (2019). *Landscape Planning with Ecosystem Services Theories and Methods for Application in Europe* (1st ed.). Springer.

Vos, W., & Meekes, H. (1999). Trends in European cultural landscape development: perspectives for a sustainable future. *Landscape and Urban Planning*, *46*(1–3). https://doi.org/10.1016/S0169-2046(99)00043-2

Warnock, S., & Griffiths, G. (2015). Landscape Characterisation: The Living Landscapes Approach in the UK. *Landscape Research*, *40*(3). https://doi.org/10.1080/01426397.2013.870541

Washbourne, C.-L., Goddard, M. A., le Provost, G., Manning, D. A. C., & Manning, P. (2020). Trade-offs and synergies in the ecosystem service demand of urban brownfield stakeholders. *Ecosystem Services*, *42*, 101074. https://doi.org/10.1016/j.ecoser.2020.101074

Webster, I. (2022, May 9). *Value of $1 from 2014 to 2022*. CPI Inflation Calculator.

Western Regional Climate Center. (2022). *Climate of Nevada*.

Wheelwright, T. (2021, April 19). *The 10 Fastest and Slowest States for Internet Speeds in 2021*. High Speed Internet.

Wichelns, D. (2017). The water-energy-food nexus: Is the increasing attention warranted, from either a research or policy perspective? *Environmental Science & Policy*, *69*. https://doi.org/10.1016/j.envsci.2016.12.018

Wiggering, H. (2014). The geology – land use – nexus. *Environmental Earth Sciences*, *71*(12). https://doi.org/10.1007/s12665-013-2908-8

Williams, J. (2019). Circular Cities: Challenges to Implementing Looping Actions. *Sustainability*, *11*(2). https://doi.org/10.3390/su11020423

Williams, S. (2022, February 28). *Indicators of Groundwater Dependent Ecosystems in Nevada*. The Nature Conservancy.

Winkelman, P., Benedict, S., & Smith, D. (2017). *Pahrump Groundwater Plan Evaluation in Regards to Identifying Projects for Preliminary Engineering Reports*.

Winkler, K., Fuchs, R., Rounsevell, M., & Herold, M. (2021). Global land use changes are four times greater than previously estimated. *Nature Communications*, *12*(1). https://doi.org/10.1038/s41467-021-22702-2

World Bank. (2020). *Access to Electricity*.

World Economic Forum. (2011). *Global risks 2011*.

World Economic Forum. (2022, May 22). *Three ways to reduce geopolitical risks in the global food system*.

World Green Building Council. (2022). *The benefits of green buildings*. World Green Building Council.

World Health Foundation. (2022, March 21). *Sanitation*.

World Population Review. (2021a). *Air Quality by State 2021*. U.S. Air Quality Index State Rank.

World Population Review. (2021b). *Income Inequality by State*.

World Population Review. (2022a). *Life Expectancy by State 2022*.

World Population Review. (2022b). *U.S. Literacy Rates by State 2022*.

Worldometer. (2022). *Largest Countries in the World (by area)*.

Wszelaki, A., Saywell, D., & Broughton, S. (2012). *Transitioning to Organic Farm Systems*.

Wyatt, J., & Kristian, M. (2021, September 14). *The True Land Footprint of Solar Energy*. Great Plains Institute.

Yue, Q., Zhang, F., Wang, Y., Zhang, X., & Guo, P. (2021). Fuzzy multi-objective modelling for managing water-food-energy-climate change-land nexus towards sustainability. *Journal of Hydrology*, *596*. https://doi.org/10.1016/j.jhydrol.2020.125704

Zhang, T., Tan, Q., Zhang, S., Zhang, T., & Zhang, W. (2021). A participatory methodology for characterizing and prescribing water-energy-food nexus based on improved casual loop diagrams. *Resources, Conservation and Recycling*, *164*. https://doi.org/10.1016/j.resconrec.2020.105124

Curriculum Vitae

Fortino Acosta

acosta.fortino@gmail.com

Education
2018-2022
Ph.D. candidate for Civil and Environmental Engineering
Howard R. Hughes College of Engineering, University of Nevada in Las Vegas, United States

2008-2010
M.A. Landscape Architecture (with merit)
University of Sheffield, United Kingdom

2000-2004
B.S. Industrial Engineering (with honor)
Universidad Iberoamericana Santa Fe, Mexico

2002
Industrial Engineering Internship
Instituto Químic de Sarriá Barcelona, Spain

Professional experience
2017 to present
Independent landscape architect and urbanist
Islas Marias Botanical Garden, Nayarit, Mexico
Guayaquil City Urban Advisor
Landscape and Visual Impact Assessments consultant for the private sector
Advisory board member for Queretaro, New Urban Agenda Q500
United Nations Development Program Communication consultant for the Invasive Species National Strategy

2017
Reforestamos
Green Cities Coordinator
Developing a national urban green space strategy based on the Sustainable Development Goals, IUCN Programme and the national biodiversity strategy

2010-2017
Nosotros Tierra
Founder and CEO /Environmental Planning
Coordinated and designed over 40 projects including: Luis Barragan's Colonia Jardines del Pedregal Strategic Plan 2035, basins management, urban regeneration, infrastructure projects, and urban developments

2014
Garry Station Development, Alberta, Canada
Developed landscape guidelines for a housing development

2011
Ashoka International
Assessment Consultant
Evaluated sustainability criteria of 56 community projects across Mexico

2007-2008
Oaxaca State Instute of Ecology / World Wild Fund
Natural Protected Areas' analyst in Oaxaca
Environmental consultant for Atoyac river conservation project

Academic experience
2019-2022
Teaching assistant, UNLV
AAE 482 Architectural Design Studio IV
AAE 660 Issues and Solutions for Cities
AAE 770 Environmental Research Methods
AAD 401 Global Design Studio (UNLV-Universidad Iberoamericana)
2014-2017
Inter-American Institute for Cooperation in Agriculture – IICA (Dominican Republic, Haiti and Mexico) Rural tourism, regional planning and project development professor.

Books
Chapter author: Green infrastructure: conceptual and methodological application bases (2023).
Landscape Design for Biodiverse Cities (2021), FONCA.
Author: The waters of Orion (2018), Children's book.

Journals
Acosta, & Haroon, S. (2021). *Memorial Parking Trees: Resilient Modular Design with Nature-Based Solutions in Vulnerable Urban Areas*. Land (Basel), 10(3), 298.
https://doi.org/10.3390/land10030298

Awards
2021 Ethnobotanical Garden Chapultepec (First place)
2018 Parking Trees in Ten Urban Proposals (First place)
2017 Parque Ciudadano, Monterrey (Second place)
2014 Pilgrimage Park, hydro-urban intervention (First place)
2008-2009 National Fund for Cultures and Arts scholarship (FONCA)