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From Uncertainties to Solutions: A Scenario-Based Framework for an Agriculture Protection Zone in Magic Valley Idaho

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Abstract: As growth in the western U.S. continues to lead to the development of land, pressure is being exerted on agricultural production, and could lead to the loss of prime agricultural land. A wide array of perspectives concerning agricultural protection requires a variety of possible solutions. Diverse and plausible scenarios, driven by stakeholders, can be modeled by researchers to guide potential solutions to address key challenges within a region. This paper addresses one stakeholder-defined social-ecological system (SES) solution in the context of southern Idaho, one of the fastest-growing states in the U.S.: agricultural protection zoning. This project demonstrates a method for incorporating an Agriculture Protection Zone (APZ) within a suite of scenarios showing land protection opportunities across a range of future conditions and challenges. The results, by way of a Geodesign framework, entail suitability analyses through a series of weighted raster overlays to analyze scenario-based solutions. The suite of scenario solutions was compared to demonstrate effective proportions of the APZ. The analysis of the results, as a solution gradient, aim to inform policy makers, planners, and developers about the efficiencies of various APZ delineations as well as a methodology to demonstrate the impact of solutions based on assumptions of stakeholder-informed future scenarios.

Keywords: agroecology; scenarios; alternative futures; agriculture protection zoning; landscape planning

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1. Introduction

Iterative modeling and stakeholder input for social-ecological systems (SES) can dictate nuance through multiple understandings of future trajectories of change in areas fraught with land use conflict [1]. With increases in development, the urban–rural fringe, preserved for future development or preservation of natural resources, is subject to this friction. Within rapid development and growth in southern Idaho, agriculture is at risk of impact. Measuring impact through a range of scenarios can provide a method to address space in land use contention. Multiple alternative future possibilities to these externalities necessitate a process designed to incorporate models of future anticipatory scenarios [2], impacts of this change, and responses through a suite of plausible actions which may be implemented by a community [3–5]. Scenarios, alternative futures, and solutions for the Magic Valley in southern Idaho, comprising nine agricultural-based counties, have been demonstrated through recent work on 'socio-ecological futures' [6,7]. To further expand possible solutions in the context of the Alternative Futures project, this paper demonstrates a policy-driven solution across food-energy-water (FEWS) scenarios as an example of stakeholder responses to uncertainty [8] and addresses this through stakeholder-driven solutions to protect and conserve agricultural land uses within the rural–urban interface. Within current research, demonstrations of applied solutions to address land use conflicts within the rural urban interface and FEWS networks are seldom demonstrated through scenarios [6]. This research provides an example of embedded solutions through stakeholder-driven guidance for operationalizing this intervention. This paper also seeks to demonstrate a method to craft and validate solutions within the context of an alternative futures project [9–11] through a SES framework. The results indicate clear geospatial delineations of areas of potential agricultural protection. The results of this paper, intend to inform SES researchers about research pathways and a workflow for replicability. This framework also intends to provide policymakers and local planners with a solution gradient to demonstrate and plan for similar policy interventions for the future of the region and for similar FEWS, RUI, and SES challenges.

The research objectives of this paper are (a) to describe the development of suitability analysis for APZ delineations for each scenario, (b) to compare and analyze scenario-specific boundaries, and (c) to propose a framework for cross-scenario solution analysis. As a synthesis of analyzed possible areas for agriculture protection, a gradient was generated from the cross-scenario analysis. This framework is aimed at providing a scaffolding for further development of similar approaches for applying solutions to alternative futures projects. As a goal of the project, we intend to answer the following research question: "How can scenario-based analysis inform solutions in the context of a Geodesign framework?" The following sections provide context, background, and rationale for addressing the research objectives.

1.1. Social Ecological Systems Solutions in Scenario Projects

A SES can be defined as decision spaces for addressing complex social patterns to manage and adapt to changes [12] within the biophysical systems in which humans manage and influence change [13,14]. Adapting to uncertainty and surprise [7,15] plays an integral role in the decision-making process through integrated methodologies and frameworks. However, if the adaptation and adoption of solutions is accepted by local governance (e.g., decision-makers, stakeholders, and land managers), plausibility and success of interventions can be achieved [16,17]. Alternative futures analysis [4,5,15] is an example of a mixed-method approach for eliciting this acceptance or trust [16,18] through creation of a suite of stakeholder-driven, research-based scenarios. Scenarios, as representations of future trajectories, ultimately demonstrate how stakeholders envision the future of an area, region, or landscape [19]. Within anticipatory and exploratory scenario projects, these understandings of the future are supported by computational scenario modeling efforts to demonstrate how shifts in thinking might unfold at various timesteps. However, due to the utility and purpose of citizen-driven scenarios, solutions are seldom integrated within the process due to perceptions of prescriptiveness [20,21]. Limitations within the process restrict solutions and systems-level interventions as mechanisms to address negative impacts. Within the Innovations at the Nexus of Food, Energy, and Water Systems (INFEWS) project in Magic Valley, researchers achieved this integration of solutions per each scenario as the interventions reflected stakeholder-defined values and interest [6,7,22–24].

1.2. The Urban–Rural Fringe in Magic Valley Idaho

The urban–rural fringe is subject to a range of significant and adverse effects at various landscape and regional scales [25]. For sustainable regional systems and land use planning, the urban–rural fringe remains a contentious space operating as a buffer between rural communities and urban areas with higher density [26]. Sprawl and various development types can play a significant role in various issues that may occur due to increased development and systematic shifts in growth or conservation trends. These fringe areas are typically used as a reserve for future development [27]; however, with informed planning and efficiency, various fringe areas (otherwise known as the rural–urban interface (RUI)) can be viewed as a solution space to many issues in our built environment [26,27]. Due to these impacts, landscapes, viewed as SESs that incorporate social and built environments, have the potential to support adaptive responses to environmental and development sustainability challenges. To better understand the demands, limits, and thresholds of areas impacted, we developed and tested plausible scenarios to measure potential futures facing these areas. The scenario project's intent was also to quantify the capability for ensuring sustainable growth for urban, natural, and agricultural areas.

Adaptive capacity, vulnerability, and feasibility studies [28–30] can provide planners and researchers with an understanding of systems-level limits, perimeter extents, and thresholds for growth for urban areas [26,31]. However, by conducting these studies, we subject our research efforts to building out our future projects to the extent or boundary of the study area. These studies provide the landscape threshold or carrying capacity [31] which, in a high-development scenario, the absolute capacity of the urban–rural fringe will be built out to its extent. Within this research, we propose a methodology to determine a gradient as a range for areas that are feasible or suitable for policy intervention within the urban–rural fringe.

2. Methods and Materials

Within Idaho's Magic Valley (Figure 1), population growth and development have the potential to become the drivers of change to impact agricultural systems within the RUI. With a decadal population growth rate of 19.91% since 2010, the region is projected to have a population of 221,703 (19.2 people per square mile) as of 2027 compared to its 2010 population of 185,790 inhabitants [32]. Due to this influx, the demand for low-density residential development has impeded on the urban–rural fringe, primarily consisting of highly productive agricultural land. To remediate effects of this rapid change in regions with similar issues, solutions and networks have been adopted. The following sections present these solutions.

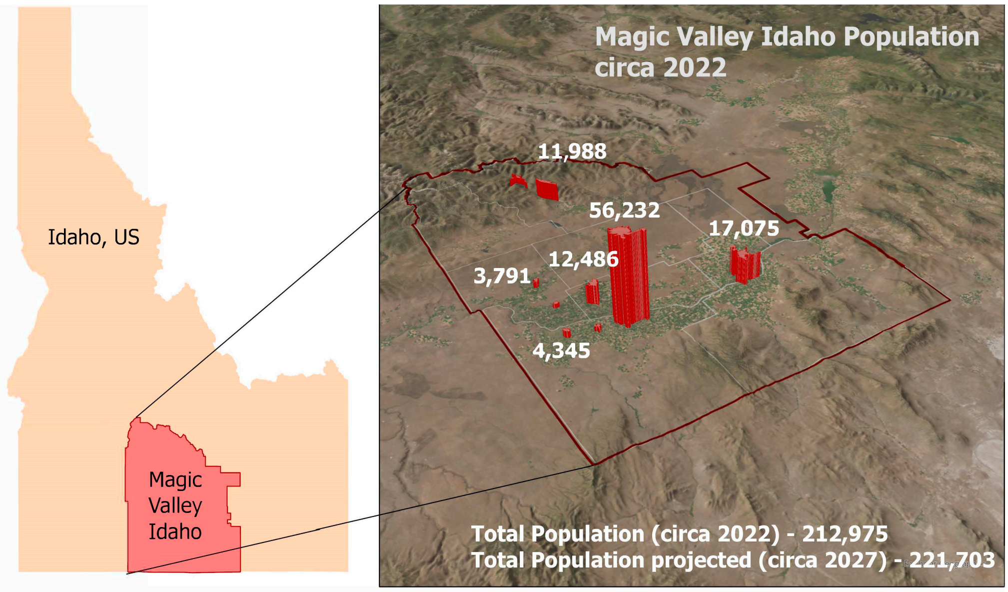

Figure 1. This figure gives context for Magic Valley Idaho as well as current population and projected population for urban areas within the region. Magic Valley urban areas (depicted as red histograms) showcase the population proportionately in the context of the region.

2.1. Best Management Practices in Agroecology

Best Management Practices (BMPs) are a tool that can assist with addressing issues and challenges within SES as structural or policy interventions. Within the context of agroecological systems, biophysical as well as agrarian needs require place-based influence and buy-in from individuals who manage those particular systems [16,33]. Agricultural BMPs require proper planning, siting, sizing, and permitting based on federal as well as local agencies (e.g., Idaho Department of Environmental Quality, NRCS, USDA NASS). A stakeholder group, comprising local experts, has the ability to conceptualize, validate, and operationalize these BMPs as well as their networks through scenario permutations [11]; however, justification of land use and land cover change per each scenario must be justified through iterative spatio-temporal modeling efforts [34,35]. Within the INFEWS project, a solution set was developed which comprised a categorization of two different types of BMPs: structural BMPs and policy-driven BMPs. The following sections provide background and explanation of one of the stakeholder-defined BMPs: the Agriculture Protection Zone (APZ).

2.1.1. Current Agriculture Protection Zoning

Throughout the western United States, effects of urban sprawl have caused detrimental impacts to water, soils, and ecosystems within the natural and built environment. Urban stream syndrome [36], erosion, stream turbidity, and conversion of prime agricultural land to low-density residential land contribute to these impacts and cause myriad issues within the RUI and contiguous areas. To address this protection of critical agrarian land, permitted uses and restrictions have been utilized through various methods and an exemplary case study [37]. As a synthesis of these methods and planning tools, it can be assumed that exclusive agricultural zoning, entailing strict land use regulations and limitations specifically for agriculture and agricultural-based operations, has a low success rate due to its exclusionary nature. However, sliding scale zoning (maximum and minimum residential lot sizes specified) [37,38] and combination approaches allow for the creation of agriculture protection districts to develop a ratio-based proportion [39] of residential-to-preserved permanent agriculture within a given area.

2.1.2. Agriculture Protection Zoning Effectiveness

These approaches address and ameliorate growth patterns within the RUI; however, leapfrog development can potentially occur within these areas [40] as well as changing in zoning ordinances due to reduced land values [39]. Due to this impact, many states have evoked agricultural protection zoning through agricultural district laws and guidelines [41] which protect farmlands of state-wide importance. Agricultural protection zoning districts require farmland of state-wide importance as a criterion for suitable areas for an APZ. Additionally, standard design principles are typically found, and are occasionally added depending on regional needs, in the suitability [39,42] of agriculture projection zoning: (a) prime agricultural land and soils, (b) soils of statewide importance, (c) land capability classes (for example, category I–VIII from the NRCS-USDA [43]), and (d) proximity to supporting infrastructure (crops, dairies, processors, supporting businesses, roadways). The suitability mapping utilized within this study expands upon these criteria specific to each scenario.

2.2. Stakeholder Engagement through Geodesign

We engaged with a group of key individuals who shared interests aligning with the objectives of our project, specifically understanding and reducing impacts to water and agricultural systems with regard to Magic Valley. The stakeholder advisory group (SAG) comprised twelve regional experts including representatives from the following organizations, sectors, and agencies: a canal company executive, municipal water engineers, food processing managers and executives, a rural planning NGO member, Native American Tribe representatives, and dairy industry advocates. Stakeholder meetings were held twice per year, totalling seven workshops; however, individual follow-up sessions were conducted to gain further clarification regarding input. Stakeholders were provided compensation for their time. A full description of challenges and accomplishments of the process is presented within Kliskey et al., 2023 [6].

Regional stakeholders [7] helped define the criteria utilized to model suitability of the APZ policy-intervention within a food-energy-water scenario planning process [6] and the research team developed a method to validate its utility. Stakeholder-defined criteria were put into a suitability analysis within the context of a broader alternative futures analysis [7].

The suitability analysis included weighted criteria to denote the feasibility of optimal locations for an APZ for each scenario. Weights were based on criteria and narratives validated by a stakeholder group [7]. The alternative futures analysis then weighed the LULC impacts of an APZ across the entire suite of scenario solutions. The combination of the suitability analyses and the alternative futures analysis provided plausibility as well as effectiveness of the solution catered to southwest Idaho.

We modeled the impact of the APZ suitability approach (Figure 2) using the Steinitz Geodesign framework [21] by developing the following models:

(a) Process Model—the APZ suite of suitability models evaluated by indicators of total agricultural land;
(b) Change Model—a composite APZ (including each scenario APZ boundary) to align projected agricultural land for each Alternative Future circa 2050 [7];
(c) Impact Model—this model is a comparison of the current agricultural lands with the APZ Suite to determine effectiveness of the APZ under the assumptions of each scenario;
(d) Decision Model—the decision model, as a 'low to high' suitability gradient of feasible APZ areas, provides a synthesis of the process to demonstrate a range of the composite APZ along with the agriculture projection zoning.

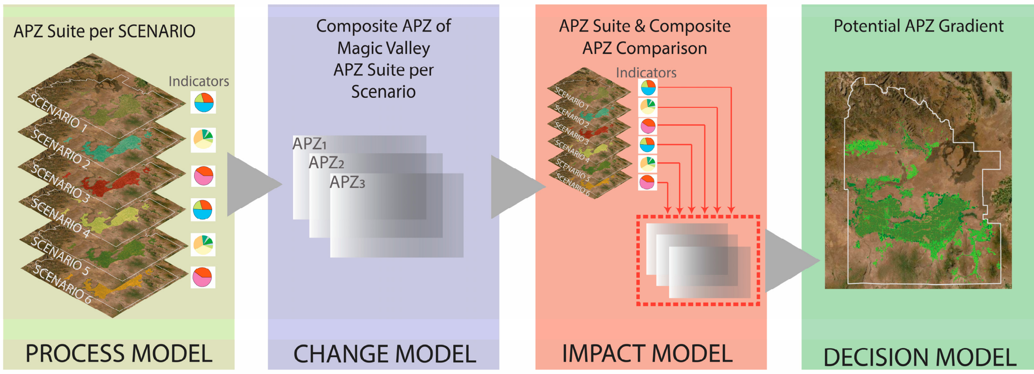

Figure 2. Figure 2 demonstrates the methodological process utilized within this research aligning Geodesign models with key aspects of the methodology within this study.

2.3. Suitability Analysis for the APZ

Suitability analysis for the Agriculture Protection Zone (APZ) refers to areas that may potentially operate as agricultural reserve districts. This delineation intends to limit low-density residential areas and other zoning ordinances which may encroach on highly productive agricultural land. Suitable areas, per each scenario-specific criteria set, were configured using ESRI ArcGIS Pro weighted raster overlay tools [44], first during stakeholder meetings and then finalized by the research team.

2.4. Materials and Data Sources

For the suitability analysis, Cropland Data Layer (CDL) [45] raster datasets were aggregated to generate the 'crops allocated' and 'minimum acreage' criteria in the suitability analysis for each scenario. The 'Top Commodity Crops' were defined by stakeholders as being corn, barley, spring wheat, winter wheat, alfalfa, sugar beets, and potatoes. 'Crops of Community Importance' were validated as being 'Top Commodity Crops' along with sorghum, oats, and dry beans. Both categories were processed from CDL data classes. For data consistency, CDL datasets from 2019 were used to generate the alternative futures used within the suite of FEWS scenarios. USA SSURGO Farmland Classes [43] were processed to generate the 'Soils of Importance' criterion. 'Land Capability Classes' were also generated from USA SSURGO [43]. Land capability classifications are groupings of soils based on their ability to produce and support commonly cultivated crops. Lower numeric classifications denote less susceptibility for each soil to deteriorate over time. Class I soils have few limitations that restrict their use. Class II soils have very severe limitations that reduce the choice of plants or that require very careful management, or both. Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both. Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both [43]. Classes 5–8 were not included within this analysis due to their restricted use for wildlife, forestland, or pasture land use allocations. Because of these restrictions, our stakeholder suggested only using Classes I–IV, being that these types allow for agricultural practices.

2.5. APZ Suitability Criteria per Each INFEWS Scenario

The criteria used within the weighted raster overlay procedure were conducted using stakeholder input from workshops and interviews in the INFEWS project [7]. Criteria changed per each scenario, so multiple weighted raster overlays were conducted. Two of the scenarios did not have an APZ applied and, therefore, the procedure was not run for two scenarios (see Scenario 2 & 4 in Table 1). The criteria utilized are as follows: crops allocated, minimum acreage, soils of importance, and land capability classes. Exclusion areas included urban areas consisting of residential, commercial, industrial areas, public facilities, and the Area of City Impact (AOCI) for the communities in Magic Valley. The AOCI is a statewide code instituted by Idaho state government that requires cities to define a preferred growth boundary, defined by each county, for areas where a city is expected to grow in the future [46].

Table 1. The information below showcases the scenarios produced within the INFEWS project aligned with the data processed. Columns depict the criteria utilized for analysis, and rows depict each scenario nuance within the process elucidated from stakeholder feedback.

Scenario	Crops Allocated	Minimum Acreage	Soils of Importance	Land Capability Classes
Scenario 1: Business as Usual	Top Commodity Crops	Greater than 40 Acres	Soils of Statewide Importance	Classes I–IV
Scenario 2: The Courts Call	No APZ			
Scenario 3: Locavore	Top commodity crops and community importance	Greater than 25 Acres	Prime Agricultural Soils	Classes I–IV
Scenario 4: Population Boom	No APZ			
Scenario 5: Megadrought	Top commodity crops and dairy agriculture	Greater than 40 acres	Prime Agriculture Soils	Classes I–IV
Scenario 6: Happy Valley	Top commodity crops and dairy agriculture	Greater than 40 acres	Prime Agriculture and Transitional Soils	Classes I–IV

A solution suite of APZ boundaries per each scenario was generated using ESRI's weighted raster overlay tools [44] (Table 1). Weights for suitability analysis were designated from interviews and workshops with stakeholders. Weights were then applied to the weighted raster overlay to indicate a range from suitable to less suitable areas for APZ delineations (Table 2). These delineations were used to process a 'Composite APZ Analysis'.

Table 2. The table below demonstrates weights produced within the suitability analysis. Columns depict the weights and criterion utilized for analysis, and rows depict each variation of change in the suitability analysis.

Weights	Crops Allocated	Minimum Acreage	Soils of Importance	Land Capability Classification
1	Top Commodity Crops	-	Soils of Statewide Importance	-
2	-	-	-	Class IV
3	Top commodity crops and community importance	Greater than 25 Acres	Prime Agricultural Soils	Class III
4	-	-	-	Class II
5	Top commodity crops and dairy agriculture	Greater than 40 Aces	Prime Agriculture and Transitional Soils	Class I

3. Results

3.1. Composite APZ Analysis Outputs

To create a composite of all identified APZ areas, the weighted raster overlays were combined into a single raster with an associated gradient to define areas of aligned APZ boundaries (Figure 3). This analysis identified the most common areas for APZ designation, used later for consensus generation among the stakeholders.

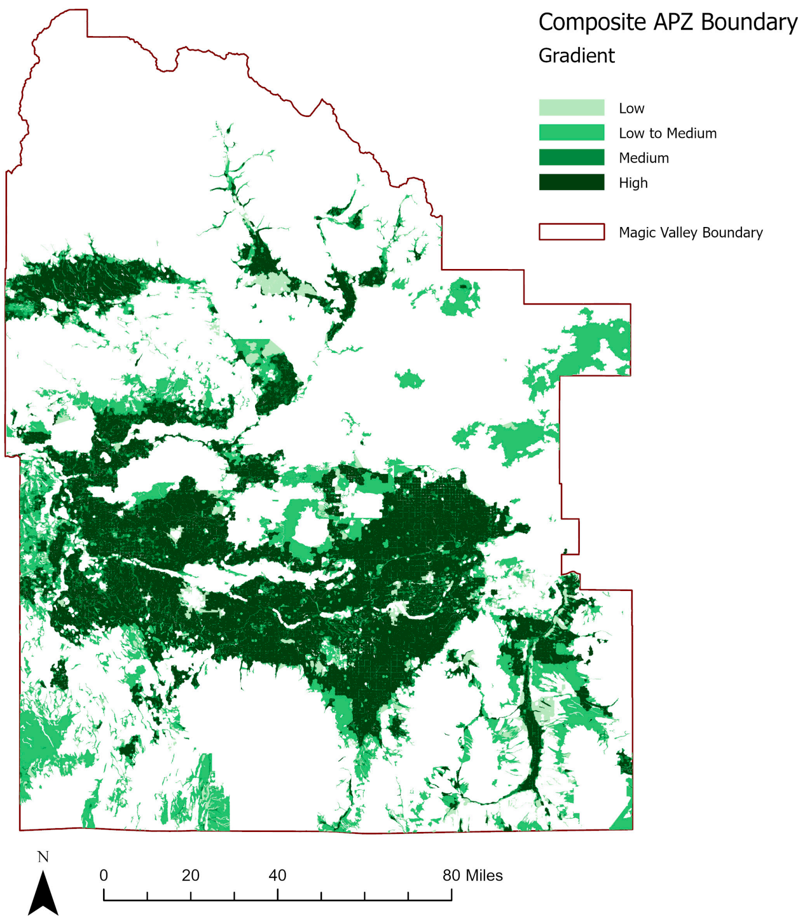

Figure 3. This diagram illustrates the outputs of the top 4 suitable areas from the combined APZ boundaries across the FEWs scenarios. The values represent a gradient of high- to low-impact areas.

This 'Decision Model' (Figures 2 and 3) as presented through the Composite APZ Output demonstrates a range of areas which can provide policy delineations for agricultural protection in a range of various scenarios. For example, within a 'Megadrought Scenario', areas designated as 'high' and 'medium' can be preserved to protect the integrity of the systems, whereas within a 'Happy Valley Scenario', 'high–low' designations fall within the APZ boundary.

Table 3 identifies how many acres fell into each of the four categories of APZ agreement across the scenarios.

Table 3. The following table depicts the four values (low to high) generated from the composite APZ boundary.

APZ Agreement	Acres (Area)	Hectares (Area)
Low	201,629.23	81,596.45
Low to Medium	819,833.96	331,775.03
Medium	183,586.32	74,294.75
High	1,362,596.23	551,423.13

3.2. APZ Suite and Composite APZ Output Comparison

Comparing the scenario-defined APZs and the composite APZ suggests that the scenario-specific APZ boundaries, validated by stakeholders and processed through suitability analysis, are proportionally larger than the composite APZ impact areas (high- to low-priority areas) (Figure 4). A 'Low to Medium' category was included to capture the large amount of intermediate acreage which fell between the adjacent categories.

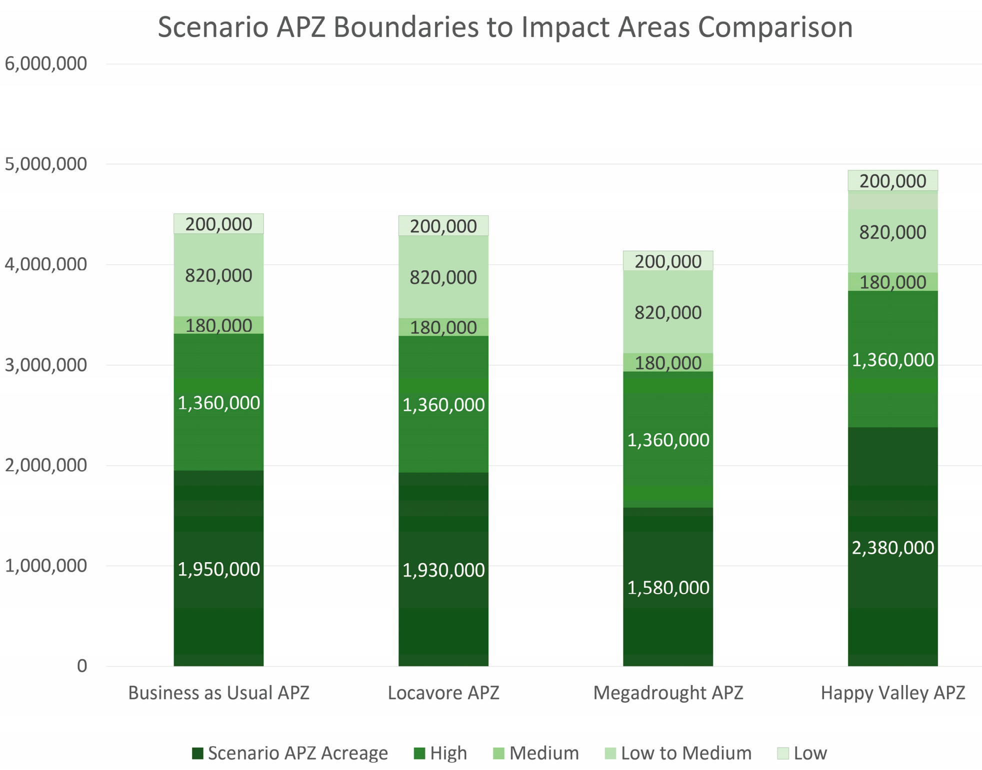

Figure 4. Scenario APZ boundaries compared to High-Impact to Low-Impact Areas derived from the Composite APZ.

The comparison of the scenario-specific APZ boundaries to the composite APZ evaluation demonstrates that each agricultural protection zone allocated will conserve both areas, denoted as being a 'High-Impact Area' and 'Medium-Impact Area' within the Composite APZ outputs combined (Figure 5). In short, 'Low to Medium' and 'Low' impact areas in a scenario with a high likelihood of drought (e.g., Megadrought scenario) or reliance on local agriculture (e.g., Locavore scenario) may be removed from the agricultural protection zone by decision-makers based on impact. Providing a gradient of high-priority APZ to low-priority APZ defines areas due to crop rotation, changes in land use planning and zoning, and changes in ownership and/or water rights allocations [47] which, in turn, may help to prioritize decision-making under various circumstances related to the scenario conditions.

These results provide significant guidance for decision-making through an applied framework for denoting various scenario allotments for the protection of agricultural areas and an evaluation of these results by way of comparison to a composite suitability analysis. Application of similar scenario-based Geodesign frameworks [21] can provide improvements to local and regional understandings of landscape systems, implications of planning, and the potential impacts of decision-making through the purview of other scenarios, or alternative futures. The results of this project intend to provide evidence of the application of the Geodesign framework [21] to address agriculture protection and conservation by (a) understanding system processes (Process Models), (b) denoting nuance through scenario specific modeling efforts (Change Models), (c) evaluating impacts across all scenarios, and (d) activating these impacts into a geospatial solution gradient (Decision Models).

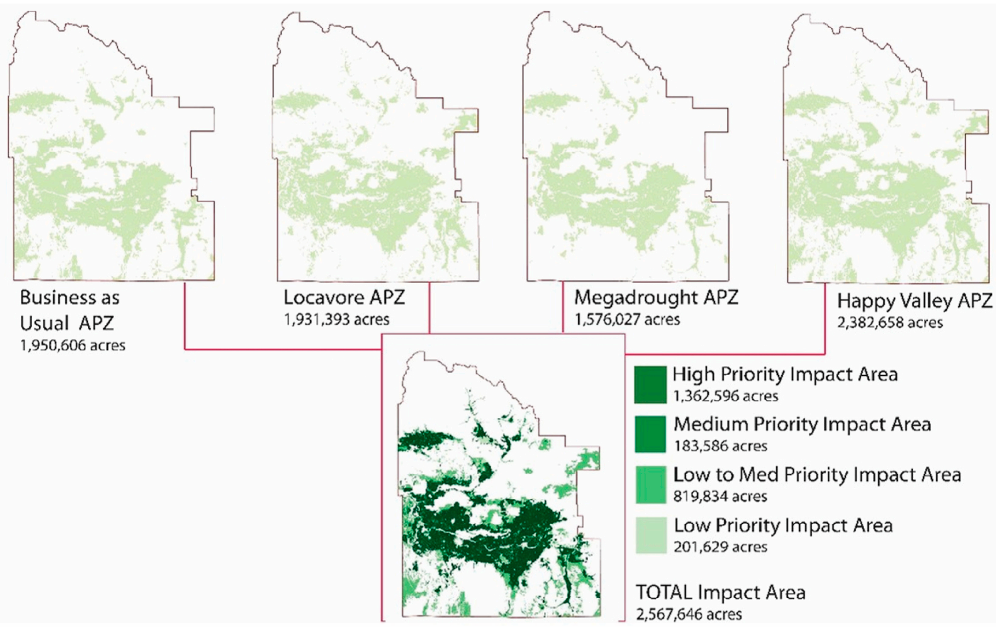

Figure 5. This representation further illustrates the process of comparing the APZ boundaries geospatially with the High-Priority Impact areas to Low-Priority Impact Areas derived from the composite APZ.

4. Discussion

4.1. Solutions for Agroecological Systems in Magic Valley

Defining challenges indicated by stakeholder groups through participatory action research projects allow for co-creation of knowledge recognized in land suitability in agroecology as well as agroforestry [48–50]. Furthermore, solutions from participatory action research integrated in agroecology relies on two key principles which were applied in this FEWS project [51]: (a) address barriers limiting agroecological planning practices, and (b) assess the performance of agroecological management strategies. These objectives were achieved through the application of an iterative framework for development and impact measurement of solutions. The research developed through this methodology demonstrates this process for solution development through the APZ solution set and the geospatial composite APZ as an impact indicator.

4.2. Magic Valley INFEWS Agricultural Protection Zone Gradient

The outcomes of applying the suitability analysis combined with an outcome metric composed of an analytical approach (composite APZ) of all alternative futures circa 2050 were used to generate a possible APZ gradient. Similar approaches to creating geospatial policy and structural solutions can be applied to projects with similar conditions utilizing stakeholder input to guide solutions. As utilized in the project, modeling through a Geodesign Framework [21] can be applied as a formalized methodology to activate stakeholder input into qualitative responses to critical issues on the landscape and in planning policy. However, a critical component is the integration of stakeholder feedback into the process iteratively. Stakeholder responses to validate and demonstrate (a) the likelihood of potential futures, (b) solutions to critical issues, and (c) criteria for suitability of solutions aid within the scenario planning and development process. Without this input, validity of the project and solutions, such as the APZ delineations, may remain hindered in plausibility and viability to local decision-making and planning.

4.3. Planning and Zoning Impact within the Rural–Urban Interface

Within the state of Idaho, the RUI remains an annex for various planning strategies such as AOCI expansion areas; however, incorporation of Conservation Overlay Districts [52] can protect land use conflicts through residential zoning for protection of areas such as conservation subdivisions [53]. Protection of key agricultural lands within these fringe areas can similarly be achieved with APZ suitability mapping and feasibility indices co-created through a Geodesign framework [21].

5. Conclusions

5.1. Lessons Learned

With the onset of rapid development, areas experiencing land use conflict require tools to understand and adapt to changes that may occur in their agroecological systems. Scenarios and embedded solutions can provide these tools. Within the context of FEWS, SES, and participatory scenario planning, solutions are seldom incorporated or adopted into the scenario or model development [7]. This project provides a demonstration of a framework for replicability as well as a solution example embedded within the scenario process. The methodology and results in this study indicate that the proposed APZ across scenarios may work to support a gradient of possible changes at the landscape scale (e.g., Magic Valley, Idaho). Suitability mapping for the delineation of geospatial policy solutions evaluated through a composite of scenario possibilities can be used as an evaluation tool for land use solution suitability and feasibility analysis. Further analysis is needed to test specific variables; however, cross-scenario analyses can indicate the impacts elucidated through stakeholder input for a complex SES. Similar frameworks utilizing stakeholder-informed and scenario-based models can potentially be used to guide decision-making for various solutions for similar projects facing land use conflicts with agriculture and urban growth.

With regards to our initial research question as well as our research objectives, the Geodesign framework can incorporate stakeholder feedback as a primary driver to inform scenario development as well as informed solutions. Through the evaluation, we were able to comparatively analyze findings from each Magic Valley APZ scenarios (Business as Usual, Megadrought, Locavores, and Happy Valley) by way of a weighted overlay. The results explain proportions of land which may vary in agriculture protection through low water, decreased precipitation, and high development trends, however a consensus was formed over larger proportions of the region. These results indicate that predominately prime agriculture under the assumptions of any climate change and/or development trend should be protected. The process developed, validated, and the embedding solutions provides viable possibilities for a region undergoing conflict within the RUI in regard to agroecology. Specifically, this framework depicts a solution set for agricultural protection within a range of climate change scenarios. Stakeholder assumptions and validation of effective solutions for each scenario are germane to a Geodesign framework, and this project demonstrates this informed and iterative ground truthing. In terms of replicability, stakeholder collaboration and engagement are central to envisioning plausibility and potential solution adoption [6,7,54]. The research within this study proves a transferable framework for projects with similar conditions and needs.

5.2. Broader Impacts

The results indicate a plausible response to the need for a significant set of solutions which can protect agricultural land use under the assumptions of specific scenarios. The solutions and framework proposed in this project intend to inform policy makers, planners, developers, and landscape architects about the efficiencies of various APZ delineations under the assumptions of stakeholder-informed scenarios. These outputs depict modeled landscape change with the application of an APZ solution.

Furthermore, the methodology presented in this paper provides a transferable geospatial evaluation of stakeholder-informed solutions across various alternative futures and scenarios of agroecological change. This research intends to contribute to the body of knowledge in complex adaptive management in SES [55,56] research through participatory methods through co-creation of stakeholder-informed, researcher-facilitated solutions to key challenges in the RUI for rural communities.

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Informed Consent Statement: All subjects gave their informed consent which was obtained from all subjects involved in the study.

Data Availability Statement: Publicly available datasets were analyzed in this study. This data can be found here: https://data.nal.usda.gov/dataset/cropscape-cropland-data-layer, accessed on 31 March 2023.

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