DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

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December 18, 2024

The Honorable Ronald D. Kouchi
President and Members
of the Senate
Thirty-Third State Legislature
State Capitol, Room 409
Honolulu, Hawaii 96813

The Honorable Nadine K. Nakamura
Speaker and Members of the
House of Representatives
Thirty-Third State Legislature
State Capitol, Room 431
Honolulu, Hawaii 96813

Dear President Kouchi, Speaker Nakamura, and Members of the Legislature:

For your information and consideration, I am pleased to transmit the Soil Classification Systems and Use in Regulating Agricultural Lands Study Final Report, prepared for the Office of Planning and Sustainable Development (OPSD) by Supersistence LLC.

This study was undertaken pursuant to Act 189, Session Laws of Hawaii 2022, which directed OPSD to conduct a study of the suitability of the Land Study Bureau (LSB) Soil Overall (Master) Productivity Rating System and other soil classification systems for the regulation of agricultural lands by the State and counties, and to submit a report of its findings and recommendations to the Legislature. An interim report was submitted to the Legislature prior to the 2024 legislative session.

The Final Report provides an evaluation of existing soil classification systems used in Hawaii, research on best practices from other jurisdictions, and recommendations for improving use of soil classification systems in regulating and managing agricultural lands in Hawaii that was developed based on the research and stakeholder and public outreach.

In accordance with Section 93-16, Hawaii Revised Statutes, I am also informing you that the report may be viewed electronically at: http://dbedt.hawaii.gov/overview/annual-reports-reports-to-the-legislature/.

Sincerely,

James Kunane Tokioka
DBEDT Director

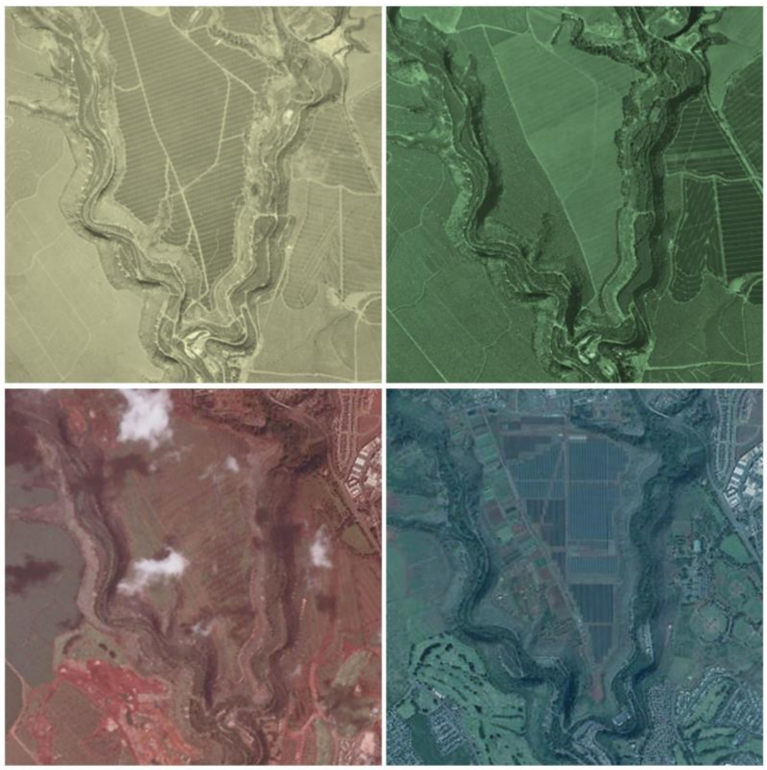
Enclosure

c: Legislative Reference Bureau

SOIL CLASSIFICATION SYSTEMS & USE IN REGULATING AGRICULTURAL LANDS STUDY

Final Report

November 2024



Prepared for:
State of Hawaiʻi | Office of Planning and Sustainable Development

Issued by:
Supersistence LLC

This project was requested and funded through an appropriation of the
Hawaiʻi State Legislature for a soil classification system study in
Act 189, Session Laws of Hawaiʻi 2022.

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ACRONYMS

AFT - American Farmland Trust

AGM - Agriculture and Markets

ALISH - Agricultural Lands of Importance to the State of Hawaiʻi

AML - Agriculture and Markets Law

ASR - Annual Soils Refresh

CEC - California Energy Commission

CEQA - California Environmental Quality Act

CFCP - California Farmland Conservancy Program

CIM - Cropland Index Model

COMAR - Code of Maryland Regulations

CTAHR - College of Tropical Agriculture and Human Resources

CUGIR - Cornell University Geospatial Information Repository

DBEDT - Department of Business, Economic Development and Tourism

DLNR - Department of Land and Natural Resources

EC - Electrical Conductivity

FAO - Food and Agriculture Organization

FMPP - Farmland Mapping and Monitoring Program

FPPA - Farmland Protection Policy Act

FPWG - Farmland Protection Working Group

GIS - Geographic Information System

gSSURGO - Gridded Soil Survey Geographic Database

HAR – Hawaiʻi Administrative Rules

HDOA – Hawaiʻi Department of Agriculture

HILT – Hawaiʻi Land Trust

HNRIS – Hawaiʻi Natural Resources Information System

HRS – Hawaiʻi Revised Statutes

IAL - Important Agricultural Lands

LCC - Land Capability Classification

LE - Land Evaluation

LESA - Land Evaluation and Site Assessment

LIM - Land Inventory and Monitoring

LLCP - Legacy Land Conservation Program

LSB - Land Study Bureau

LUC - Land Use Commission

LUNR - Land Use and Natural Resources

LURF - Land Use Research Foundation

MALPF - Maryland Agricultural Land Preservation Foundation

MALPP - Maryland Agricultural Land Preservation Program

MSG - Mineral Soil Group

MSRI - Modified Storie Rating Index

NALS - National Agricultural Lands Study

NASIS - National Soil Information System

NASS - National Agricultural Statistics Service

NRCS - Natural Resources Conservation Service

NYS - New York State

NYSDAGM - New York Department of Agriculture and Markets

NYSERDA - New York State Energy Research and Development Authority

OPSD - Office of Planning and Sustainable Development

PACE - Purchase of Agricultural Conservation Easements

RC&D - Resource Conservation and Development Council

REEIS - Research, Education, and Economics Information System

RES - Renewable Energy Standard

RSI - Revised Storie Index

SA - Site Assessment

SALUB - Statewide Agricultural Land Use Baseline

SAR - Sodium Adsorption Ratio

SC - Steering Committee

SCS - Soil Conservation Service

SI - Storie Index

SCS - Soil Conservation Service

SLH - Session Laws of Hawaiʻi

SSURGO - USDA-NRCS Soil Survey Geographic Database

TDN - Total Digestible Nutrients

UH - University of Hawaiʻi

USBR - United States Bureau of Reclamation

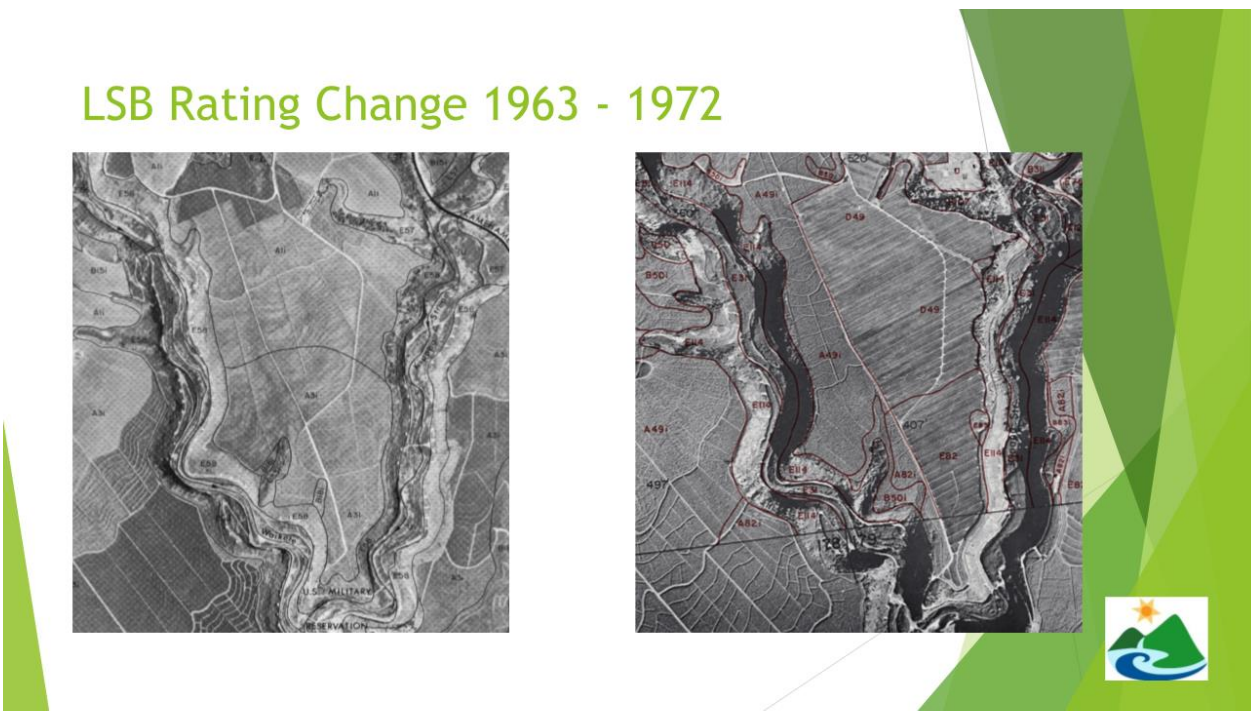
USDA - United States Department of Agriculture

I. Executive Summary

Whither Land Evaluation?

In the intricate tapestry of Hawaiʻi's land use, an area in the ʻEwa moku of Oʻahu offers a revealing glimpse into how land classification and governance has evolved from the ahupuaʻa—Hawaiʻi's original land evaluation system—through plantation agriculture to modern development pressures. The traditional ahupuaʻa system classified and managed land by recognizing the relationship between natural resources, considering the flow of water from mountain to sea. This parcel straddles the ahupuaʻa of Waikele on the west and Waipiʻo on the east—a boundary that would later coincide with crucial differences in Land Study Bureau (LSB) classifications. These lands were originally part of the Hawaiian royal lands before being granted in the mid-19th century to Bennett Nāmākēhā and John Papa Īʻī, both prominent advisors to King Kamehameha III who served together on the Hawaiian Kingdom Privy Council. After Īʻī's death in 1870, much of his land was sold to Castle & Cooke, marking a shift from traditional Hawaiian land management to plantation-era agriculture.

Following the overthrow of the Hawaiian Kingdom, Western approaches to land evaluation, like the 1895 Land Act, increasingly dominated land use decisions. By the mid-20th century, the Land Study Bureau emerged as the primary system for evaluating and classifying agricultural lands. However, as this report reveals, the LSB's snapshot-in-time evaluations have effectively locked Hawaiʻi's land use governance to particular moments in plantation history—in ways that sometimes inadvertently echo traditional land divisions.



Aerial imagery from 1951-1954 was used to plot the LSB's initial classifications released in the 1963 Detailed Land Report for Oʻahu. That 1951-1954 imagery shows the entire area of interest used for irrigated sugarcane, and LSB gave the area an 'A' rating. In 1955, the USDA released the first comprehensive soil type mapping of the islands, categorizing soil in both the east and west portions of this area as the same. However, by 1959 the entire area was used for pineapple. Despite this frequently shifting land use and crop cover, when the Oʻahu mapping was redone for the LSB's 1972 report, the soil classification created a stark divide that aligned with the ancient ahupuaʻa boundary—the west side (Waikele) was classified 'A,' while the east side (Waipiʻo) was rated 'D.' This distinction arose from a change in irrigation based on crop selection, with the west area still irrigated and used for sugarcane, while the east area was cultivated in pineapple and no longer irrigated.

The lasting impact of this classification divide mirrors the traditional ahupuaʻa boundary today: the Waikele portion is now the Mililani Agricultural Park while the Waipiʻo portion houses a solar energy facility developed across 131 acres. Thus, the mid-century crop selection captured in LSB ratings, by happenstance aligned with traditional land divisions, directly influenced whether these agricultural lands would be preserved or developed despite having similar soils.

This evolving narrative highlights a critical challenge: outdated land classifications persist in regulatory frameworks, often out of step with current agricultural realities. As Hawaiʻi faces increasing pressure to balance housing, energy development and food production, understanding the full history and future potential of its lands has never been more urgent. This report delves into the ways past practices continue to influence modern land use decisions—and how new approaches can better align our understanding of land productivity with present and future needs.

These legacy classifications not only obscure the true potential of Hawaiʻi's lands but also complicate efforts to adapt to modern agricultural and land development needs, representing a dramatic departure from the holistic resource management principles of the ahupuaʻa system.

This report explores how these historical systems, though originally designed to support sustainable land use, now constrain Hawaiʻi's ability to respond to contemporary challenges like food security and renewable energy development. It is thus essential to reassess how land and productivity are evaluated, revising outdated frameworks into modern systems that reflect Hawaiʻi current and future needs.

PROJECT ORIGIN

Hawaiʻi's agricultural lands are vital to the State's economy, food security, and cultural heritage. In the mid-20th century and onwards, land evaluation systems were developed to classify and map the productive potential of agricultural lands across the islands, evaluating factors like soil properties, slope, drainage, climate and crop suitability to categorize lands for agricultural productivity. These systems, while focused on soil properties, incorporated broader land evaluation principles by considering multiple factors beyond just soil, such as topography, climate, and productivity to assess the overall capability of land for agriculture. The resulting maps and data have served as important inputs for land use regulation and policymaking aimed at preserving productive agricultural lands and guiding development. However, these systems are increasingly outdated, lacking routine updates they fail to capture drastic changes in Hawaiʻi's economic, social, and agricultural landscapes, which limits their utility for contemporary planning and decision-making.

Act 189 (SLH 2022)

Act 189 (Session Laws of Hawaiʻi 2022) directed the Office of Planning and Sustainable Development to conduct a study of the suitability of the Land Study Bureau soil overall (master) productivity rating system and other soil classification systems in the regulation of agricultural lands and make recommendations for the use of soil classification systems in regulating use of agricultural land.

The first statewide soil classification study was conducted by the Land Study Bureau of the University of Hawaiʻi (LSB) from the early 1960s through 1972. Lacking other means to differentiate between more productive and less productive lands in the State Agricultural District, the LSB ratings were incorporated in Hawaiʻi Revised Statutes (HRS), §§ 205-2 and 205-4(b) as an attempt to limit permissible uses on the best lands to primarily agricultural activities. This classification system remains the master reference for the regulation of lands in the State Agricultural District by the State and counties in HRS, Chapter 205. Act 189 is partly in response to concerns expressed by landowners and government land use regulators over the lack of a means to update or amend LSB soil ratings.

In addition to the LSB rating system, there are other soil classification and productivity rating systems currently in use. The State also uses the Agricultural Lands of Importance to the State of Hawaiʻi (ALISH) to rate the quality of agricultural lands. The U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) maintains detailed information on Hawaiʻi soils as part of its national soil survey and soil classification system, which is regularly updated by NRCS. The United States Department of Agriculture's soils survey and classification system and its Soil Survey Geographic database (SSURGO) is also the reference dataset for many of the United States Department of Agriculture's programs. The federally initiated Land Evaluation and Site Assessment (LESA) rating system also evaluated a parcel's relative agricultural importance.

Project Team

The study was conducted by Supersistence LLC with support from a contractor team including G70, Plasch Econ Pacific, and Stantec, with guidance from OPSD and the Steering Committee comprised of representatives from the Department of Agriculture, the University of Hawaiʻi College of Tropical Agriculture and Human Resources, and the Land Use Commission.

STUDY APPROACH

Although titled the "Soil Classification Systems & Use in Regulating Agricultural Lands Study," following language used in Act 189 (SLH 2022) and the resulting solicitation and contract, the study primarily examined land evaluation systems. While soil classification focuses on categorizing and describing soil properties such as texture, structure, and depth, land evaluation assesses those intrinsic soil characteristics as qualities that impact land uses, often with additional factors like topography, climate, and socio-economic conditions. Land evaluation thus assesses not only the current state of the land but also its broader potential for agricultural and other uses.

The Land Study Bureau's Overall (Master) Productivity Rating, for instance, while commonly referred to as a soil classification system, is more accurately described as a land evaluation system. It considers not just soil properties but also factors like irrigation status and crop suitability to determine agricultural productivity ratings. Understanding this distinction is crucial as it shapes both the analysis of existing systems and the development of recommendations for future approaches to agricultural land use regulation in Hawaiʻi.

The investigation centered on four key objectives: to assess the strengths and weaknesses of the LSB and other soil classification systems, including how they are updated to reflect changing conditions; to understand how decision-makers and stakeholders use the current classification system; to identify and learn from best management practices in other jurisdictions that use soil classifications systems to guide their agricultural land regulation; and to develop recommendations on soil classification systems and their role in agricultural land use regulation.

The team conducted extensive research on existing soil classification systems (LSB, ALISH, LESA, SSURGO) to understand their methodologies, strengths, and limitations (Section III). This assessment revealed that each system had a unique approach and varying degrees of detail and accuracy. The research team evaluated and rated existing systems based on a set of criteria developed to assess their effectiveness and relevance to modern agricultural practices. This systematic evaluation highlighted the strengths and weaknesses of each system, which later informed potential improvements (Section IV).

The team created overlay maps to visualize the geographic coverage and distribution of the various soil classifications across the state (https://arcg.is/1T99X0). These maps helped identify areas of overlap and gaps in coverage, which aided in the analysis of system effectiveness and potential integration opportunities. The team compiled and reviewed relevant state and county regulations pertaining to agricultural land use and soil classification (Section V). This analysis revealed inconsistencies and potential conflicts between different regulatory frameworks, which informed recommendations for harmonization.

The team gathered stakeholder input through the steering committee, focus groups, county meetings, and an online forum (Section VI). This initial engagement ensured that diverse perspectives were considered in the preliminary analysis. An Interim Report was submitted to the 2024 legislative session, which provided a preliminary overview of the study's activities and findings to date and set the foundation for subsequent research and analysis.

The team researched and analyzed agricultural land evaluation approaches from three jurisdictions (California, Maryland, and New York) to identify transferable practices and methodologies (Section VII). Initial recommendations were developed based on the research findings, best practices, and initial stakeholder input (Section VIII). The team conducted a second round of extensive stakeholder consultations through focus groups, one-on-on follow-ups, and a public meeting. These sessions were used to present the initial recommendations, gather feedback, and engage in collaborative dialogue to refine the proposed solutions, leading to the development of the final recommendations (Section X).

FINDINGS

Key findings highlighting the issues the recommendations aim to address:

- **Outdated Land Classification System**: The current Land Study Bureau (LSB) model is based on data and methodologies from the 1960s and 1970s, which fail to reflect Hawaiʻi's contemporary agricultural landscape, economic conditions, and soil science advancements. This limits the model's effectiveness in supporting accurate, data-driven agricultural policy and land-use decisions.
- **Lack of Historical and Current Land Use Data**: The existing LSB model does not consider the effects of historical land use impacts or current data on aspects like irrigation, which are essential for understanding long-term soil quality and crop potential. This omission restricts the model's ability to assess land suitability comprehensively and misses insights into infrastructure that could support sustainable land use.
- **Static and Inflexible Framework**: The LSB model is static, providing a snapshot that doesn't accommodate shifting agricultural needs, emerging crop potentials, or environmental changes. This inflexibility hinders Hawaiʻi's ability to respond to market demands and climate variability, limiting proactive agricultural planning.
- **Limited Public and Stakeholder Input**: There is currently little opportunity for local stakeholders to participate in the classification process or provide feedback on land suitability, which reduces transparency and can lead to decisions that don't fully align with community needs or on-the-ground realities.
- **Inconsistent Parcel-Level Classifications**: Classification disparities at the parcel level create inaccuracies that can misrepresent land productivity. Adjacent parcels, even with similar soil types, may be rated differently over time due to irrigation or infrastructure changes, which the current model cannot accurately capture.
- **Lack of Routine Updates**: The absence of a mandated update framework means the LSB model cannot keep pace with changes in agriculture, environmental conditions, or advancements in soil science. This lack of routine updates has led to the system's current state of obsolescence, limiting its relevance in planning and policy.
- **Outdated and Inconsistent Regulatory References**: Existing regulations and policies refer to various outdated soil classification systems, creating inconsistencies and confusion in land-use planning. This misalignment between policy and modern agricultural needs weakens the effectiveness of the regulatory framework in promoting sustainable land management practices.
- **Ambiguity in Classification References**: Some regulations do not specify which soil classification system to use, leading to discrepancies and potential regulatory conflicts. This ambiguity complicates the implementation of consistent land-use policies and creates barriers to unified agricultural planning across Hawaiʻi.

These findings underscore the need for a comprehensive update to the LSB model, integration of current and historical data, a more adaptable and transparent classification process, and clear regulatory alignment.

RECOMMENDATIONS

The **seven core recommendations** in order are:

- Update the Land Study Bureau (LSB) Land Classification Model
- Assess Integrating Historical and Current Land Use into LSB Model Update
- Analyze Sustained Land Productivity with Strategic Crops and Public Tools
- Refine Updated LSB Model Outputs through Participatory Map Review
- Mandate Routine Map Updates and Model Revisions
- Update Outdated Classifications in Regulations
- Clarify Classification References in Regulations

CONTEXT AND RATIONALE

Details, including context and rationale for each recommendation, are provided below. The context outlines the intent, process, and specific issues each recommendation addresses, while the rationale draws on research findings, stakeholder feedback, and best practices from other jurisdictions. Where applicable, references to relevant sections of the report link recommendations directly to detailed findings, guiding readers to pertinent sections and situating each recommendation within Hawaiʻi's unique agricultural and regulatory landscape. Together, these recommendations lay the foundation for an updated, adaptable soil classification system, with the goal of making it a valuable resource for sustainable agricultural planning and informed decision-making across the state.

1. Update the Land Study Bureau (LSB) Land Classification Model

The cornerstone recommendation is to update the Land Study Bureau (LSB) land classification model. This foundational step is crucial for creating a modern, accurate, and dynamic system for evaluating agricultural land in Hawaiʻi.

The current LSB model, last updated in the 1960s and 1970s, no longer accurately reflects the state's current agricultural landscape. Our research, detailed in Section III of the study, reveals that the existing system is based on outdated data and methodologies that do not account for significant changes in agricultural land use patterns, environmental conditions, soil science, or best practice in land evaluation over the past half-century. This outdated system compromises the state's ability to make informed decisions about land use and agricultural policy.

The LSB model should be updated to a dynamic, statewide system that retains the familiar LSB title and A to E output classes. This approach balances the need for modernization with the benefits of continuity, addressing concerns raised by stakeholders during outreach efforts (as detailed in Section VI). By maintaining the familiar LSB framework while updating its underlying data and methodologies, disruption to existing policies and statutes can be minimized while significantly improving the accuracy and relevance of the system.

The updated model would integrate the latest USDA Natural Resources Conservation Service (NRCS) soil data, current agricultural land use information, and other relevant factors. This integration would provide a more comprehensive and accurate assessment of land suitability for agriculture. Importantly, the update would expand the classification system to provide statewide coverage, addressing a significant limitation of the current system.

While this update represents a significant undertaking, our research into best practices from other jurisdictions (detailed in Section VII) suggests that such comprehensive updates are both feasible and highly beneficial. States like

California and New York have successfully implemented similar updates to their soil classification systems, resulting in more effective land use planning and agricultural policy.

By updating the LSB model, Hawaiʻi will lay the groundwork for more informed, data-driven decision-making in agricultural land use. This updated system will serve as the foundation for the subsequent recommendations, each of which builds upon and extends the capabilities of this modernized LSB model.

2. Assess Integrating Historical and Current Land Use into LSB Model Update

The second recommendation emphasizes the need to thoroughly assess the potential effects of integrating historical and current land use data into the updated Land Study Bureau (LSB) model.

The current LSB model has significant limitations due to its lack of historical data and insufficient current use information, such as outdated irrigation extent as detailed in Section III. Without these details, the model may overlook valuable insights regarding soil conditions, crop suitability, and existing infrastructure that may not be evident from soil data alone.

Incorporating both historical and current land use information addresses these gaps by providing a more comprehensive understanding of land potential and value over time. This integration allows for a nuanced approach that may enable the system to effectively reflect the long-term value and impacts of land use without inadvertently limiting future use possibilities.

Research into best practices from other jurisdictions (detailed in Section VII) suggests that incorporating historical context, particularly use history impacts on soil quality, into land classification systems can lead to more informed and sustainable land use decisions. Additionally, research detailed in the review of existing systems (Section III) suggests that historical irrigation extent is outdated. This approach could balance the value of historical context with contemporary agricultural realities, addressing stakeholder concerns (detailed in Section VI).

Ultimately, integrating this broader dataset aims to enhance the LSB model's ability to provide a more comprehensive and contextually rich system for evaluating agricultural land. Revising the LSB model through this integration not only enriches its evaluation capabilities but also aligns Hawaiʻi's land management practices with both past and present realities, fostering more sustainable and informed agricultural development.

3. Analyze Sustained Land Productivity with Strategic Crops and Public Tools

The third recommendation advocates for a forward-looking approach to land classification by incorporating crop suitability modeling and developing accessible public tools. This enhancement is essential to refine the Land Study Bureau (LSB) model, making it more adaptive and responsive to Hawaiʻi's diverse agricultural landscape and evolving needs.

Currently, the LSB model relies on static assessments that may miss emerging opportunities or challenges in crop selection and land management, limiting its effectiveness in evaluating shifts in agricultural potential. Moreover, the lack of transparency in the existing framework restricts stakeholders' ability to understand, influence, and make informed decisions about agricultural land use. Without a robust, dynamic system for evaluating diverse crops and land-use potentials, Hawaiʻi's capacity to optimize agricultural productivity and respond to changing environmental and market conditions remains limited.

This recommendation proposes integrating a comprehensive crop suitability analysis within the LSB model, drawing on data such as soil quality, water resources, and climate projections to assess both current and future crop viability. This approach would generate detailed suitability maps that visualize potential productivity across varied land parcels, providing clear, accessible insights for producers, land managers, and the public. By making these maps publicly available and including decision-support tools, the updated model would empower stakeholders to evaluate land suitability for diverse crops and land uses, fostering a more data-informed approach to agricultural planning. These and similar data on other agricultural land use types could be aggregated, akin to the original LSB approach (Section III), into overall ratings.

Drawing from best practices, such as those observed in New York's crop-specific analysis model (Section VII), and informed by stakeholder outreach (Section VI), this dynamic approach will support proactive land use planning and policy-making. Integrating feedback from community stakeholders—emphasizing native and high-value crops suited to Hawaiʻi's ecosystems—ensures that the LSB model reflects both technical data and local knowledge.

In summary, this update will transform the LSB model into a transparent, user-friendly decision-support tool that merges scientific insights with community perspectives. It will offer Hawaiʻi's agricultural community a valuable resource for sustainable land management, aligning technical assessments with the diverse needs of local producers and supporting resilient agricultural planning across the state.

4. Refine Updated LSB Model Outputs through Participatory Map Review

The fourth recommendation emphasizes a stakeholder-driven review process for the updated Land Study Bureau (LSB) model outputs. This participatory approach will involve agricultural producers, land managers, and community members in reviewing draft classification maps, allowing local insights and expertise to guide the development of an accurate, practical, and locally relevant land classification system for Hawaiʻi.

As reflected in Section III (Evaluation of Existing Soil Classification Systems) and stakeholder concerns (Section VI), parcel-level classification disparities can create confusion and inaccuracies for users. Even within similar soil types, adjacent parcels might develop different ratings over time, over- or underestimating productive capacity due to changes in irrigation availability. This issue is exacerbated due to limited access to and understanding of the historical data used to generate these ratings.

Updated LSB model outputs should be refined through a Participatory Map Review. Along with highlighting the need for an updated, more accurate classification system that considers current conditions, refining model outputs through public review and input on draft output maps can enhance the accuracy and credibility of land classification systems. This approach balances the need for scientific rigor with the importance of local expertise, addressing concerns raised by stakeholders during outreach efforts (Section VI).

The need for a participatory map review process arose from stakeholder concerns about parcel-level classification disparities, which call for a systematic and equitable approach to land evaluations, while mitigating the risk of system manipulation that could lead to impermissible land uses. By allowing public input on draft maps, this approach aims to enhance transparency, ensure consistency, and identify errors before finalizing maps, thus strengthening the classification system's utility and integrity.

A participatory map review process can address these issues by integrating community and expert feedback into the updated model. This approach will enhance scientific rigor with local knowledge, ensuring that draft classification maps reflect current agricultural conditions and Hawaiʻi's unique agricultural needs. Through facilitated workshops and feedback sessions, participants could provide input on crop and land-use suitability maps, helping to refine the model outputs based on practical, on-the-ground considerations.

By refining the LSB model outputs through a stakeholder-driven map review, Hawaiʻi will benefit from a classification system that is transparent, credible, and tailored by local knowledge. This improved model will serve as a valuable tool for policymakers, farmers, and land managers, enabling more informed and equitable land-use decisions that benefit from a reproducible model enhanced by local knowledge.

5. Mandate Routine Map Updates and Model Revisions

The fifth recommendation focuses on establishing a framework for routine updates and revisions of the Land Study Bureau (LSB) model. This step is crucial to ensure that the modernized land classification system remains relevant, accurate, and responsive to Hawaiʻi's evolving agricultural landscape over time.

While the LSB intended to conduct periodic updates to its land classifications, the agency was defunded in 1974, preventing these updates from being implemented (Section III), leading to obsolescence over the decades. As detailed in Section IX, stakeholders shared concerns that a static classification system could not effectively respond to the dynamic nature of agricultural practices, environmental changes, and technological advancements. This gap indicates a pressing need for a more flexible and contemporary approach.

The recommendation proposes a mandated schedule for routine updates and reviews, ideally supported by statutory measures. This framework would ensure that new data and methodologies are systematically integrated, and addresses stakeholder concerns about the necessity of balancing stability in land use planning with adaptability, as discussed during outreach efforts (Section VI and IX). By implementing a routine update process, the LSB model can remain a valuable decision-making tool amid changing climatic, economic, and agricultural conditions.

The update model could include automated data inputs such as the NRCS's Annual Soils Refresh of SSURGO. This would seamlessly integrate the latest soil and environmental data and allow for real-time adjustments to the model, maintaining its accuracy and relevance for land use and agricultural policy decisions.

While establishing a system for routine updates represents an ongoing commitment, our research into best practices from other jurisdictions (detailed in Section VII) suggests that such regular revisions are essential for maintaining an effective land classification system. States like California and New York have successfully implemented similar update frameworks, resulting in classification systems that remain responsive to changing environmental and agricultural conditions.

By mandating routine map updates and model revisions, Hawaiʻi will ensure that its land classification system remains a reliable and adaptable tool for agricultural planning and policy-making. This approach will safeguard the relevance of the LSB model, enabling it to continue serving as a valuable resource for farmers, policymakers, and planners in the face of evolving agricultural needs and environmental conditions.

6. Update Outdated Classifications in Regulations

The sixth recommendation emphasizes the need to replace outdated classifications in regulations with the modernized Land Study Bureau (LSB) model. This transition is crucial for ensuring consistency and accuracy in land use decision-making, thereby enhancing the effectiveness of the updated LSB model across jurisdictions.

Research on Soil Classification Systems References in State and County Codes and Regulations (Section V) reveals that current regulations include outdated references to soil classification systems. This can lead to unintended consequences, such as misallocated resources and policy mismatches, compromising the state's ability to make informed decisions about land use and agricultural policy.

To address this issue, the recommendation proposes transitioning to the updated LSB model across all levels of land use policy. Aligning regulations with the updated LSB classification can provide a cohesive framework that supports a unified statewide approach to agricultural land management with the benefits of using the most current and accurate data.

7. Clarify Classification References in Regulations

The seventh recommendation focuses on amending Hawaiʻi's land use regulations to ensure clear and consistent references to the updated Land Study Bureau (LSB) model. This critical step is essential for preventing confusion and inconsistency in the application of soil classifications across jurisdictions.

Some current regulations refer to soil classifications without specifying which system should be used, leading to potential disparities in policy interpretation (Section V). This lack of clarity can create regulatory conflicts and inefficiencies, inhibiting the state's ability to implement consistent land use policies.

To address this issue, the recommendation proposes to amend regulations to explicitly reference the updated LSB model where soil classifications are required. This approach balances the need for regulatory precision with the benefits of a unified classification system, addressing concerns raised by stakeholders during our outreach efforts. Providing clear classification references can enhance regulatory transparency and ensure uniformity in land classification applications across agencies and counties.

The amendment process would involve reviewing existing regulations to identify all instances where soil classifications are mentioned, then updating these references to specifically cite the LSB model. This effort simplifies the application of soil classifications for all stakeholders, including agricultural producers and county planners, by providing a standardized reference point.

CONCLUSION

The evolution of Hawaiʻi's land classification and governance—from the holistic resource management of the ahupuaʻa system to the plantation-informed Land Study Bureau (LSB) model—demonstrates the enduring need for adaptive land governance. The current land evaluation systems, developed with mid-century plantation-era data, now lag behind the diverse agricultural needs of Hawaiʻi. These systems fail to reflect contemporary realities, like climate variability, shifting market demands, and the unique potential of Hawaiʻi's lands. A revitalized, data-driven approach to land evaluation would better guide land-use policy in Hawaiʻi.

Implementing an effective, modernized land evaluation system for Hawaiʻi requires a balanced approach that integrates advanced technology, historical context, and community insight. Key considerations include ensuring flexibility, transparency, and routine updates while avoiding rigid, static frameworks that limit adaptability.

First, a successful implementation hinges on creating a system that is dynamic and responsive to Hawaiʻi's rapidly evolving land use. Findings indicate that the current Land Study Bureau (LSB) model's static nature limits its relevance, as it cannot accommodate changes in climate conditions, soil science, or agricultural production. To address this, the modernized system must support regular data updates and adapt to reflect contemporary and future agricultural realities. Routine updates should be prioritized, with statutory support to ensure they remain a consistent part of the process rather than occasional adjustments.

Transparency and community engagement are also essential. Findings show that outdated, inflexible classifications and limited stakeholder understanding and input have contributed to a lack of trust and alignment between land use policies and community needs. Implementing a participatory review process—where local farmers, community members, and land managers can provide input on crop suitability assessments and draft classifications—will enhance the system's credibility and relevance. This collaborative element will help align the system with Hawaiʻi's agricultural landscape while addressing local insights that existing classifications overlook.

The findings underscore the pitfalls of relying on mid-century data and classification systems that freeze land evaluations in outdated contexts, as demonstrated by mismatched parcel classifications that persist today. Instead, the updated system must integrate both historical and current data, including productive potential under ideal conditions like irrigation presence while considering the effects of previous land uses, to ensure a comprehensive view of each area's capability.

Finally, regulatory alignment is key. Outdated references and ambiguous classification standards within current regulations create inconsistencies that weaken land use policy. Aligning updated classifications with regulatory frameworks across state and county levels will ensure that land use policies are grounded in accurate, up-to-date data.

By focusing on adaptability, community involvement, and regulatory coherence, the implementation of a modern land evaluation system will not only reflect Hawaiʻi's unique agricultural needs but also provide a resilient foundation for future growth. With careful attention to these principles, Hawaiʻi's land use policies can transition from static assessments to a forward-looking, sustainable approach that supports both agricultural productivity and resource preservation for generations to come.

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II. INTRODUCTION

Agricultural land classification systems have played a critical role in protecting and managing productive lands for food security, and economic development. In Hawaiʻi, these systems faced mounting challenges as agriculture evolved from historical plantation operations to diverse modern farming practices. This transformation raised important questions about how well existing classification approaches served current agricultural needs and future sustainability goals.

While the United States Department of Agriculture maintained and regularly updated detailed soil information through its national classification system, the state's primary regulatory framework remained rooted in plantation-era agriculture. Most remarkably, soil data collected in the 1930s, released in the 1950s, and incorporated into Land Study Bureau ratings in the 1960s continues to govern critical land use decisions - such as where solar energy projects will be established on agricultural lands in the 2030s. This system, which still serves as the master reference for regulating agricultural lands at both state and county levels, reflects an agricultural landscape dominated by sugar cane and pineapple plantations - a context markedly different from today's diverse agricultural sector.

Several other classification systems had been developed over time to identify and regulate Hawaiʻi's agricultural lands, each reflecting the agricultural understanding and priorities of its era. However, the rapidly changing nature of agriculture, continued pressures of urban and housing development, increasing agricultural land use for energy production, along with concerns about food security and sustainable land use, demanded a fresh examination of these tools.

To address these issues, Act 189 (Appendix A) of the 2022 Hawaiʻi State Legislature directed the Office of Planning and Sustainable Development (OPSD) to undertake a study of the Land Study Bureau's Overall (Master) Productivity Rating system and other soil classification systems used to regulate agricultural lands across Hawaiʻi. The goal of the study was to evaluate these systems and develop recommendations with consideration of their role in protecting the State's agricultural land resources.

The study was conducted by Supersistence LLC with support from a contractor team including G70, Plasch Econ Pacific, and Stantec, with guidance from OPSD and a Steering Committee comprised of representatives from the Department of Agriculture, the University of Hawaiʻi College of Tropical Agriculture and Human Resources, and the Land Use Commission.

The investigation centered on four key objectives:

1. To assess the strengths and weaknesses of the LSB and other soil classification systems, including how they are updated to reflect changing conditions.
2. To understand how decision-makers and stakeholders use the current classification system.
3. To identify and learn from best management practices in other jurisdictions that use soil classifications systems to guide their agricultural land regulation.
4. To develop recommendations on soil classification systems and their role in agricultural land use regulation.

Through this examination, the study aims to chart a path toward more effective agricultural land classification to support Hawaiʻi's evolving agricultural sector while safeguarding its most fundamental agricultural resource: productive land.

PROJECT OVERVIEW

The study's approach involved a two-phase process, capitalizing on the contractor team's diverse expertise in agricultural land evaluation, policy, economics, soil science, and stakeholder engagement. Phase I of the study was dedicated to comprehensive research and initial stakeholder outreach. This phase involved a multifaceted approach, including:

- **Soil Classification Systems Research:** The team conducted extensive research on existing soil classification systems (LSB, ALISH, LESA, SSURGO) to understand their methodologies, strengths, and limitations. This assessment revealed that each system had a unique approach and varying degrees of detail and accuracy.
- **Comparison of Current Systems:** The research team evaluated and rated existing systems based on a set of criteria developed to assess their effectiveness and relevance to modern agricultural practices. This systematic evaluation highlighted the strengths and weaknesses of each system, which later informed potential improvements.
- **Overlay Mapping:** The team created overlay maps to visualize the geographic coverage and distribution of the various soil classifications across the state. These maps helped identify areas of overlap and gaps in coverage, which aided in the analysis of system effectiveness and potential integration opportunities.
- **State and County Regulations:** The team compiled and reviewed relevant state and county regulations pertaining to agricultural land use and soil classification. This analysis revealed inconsistencies and potential conflicts between different regulatory frameworks, which informed recommendations for harmonization.
- **Initial Stakeholder Outreach:** The team gathered stakeholder input through the steering committee, focus groups, county meetings, and an online forum during Phase I. This initial engagement ensured that diverse perspectives were considered in the preliminary analysis.
- **Interim Report:** Phase I culminated in an Interim Report submitted to the 2024 legislative session, which provided a preliminary overview of the study's activities and findings to date, and set the foundation for Phase II activities.

Building on the foundation established in Phase I, Phase II shifted its focus towards the generation and refinement of actionable recommendations. This phase involved:

- **Best Practices Research:** The team researched and analyzed agricultural land evaluation approaches from three jurisdictions (California, Maryland, and New York) to identify transferable practices and methodologies.
- **Generating Recommendations:** Initial recommendations were developed based on the research findings, best practices, and initial stakeholder input. The team developed a comprehensive set of recommendations drawing upon insights from Phase I research, best practices identified from other jurisdictions, analysis of existing state and county regulations, and feedback gathered during initial stakeholder outreach.
- **Follow-Up Stakeholder Outreach:** The team conducted a second round of extensive stakeholder consultations through focus groups, community meetings, and a digital forum. These sessions were used to present the initial recommendations, gather feedback, and engage in collaborative dialogue to refine the proposed solutions.
- **Finalizing Recommendations:** The recommendations were refined based on the stakeholder consultations, ensuring they were both well-informed and aligned with stakeholder needs.
- **Final Report:** This Final Report presents the comprehensive activities and outcomes of Phases I and II, including detailed best practices from other jurisdictions, the complete recommendation development process, stakeholder feedback gathered through multiple rounds of consultations, and final recommendations.

This Final Report presents the outcomes of the Soil Classification Systems & Use in Regulating Agricultural Lands Study. The report builds on the research conducted in Phase I and provides an evaluation of soil classification systems used in agricultural land regulation in Hawaiʻi. The final recommendations presented here are the culmination of efforts from both Phase I and Phase II.

During the course of the project, a project website was maintained to provide background data on existing systems, overlay maps of those systems, links to public outreach forums, and selected recording of outreach events. As of November 2024, the website can be accessed at https://arcg.is/1T99X0. Where useful, slides from outreach events are included to provide graphic representation, summaries, or additional details. Full slide decks are accessible on the project website.

The iterative process of research, analysis, and stakeholder engagement ensured that the findings in this study are grounded in contemporary best practice, and reflect the diverse needs and perspectives of stakeholders. The primary objective of this study is to provide the State of Hawaiʻi with a set of robust and actionable recommendations that will support the effective regulation and preservation of its invaluable agricultural lands for generations to come.

A Note on Terms: Soil Classification and Land Evaluation

Although the title of the effort is "Soil Classification Systems & Use in Regulating Agricultural Lands Study," the study primarily reviewed what are more commonly known as land evaluation systems. While soil classification focuses on categorizing and describing soil properties, land evaluation assesses the broader suitability and potential of land for various uses, including agriculture. The convention established in Act 189 (SLH 2022), the project solicitation, and in the contract applies the term ‘soil classification’ for what is generally regarded as land evaluation. However, soil classification and land evaluation are two distinct yet interconnected fields essential for land management and planning.

Soil classification focuses on categorizing and describing directly measurable physical (e.g., texture, structure, color, depth), chemical (e.g., acidity, nutrient content), and biological (e.g., microbial biomass, respiration) properties of soil. This process, primarily conducted by soil scientists through soil surveys, produces taxonomic systems (e.g., USDA Soil Taxonomy, World Reference Base for Soil Resources), detailed soil maps, and databases (e.g., USDA SSURGO). These outputs are used by researchers and scientists for scientific understanding, agronomy, environmental science, and communication in land management.

In contrast, land evaluation has a broader scope, assessing the suitability and potential of land for various uses by considering various factors, not only soil properties but often topography, climate, hydrology, vegetation, and socio-economic factors. It is a multidisciplinary effort involving agronomy, ecology, hydrology, economics, and social sciences. As a methodology, land evaluation models often incorporate intrinsic soil characteristics alongside other data sources to produce suitability ratings or capability classes. These ratings guide practical decision-making for land managers, planners, and policymakers, aiding in land use planning, agricultural management, conservation, and policy-making.

While soil classification codifies current soil properties, land evaluation extends this by interpreting present conditions to assess future land-use potential. Land evaluation frameworks such as the nationally applied Land Capability Classification (LCC), Land Evaluation and Site Assessment (LESA), and Hawaiʻi’s Land Study Bureau (LSB) approach use soil classification as foundational knowledge but provide a broader analysis suited for practical application. Given its comprehensive scope, land evaluation offers a more robust analysis and is often applied in regulatory systems for informed land use decisions.

This report maintained the convention established in the Act and contract, and thus often used the term ‘soil classification’ in lieu of the more common term ‘land evaluation,’ though the terms were used interchangeably. When referring to what is most commonly considered a soil classification, the report applied the terms soil survey or soil categorization. The study scope included review of local land evaluations including the Land Study Bureau (LSB), Agricultural Lands of Importance to the State of Hawai'i (ALISH), and Land Evaluation and Site Assessment (LESA), as well as the national soil properties database–the Soil Survey Geographic Database (SSURGO)–which utilizes USDA Soil Taxonomy for soil classification and the USDA Land Capability Classification (LCC) for land evaluation. As noted above, biological activity is a key component of soil assessment. Due to growing interest in the concept of soil health, of which biological activity is a critical component, scientists, producers, and policymakers are increasingly interested in biological activity in soils. While not the focus of this study, soil health is a facet of expertise held by the project team, and a topic that emerged in outreach, and was thus touched upon at various points in the report.

DEVELOPMENT OF MODERN LAND EVALUATION APPROACHES

The approach to land evaluation has evolved significantly over time. Land evaluation began to formalize in the 19th century with early soil fertility research, focused on understanding the relationships between soil conditions and plant growth via simple empirical relationships (van Diepen et al., 1991). In the late 19th century the concept of soil as a distinct, integrated unit of the natural environment influenced by various environmental factors emerged, and soon after efforts to codify soil geography developed. In 1894, the USDA Weather Bureau's Division of Soils was initially formed to research temperature and soil moisture conditions in important soil types across the country, but soon pivoted to doing "practical soil survey work of immediate benefit to farmers" that could characterize the soil properties influencing crop suitability and yield (Huddleston 1984). With the growing recognition of the importance of soils, the Division of Soils was renamed the Bureau of Soils in 1901, establishing it as an independent USDA agency.

In the 1920s and 1930s, the United States Bureau of Reclamation (USBR) developed an irrigation suitability classification method focusing on productivity and economic conditions post-irrigation and distinguishing permanent from changeable land features. The USBR considered arable and irrigable lands and drew mostly from economic data like farm budgets and payment capacity to classify areas based on productive capacity and economic viability to assess irrigation project development. The impact of USBR's irrigation suitability methods extended beyond the United States; these methods were later applied in many countries, shaping global approaches to land evaluation for irrigation and influencing the 1976 FAO Framework for Land Evaluation (Olson, 1984). Concurrently, the U.S. Soil Conservation Service was conducting groundbreaking work in the 1930s that would prove instrumental in molding modern land evaluation techniques. The legacy of these early 20th-century approaches to land evaluation, largely driven by soil surveyors who provided critical information for agricultural development, can still be observed in contemporary systems, such as the class design of the Land Capability Classification system.

Building on the early 20th century developments in land evaluation, significant advancements were made in the following decades. In 1933, Storie's Rating Index marked a pivotal moment by establishing a widely applied integration of quantitative landform soil properties criteria. This approach laid the groundwork for more sophisticated evaluation methods. The 1950's and 1960s saw further refinement of land evaluation concepts. Vink distinguished between "soil classification", "land use classification", and "administrative land classification" while assessing their various data requirements (Vink, 1958). This differentiation emphasized the grouping of soils based on practical use, rather than just scientific classification, while advocating for integrated surveys that combined multiple geographical and environmental factors.

By the late 1960s, land evaluation had expanded beyond simple soil fertility and terrain assessments to economic as well broader ecological considerations, eventually becoming more quantitative in nature (van Diepen et al, 1991). However, in the early 1970s, many existing land classification systems still faced criticism for neglecting socio-economic aspects of land use and focusing solely on physical factors (Rossiter, 1994). Further, many classification systems failed to differentiate between land uses with varying requirements, resulting in overly broad evaluations. This meant that a single classification was often applied to multiple land uses that needed more specific criteria for realistic assessments. Finally, classifications were often applied outside their intended areas without necessary adjustments, due to their perceived scientific authority, which led to inappropriate use by poorly informed evaluators. These limitations hindered the ability of classifications to support effective, rational land-use planning.

In response, the FAO's 1976 framework–itself built upon earlier systems, including the USBR's methods–expanded the scope of land evaluation significantly, and laid the foundation for modern land evaluation approaches. It defined land evaluation as the assessment of land performance for specified purposes, considering surveys and studies of a wide range of factors including landforms, soils, vegetation, climate, and other aspects. This approach aligned with the growing recognition of the complex interplay between land characteristics and agricultural productivity that had been developing since the 1930s.

Importantly, the FAO framework emphasized the need to match ecological and management requirements of land uses with land qualities while considering local economic and social conditions (George, 2005). This approach addressed some of the criticisms leveled at earlier systems in the 1970s, particularly the neglect of socio-economic aspects.

Further, the FAO framework defined six fundamental principles for land evaluation:

1. Land suitability is assessed and classified with respect to specified kinds of use.
2. The suitability classes are defined by economic criteria.
3. A multidisciplinary approach is required.
4. Evaluation should take into account the physical, economic, social, and political context of the area concerned.
5. Suitability refers to land use on a sustained basis.
6. Evaluation involves comparison of two or more alternative kinds of use.

These principles incorporated elements from earlier systems, such as the USBR's focus on economic viability, while also addressing the need for more comprehensive evaluations. The emphasis on sustained land use and the consideration of multiple factors aligned with the evolving understanding of land evaluation that had been developing since the mid-20th century.

The FAO Framework of 1976 marked a significant shift in land evaluation methodology. Van Deipen et al (1991) characterized the FAO framework as replacing soil with land as the basic unit of evaluation. This change broadened the scope of assessment, incorporating factors such as vegetation, hydrology, and climate alongside soil characteristics. The framework introduced key concepts like land use types, land characteristics, and land qualities, providing a more holistic approach to evaluation. A crucial distinction in the Framework's approach was the concept of land quality. Unlike soil quality, which was typically inferred, land quality served as a comprehensive assessment factor, synthesizing various land properties into a more manageable form for decision-making. This approach allowed for the simplification of complex data without losing essential information relevant to land use processes.

The evolution of land evaluation from the 1970s to the 1990s reflected a shift from qualitative, intuitive approaches to more systematic, quantitative, and interdisciplinary methodologies. This transition mirrored the increasing complexity and demands of land use planning in modern agricultural and environmental contexts.

In the 1990s, efforts began to focus on categorizing the classification systems themselves. Hoosbeek and Bryant (1992) classified models according to their degree of computation (qualitative to quantitative), descriptive complexity (empirical to mechanistic), and level in the organizational hierarchy (molecular to continental). Rossiter (1996) further developed this by introducing a theoretical framework that classified land evaluation models along eight axes, representing how the models considered space and time. Riveira & Maseda (2006) later contributed to the meta-analysis of land evaluation systems. They compiled characteristics of rural land use planning models, distinguishing between capability systems (for evaluating global land use) and suitability systems (for specific uses). Their work highlighted the growing importance of socioeconomic factors in flexible systems like the FAO framework and LESA.

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III. EVALUATION OF EXISTING SOIL CLASSIFICATION SYSTEMS

OVERVIEW

In the mid-20th century and onwards, land evaluation systems were developed to classify and map the productive potential of agricultural lands across the islands, evaluating factors like soil properties, slope, drainage, climate and crop suitability to categorize lands for agricultural productivity. These systems, while focused on soil properties, incorporated broader land evaluation principles by considering multiple factors beyond just soil, such as topography and climate, to assess the overall suitability of land for agriculture. The resulting maps and data have served as important inputs for land use regulation and policymaking aimed at preserving productive agricultural lands and guiding development.

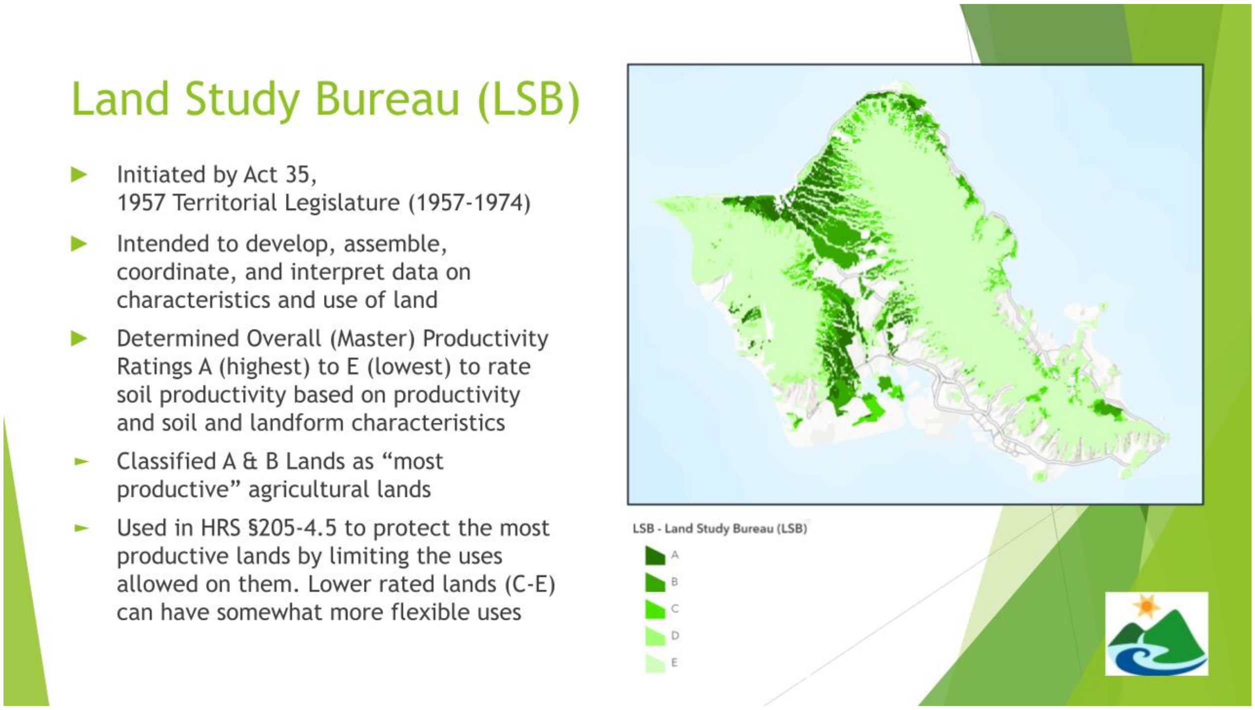
In the context of contemporary land use needs and advancements in soil science, substantial concerns have emerged regarding the limitations of these classification systems. These frameworks are widely regarded as outdated, with data reflecting conditions from decades past that may no longer align with present realities. The emphasis on inherent soil properties, for instance, appears insufficient, neglecting factors impacting productivity such as soil health and management related ecosystem service outcomes. Additionally, the classifications are often viewed as orientation towards large-scale plantation agriculture, which contrasts sharply with the requirements of today's smaller, diversified farming operations. Significant questions therefore persist regarding the suitability of these systems for current agricultural land planning and regulation.

What follows provides a focused review of the four major existing soil and agricultural land classification systems used in Hawaiʻi: Land Study Bureau (LSB), Agricultural Lands of Importance to the State of Hawaiʻi (ALISH), Land Evaluation and Site Assessment (LESA), and USDA-NRCS Soil Survey Geographical Database (SSURGO). This review thus aims to clearly outline the capabilities and constraints of current soil data and frameworks to inform forthcoming evaluation of alternative approaches.

For each system, history, methodology, mapping approach, prior studies, strengths, limitations, and opportunities for improvement are outlined. Information about each system was gathered via a literature review of documents related to United States and Hawaiʻi-based soil studies and soil classification work from a combination of sources, including archival documents, official government reports, books, peer-reviewed academic articles, and system datasets. A listing of Selected References is also provided. The Strengths and Limitations and Opportunities for Improvement sections for each soil system draw largely from past studies and reports, however may also include interpretations based on the review of those documents. To the extent possible, these sections include reviews of comparable benchmarks for each system; however, they are not meant to perform a standardized comparative analysis. Precisely because these sections rely on published documents, they include the strengths, weaknesses, and opportunities most salient in the texts, as well as those that emerged from analysis of the specific historical context, methodology, and mapping approach of that system.

Ultimately, the goal was to identify the optimal approaches for classification and agricultural land use regulation in a way that combined flexibility and foresight. This approach is essential in creating robust land use policies that fulfill current needs while also preparing for and mitigating future uncertainties.

LAND STUDY BUREAU (LSB)



Background and History

In the mid-20th century, Hawai'i's economy was heavily dependent on agriculture. Sugar and pineapple were major industries, and with the diversifying economy and increasing urbanization, there was a need to ensure the continued productivity of sugar and pineapple lands and the preservation of agricultural lands for the future. The legislature recognized the need for a dedicated agency to gather, analyze, and publish information about agricultural land in the State.

In 1957, the Territorial Legislature (Act 35) created the Land Study Bureau (LSB) to provide detailed agricultural land classification data.

The mission of the LSB was twofold: to provide immediate information through generalized land classifications, and to conduct long-range, detailed land classifications, including economic and crop capability ratings. These classifications would form the basis for the General Plan for the State of Hawai'i and the State zoning law, which reflected the need to allocate land for various purposes, including agriculture.

At the heart of the LSB's work was the assessment of agricultural land capabilities. LSB's Overall (Master) Productivity Rating system classified soils into five levels (A, B, C, D, and E) based on their overall productivity for agricultural purposes. This system aimed to identify and categorize lands suitable for farming and distinguish between lands with high and low agricultural potential.

LSB's early work informed the establishment of the State Land Use Districts (Harland Bartholomew & Associates, 1963). The Land Use Commission used the agricultural productivity ratings developed by the LSB to guide their decisions regarding land use and district boundary amendments. This reflected the recognition of the importance of preserving and promoting agriculture in the State's economy and culture.

After major classifications were complete, funding for LSB was cut and LSB was discontinued in 1974. LSB ratings, however, remain in regulatory use. For example, Hawaiʻi Revised Statutes (HRS) §205-4.5 incorporates LSB ratings as a primary tool to regulate permitted uses on agricultural lands based on productivity classifications. Under current regulations, certain agricultural lands rated by LSB are designated for specific uses, with more restrictive regulations for higher rated lands (Classes A and B) and limited allowances for solar development on B and C-rated lands.

Methodology and Components

The LSB land classification system rates the productivity potential of lands using a methodology that combines measurements and ratings of multiple factors. Lands were first classified into Land Types based on similarities in soil properties, climate, topography, and other characteristics affecting agricultural use.

Each Land Type was then given an Overall (Master) Productivity Rating to delineate general productive capacity for agricultural use (A-E). To create and vet the Overall (Master) Productivity Rating, two independent methods were utilized: the Selected Crop Productivity Ratings and application of a Modified Storie Rating Index (MSRI). This system aimed to ensure that the Overall (Master) Productivity Rating assessed the productivity capacity of the land and not the skill of management.

The Selected Crop Productivity Ratings rated lands (on a scale of lowercase a-e) for potential productivity of seven major crops and uses: pineapple, sugarcane, vegetables, orchard fruits, forage, grazing, and forestry. The initial yield specifications for the Selected Crop Productivity Ratings were developed using input from specialists at the University of Hawaiʻi's Cooperative Extension Service and Hawaiʻi Agricultural Experiment Station, as well as knowledgeable individuals from plantations, ranches, and farms across the state. Their expertise and experience with crop yields under Hawaiʻi's growing conditions were critical in establishing reasonable yield estimates for the rating system's crop productivity criteria. These ratings were based on estimated yields using prevailing agricultural practices. Using the Selected Crop Productivity Rating method, every Land Type was assessed based on the seven different uses and the results of these ratings were then averaged to determine an Overall Productivity Rating (on a scale of A-E) of the land's productive potential.

The MSRI built upon the original Storie Index (SI), developed by Berkeley researcher R. Earl Storie in 1933. The SI evaluated soil potential by considering factors like soil profile, surface texture, slope, and site conditions. Storie's method multiplied percentage values assigned to four factors: A (soil profile), B (texture of the surface soil), C (slope of the land), and X (other soil conditions). The percentage values for the most favorable or ideal conditions with respect to each factor are rated at 100 percent. The ratings for each factor are then multiplied to obtain the SI rating of the soil.

This pioneering effort was iterated on by Storie for decades, and the 1937 version was modified by the LSB to add an additional factor ("Y") for rainfall, with irrigated plots assigned a rating of 100%, signifying their moisture needs are fully met. This alteration, termed the MSRI, is represented by the equation: MSRI = A x B x C x X x Y, where:

A = % rating for the soil profile

B = % rating for soil surface texture

C = % rating for the slope of the land

X = % rating for site conditions (salinity, winds, erosion, etc.)

Y = % rating for rainfall (or irrigation)

While outputs were made for both irrigated and non-irrigated conditions, in the final index irrigated plots received a rainfall factor rating of 100% as the moisture requirements were adequately met (Land Study Bureau, 1972). The percentage outcome of the MSRI was then translated into an Overall Productivity Rating on a scale of A-E.

Utilizing the two independent methods, Selected Crop Productivity Rating and the Modified Storie Rating Index (MSRI), the Land Study Bureau could evaluate each Land Type's general capacity for agricultural use and compare between Land Types for agricultural use. Together, these ratings established a robust system to evaluate land resources.

This final Overall (Master) Productivity Rating, used in regulation and available in a statewide geographic information system (GIS) layer, represents the land's overall potential for agricultural production based on considerations of its soil, climate, topographic limitations, and productive potential. The LSB's Overall Productivity Rating is occasionally also termed the LSB "detailed land classification," "productivity rating," "master productivity rating," or "classification."

Mapping Approach and Extent

LSB conducted detailed land classification mapping for agricultural productivity across the main Hawaiian islands in the 1960s and early 1970s. Mapping was done for Hawaiʻi (1965), Maui (1967), Kauaʻi (1967), Lānaʻi (1967), Molokaʻi (1968), and Oʻahu (1972). The mapping covered the entire State at a scale of 1:24,000 using USGS topographic quadrangles.

The basic mapping units delineated were Land Types - homogeneous units defined by similarities in soil properties, topography, climate and other factors affecting agricultural use. The classification and delineation of Land Types was done through field surveys, aerial photo analysis, consultation with experts, and incorporation of soil surveys, climate data and other relevant information.

Urban areas were excluded from the land classification maps. The focus was evaluating and rating the islands' agricultural land resources. Lands were rated for overall productivity potential as well as specific major crops grown in Hawaiʻi.

The original land classification maps were produced manually. In 1998, the maps were digitized by the Office of Planning to create digital spatial data. The current geospatial layer maintained by the State represents a high-resolution inventory of agricultural lands across Hawaiʻi based on a multilayered analysis of productivity factors. The State GIS did not digitize any LSB areas rated 'U' for urban; additionally, all lands categorized within the State Land Use Urban District were removed from the layer using the 1995 Land Use District Boundary data. The LSB was disbanded in 1974 and no update has been made to the original 1960s-1970s rating efforts.

Strengths and Limitations

Strengths

The LSB system has several notable strengths, including its detailed methodology, significant data collection, and regulatory system integration. The evaluation approach used by LSB incorporated measurements of various soil properties, topography, drainage, climate, and other factors to assess land productivity potential. This level of detail allowed for objective, multifaceted analysis of land resources, answering an important need at a time when agricultural productivity was an economic priority in Hawaiʻi. Additionally, LSB demonstrated flexibility by customizing the SI method to suit island conditions by adding water availability (Factor "Y" for rainfall or irrigation) as a factor. The estimated crop yields for pineapple, sugarcane, vegetables, forage, grazing, orchard crops, and forestry (timber) are only found in the LSB. Despite being outdated with respect to crop land use and modern irrigation management (i.e., drip vs furrow irrigation), LSB's detailed data tables are used by agricultural planners and regulators to determine potential productivity for the LSB's Land Type.

Limitations

A major weakness in the LSB system is that none of the input (factors) or output (Overall) data has been updated since it was originally produced in the 1960s and 1970s. Unlike SSURGO's robust digital database related to spatial map units, the multiple inputs for the Overall (Master) Productivity Rating, such as the Selected Crop Productivity Rating for seven crops and uses and the multiple MSRI factors, have not been digitized and related to a geospatial layer of LSB Land Types. Also of note is that only the initial 1963 Detailed Land Classification report for Oʻahu was found to have been digitized in full. All other island reports containing the Selected Crop Productivity Ratings and MSRI data, including the 1972 Oʻahu report, are thus available only in hardcopy. As noted above, these MSRI and yield data, while outdated, are still utilized by agricultural specialists. Static, hardcopy maps lack responsiveness to evolving conditions that could be provided by a digital model of the LSB's Overall (Master) Productivity Rating and underlying calculations. Furthermore, it is unclear who would resource and oversee such updates.

Multiplicative productivity rating systems, such as SI and MSRI, have distinct limitations compared to additive systems, as highlighted by Huddleston (1984). One significant drawback is that only a limited number of factors can be effectively incorporated. To illustrate, multiplying five factors each with a 95% rating gives a rating of 77%. This further reduces to 60% when ten factors are incorporated, each at a 95% rating. Thus, the capacity of multiplicative systems is generally capped at around four or five factors; any more and the ratings dip so low that differentiating slight productivity variations becomes untenable.

Moreover, one factor in a multiplicative system can exert undue influence on the final rating. The MSRI's addition of a rainfall factor, where land with irrigation received a 100% rating, demonstrates how a single factor can significantly impact the overall score. For example, areas in West Molokai (Land Type 38), have an Overall (Master) Productivity Rating of D. These lands were used for non-irrigated pineapple production by Libby McNeill Libby and later by Dole's Hawaiian Pineapple Company. The same soils irrigated, say for sugarcane production which often relied on irrigation, would have received an A rating. In this way the LSB's Overall (Master) Productivity Rating is shaped by historical irrigation extent and previous crop selection. This results in some current user confusion, where drastically different soil ratings occurred on either side of a fence line or even within a modern parcel boundary with no visible reason for the difference. Without consulting the LSB's printed reports' data tables, or having a deep knowledge of previous land uses and irrigation extents, a high rated field (say used for irrigated sugarcane) may abut a low rated one (say used for non-irrigated pineapple). Furthermore, the extent of irrigation has changed significantly since the LSB developed its ratings, which means that ratings may significantly under and/or overestimate potential productive capacity. As few users, and none of the regulations, consult the LSB's printed tables books for deeper insights, the Overall (Master) Productivity Rating leads to not just confusion by current users seeking to understand their fields, but also means that historical crop selection and irrigation extents are shaping current agricultural productivity assessments and land use regulatory decisions.

Aerial imagery from 1951-1954 was used to plot the LSB's initial classifications released in the 1963 Detailed Land Report for Oʻahu. That 1951-1954 imagery shows the entire area of interest used for sugarcane, however 1959 imagery identified by the Project Team shows the entire area used for pineapple. Sugarcane was commonly irrigated while pineapple often wasn't. Despite this shifting land use and crop cover, the 1963 LSB report's land classification data was field mapped in 1961-1962. An area at the south tip of Mililani, north of where the Waikele and Kīpapa streams meet, was largely mapped with Land Classification Symbols A1i and A3i, with A representing the Overall (Master) Productivity rating with Land Type Number 3 and "i" indicating irrigated status (Land Study Bureau, 1963, Map Sheet No. 39).

When the Oʻahu mapping was redone for the 1972 report, the soil on the west side of a road dividing the areas was classified "A49i," while soil on the east side of the road was rated "D49" and "E82" (@lsb_1972, Map 164). This distinction likely arose from a change in crop use, with the west area still irrigated and used for sugarcane, while the east area was cultivated in pineapple and no longer irrigated. This shift in crop use is reflected today, as the west parcel is now the Mililani Agricultural Park while the east portion is now the 14.7 megawatt Mililani Solar II energy facility developed by Clearway Energy Group. Thus, despite having similar Land Type characteristics the mid-century crop selection directly led to the preservation or development of agricultural lands. This site specific classification and use history can be explored through aerial imagery and maps with notes at https://storymaps.arcgis.com/stories/66eecc7a52c34bfcae184baf1c754302/.

This example highlights a critical limitation—historical irrigation practices still influence productivity ratings despite no longer being relevant. The lack of accessibility to detailed land characteristics and historical irrigation status perpetuates outdated assessments. This can result in land classified as highly productive due to past irrigation continuing to hold a high rating in modern regulatory tools, even though it may no longer be irrigated or suitable for certain types of agriculture. Such outdated classifications distort land use planning and agricultural productivity assessments, which in turn affect current land management decisions and policy.

Opportunities for Improvement

The utility of LSB ratings can be greatly enhanced with the integration of information on the current irrigation extent of lands, updating information on irrigation from the 1960s and 1970s when studies were conducted. This could include details like average water volumes with enough data to determine potential gallons per acre per day, as well as the quality of irrigation water sources–for instance, surface, groundwater, salinity, reclaimed water, Hawaiʻi Department of Health (HDOH) rating, and mixed water information.

As the MRSI rainfall factor considers both precipitation and irrigation extent, changes in climate and irrigation infrastructure underscores the need for periodic reassessment and adjustments in such rating systems to ensure they remain relevant and accurate.

As with many soil and land classification systems, resurveying lands, incorporating contemporary climate data, and harnessing the latest technological progress in mapping and data analysis can optimize the system. Regular updates would ensure that the system remains pertinent to land-use needs, and support decision-making in land-use planning and regulatory systems.

Digitizing the remaining Detailed Land Classification reports for islands other than Oʻahu would provide a complete and accessible digital record of LSB data. This effort should go beyond basic scanning with optical character recognition (OCR) and include converting tables into database or spreadsheet formats. Such an approach would significantly enhance the accessibility and analytical utility of the LSB's Selected Crop Productivity Ratings and MSRI data for more effective planning and decision-making.

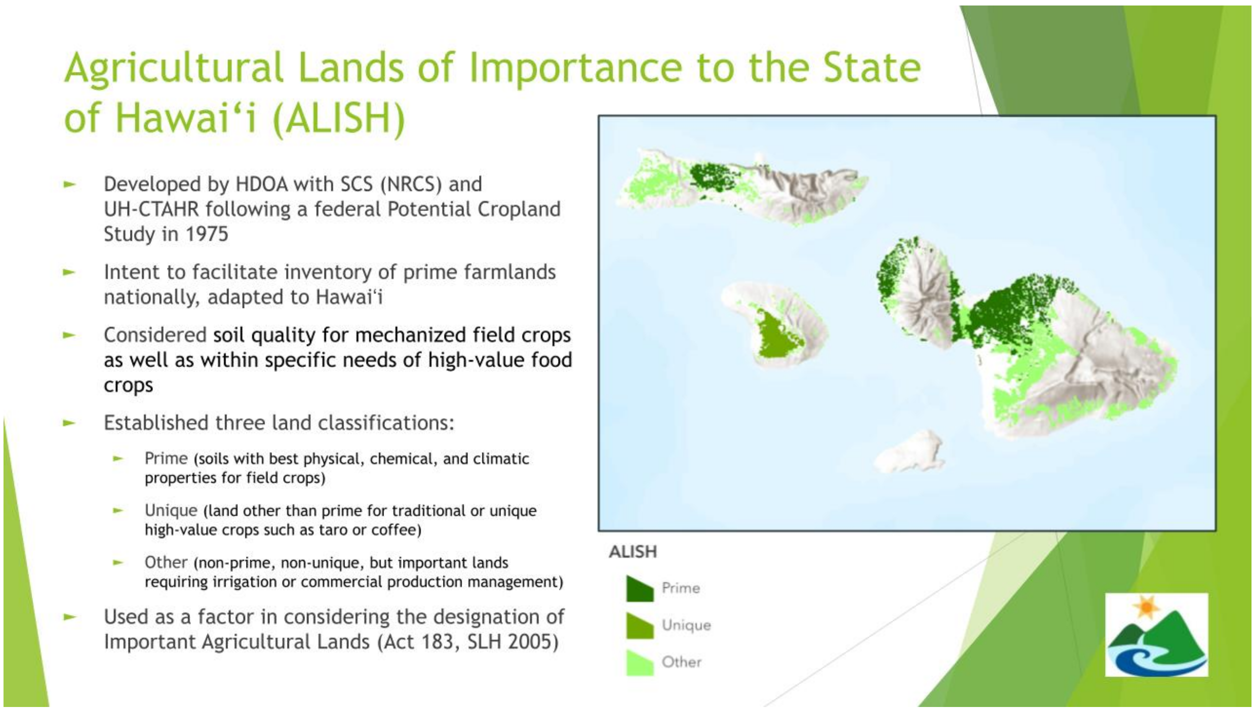
In 2005, the University of California (UC) introduced an advanced version of the 1978 SI, leveraging the National Soil Information System (NASIS) to curtail the subjectivity and inconsistencies inherent to the traditional hand-generated Storie ratings. NASIS, the NRCS’s database for generating SSURGO data products, was used to digitally model the SI criteria. By relating soil properties embedded in the SSURGO data with a modification of the 1978 SI to reduce subjectivity, the UC's revision enables rapid generation of SI outputs that correlate well with hand-generated Storie ratings. The digitization and elimination of subjective scoring would reduce variability and time required for resampling and updating of ratings.

Prior Reports and Studies

The LSB's primary agricultural land rating reports are the Detailed Land Classifications by island:

- Detailed land classification: Island of Hawaii. Honolulu: Land Study Bureau, University of Hawaii, Nov. 1965.
- Detailed land classification - Island of Kauai. Honolulu: University of Hawaii, Land Study Bureau, Dec. 1967.
- Detailed land classification - Island of Lanai. Honolulu: University of Hawaii, Land Study Bureau, May 1967.
- Detailed land classification: Island of Maui. Honolulu: Land Study Bureau, University of Hawaii, May 1967.
- Detailed land classification: Island of Molokai. Honolulu: Land Study Bureau, University of Hawaii, June 1968.
- Detailed land classification: Island of Oahu. Honolulu: Land Study Bureau, University of Hawaii, Jan. 1963 and Dec. 1972.

AGRICULTURAL LANDS OF IMPORTANCE TO THE STATE OF HAWAIʻI (ALISH)



Background and History

The Rural Development Act of 1972 directed the United States Secretary of Agriculture to carry out a program to study soil erosion, land use change, and related natural resource concern issues, and report on findings every five years (Schnepf, 2008). In 1975, the Soil Conservation Service (SCS) issued Land Inventory and Monitoring (LIM) Memorandum-3 which defined prime and unique farmland criteria and established other categories of important farmlands that could be defined by state and local governments (Berg, 1979). The LIM criteria drew upon physical and chemical soil characteristics and land use to classify lands based on their suitability for agricultural production. The memorandum and SCS's related Important Farmland mapping project initiated a program of county and state mapping efforts.

After the SCS adoption of the prime and unique criteria, around 100 counties nationwide, including Honolulu and Maui, were selected to be classified using the system. Hawaiʻi became an early participant to ensure the inventory's relevance to the State's unique agricultural landscape and needs, and pursued statewide mapping through a contract with a planning firm that was producing an agricultural master plan for the State.

An ad hoc committee, with members from diverse entities like the SCS, the University of Hawaiʻi College of Tropical Agriculture and Human Resources (CTAHR), and various State of Hawaiʻi Departments, was formed. Led by the Hawaiʻi Department of Agriculture, the committee collaborated to develop the classification system specifically tailored to Hawaiʻi's agricultural conditions.

This Agricultural Lands of Importance to the State of Hawaiʻi (ALISH) system was designed to classify agricultural lands in Hawaiʻi based on their potential suitability for various types of crop production, taking into account factors such as soil quality, growing season, temperature, humidity, sunlight, and other criteria relevant to Hawaiʻi's agricultural landscape.

In early 1977, the State Board of Agriculture formally adopted the ALISH system, which classified lands of agricultural importance into three categories: Prime Agricultural Land, Unique Agricultural Land, and Other Important Agricultural Lands.

Prime Agricultural Lands offer optimal conditions for sustained high crop yields with minimal energy and financial input; Unique Agricultural Lands are non-Prime lands dedicated to the production of specific high-value food crops due to its unique conditions; and Other Important Agricultural Lands either support the State's agricultural economy or hold potential for future agricultural endeavors. Lands not considered for classification in the ALISH system were developed urban lands, public use lands, forest reserves, steep slopes, and most military lands.

The ALISH report notes that the classifications should "provide decision makers with an awareness of the long-term implications of various land use options for agricultural production" (Baker, 1979). A few years later, the 1982 State Agricultural Plan underscored the continued need for cohesive strategies in land-use decisions. The plan stressed the need to preserve Prime agricultural lands, as land use redistricting was shrinking their availability for agriculture, jeopardizing future self-sufficiency and export potential. In light of this, the plan included a recommendation to replace the LSB's "A" and "B" classifications with the ALISH classes (Duncan, 1987). While this recommendation was not adopted, in 2005 ALISH was included as a criteria for identifying Important Agricultural Lands (IAL), and references to ALISH and LSB can be found in Hawaiʻi's State and County land use regulations and rules.

Methodology and Components

The State of Hawaiʻi's three agricultural land classes were originally created to support the national prime farmland inventory by the Soil Conservation Service. The ALISH classification was adapted to local agricultural practices with these categories:

TABLE 1. ALISH & SCS CLASSIFICATION SYSTEM TERMINOLOGY

ALISH Classification System	SCS Classification System
Prime Agricultural Land	Prime Farmland
Unique Agricultural Land	Unique Farmland
Other Important Agricultural Land	Additional Farmland of Statewide and Local Importance

The goal was establishing a localized classification aligned with national standards for prime agricultural lands. The classification system and criteria were developed by an ad hoc committee with representatives from multiple State and federal agencies, led by the State Department of Agriculture. The criteria for Prime Agricultural Land align with the national soil-focused criteria used by the Soil Conservation Service (now NRCS) and focus on soil properties like moisture supply, drainage, texture, and organic matter content (see below for exact criteria). The criteria for Unique and Other Important Agricultural Lands consider additional factors like specific high-value crops, seasonal wetness, erodibility, flooding risk, and more. The cooperative development of tailored criteria, involving soil experts, economists, foresters, and planners, allowed the system to meet both State and federal objectives.

The SCS has published methodology for classifying prime farmland soils based on soil taxonomy units, soil properties, growing season length, and other factors. Per the SCS approach adopted by the ALISH committee, Prime Agricultural Land met the following criteria:

1. The soils have a dependable and adequate moisture supply and good water storage capacity.
2. The soils have a mean annual temperature and growing season suitable for growing the prevailing crops.
3. The soils are neither too acid nor too alkaline for vigorous plant growth.
4. The water table is either lacking or so deep that it does not adversely affect plant growth.
5. The soils are not salty or otherwise limiting in the root zone.
6. The soils are not flooded frequently during the growing season.
7. The soils do not have a serious erosion hazard.
8. The soils transmit water readily and without drainage problems.
9. The soils are not so stony in the surface layer as to cause difficulty in cultivating with large equipment.

The soils have stability characteristics which permit the use of large equipment.

Unique Agricultural Land refers to lands distinct from Prime Agricultural Land, specifically cultivated for certain high-value food crops due to its unique combination of factors like soil quality, climate, sunlight, elevation, proximity to markets, and other conditions. Such crops included coffee, taro, rice, watercress, and non-irrigated pineapple. However, if lands used to cultivate a unique high-value crop met the criteria for Prime Agricultural Land, those lands were classified as Prime.

Other Important Agricultural Land is land crucial for the production of various crops but doesn't fit into Prime or Unique categories. This classification often involves lands with challenges like seasonal wetness, erosion, limited rooting zones, and others that don’t meet the Prime or Unique criteria. However, with additional efforts like fertilization, drainage improvements, and erosion control, these lands could produce reasonable crop yields. The lands qualified as Other Important Agricultural Land are based on specific criteria, such as having slopes less than 20% suitable for crops or slopes less than 35% suitable for grazing. Another qualifying factor is the presence of thin soils atop lava with favorable growing conditions.

In general, criteria used for classification in the ALISH system include soil quality, moisture supply, temperature suitability, pH levels, water table depth, salinity, erosion hazards, drainage properties, stoniness, and stability. Suitability of a soil for a particular category is determined by meeting specific criteria for that category. Factors and criteria were not explicitly weighted in the ALISH system.

Mapping Approach and Extent

The ALISH system considered lands across all islands and included land that may or may not have been in agricultural use. However, the criteria applied resulted in an output focused mostly on lands where production was already present. The three primary classifications of ALISH lands were plotted on standard United States Geological Survey quadrangle maps. These maps, with a 1:24,000 scale, encompassed the whole of Hawaiʻi (Baker, 1979). The ALISH study was a one-off effort that delineated important agricultural lands and has not been updated or reproduced subsequently.

Certain categories of land are excluded from consideration for classification under ALISH. These exclusions include urban areas greater than 10 acres; enclosed bodies of water, both natural and man-made, of more than 10 acres; forest reserves; parks, historic sites, and other public use lands; and lands with slopes exceeding 35% grade. In addition, military installations are generally excluded from classification, aside from undeveloped areas on military installations over 10 acres (Baker, 1979).

Strengths and Limitations

Strengths

ALISH provides a consistent, objective methodology for evaluating agricultural land quality that establishes a framework for prioritizing the protection of the best agricultural lands, including for specialty crops that have unique value to Hawaiʻi. By integrating detailed soil data with climate and crop suitability factors, the system is able to help identify lands that are often excluded or poorly rated by other systems. For example, lands in the South Kona coffee belt, categorized as class D in the LSB Overall (Master) Productivity Rating system, fall within the ALISH Other Important Agricultural Lands class (Roehrig, 2002). Permissible uses within LSB class D agricultural lands are not governed by HRS §205-4.5. ALISH however is included as a standard and criteria for the identification of important agricultural lands in HRS §205-44, meaning these lands could be included in an IAL petition. This demonstrates how disparity between classification system outcomes and regulatory application can lead to vastly different use and protection of a singular land parcel.

Limitations

The ALISH system's data has not been updated since the original classification over 40 years ago in the late 1970s, potentially making it outdated and unreflective of current conditions. Two criteria for the Prime classification consider limitations framed by the use of large cultivation equipment, a practice that contrasts with the small-scale, diversified nature of most farms in the State. Criteria also do not account for new crops, technologies, farming methods, or the actual agricultural productivity of the lands; and, because the classifications were based predominantly on soil surveys, they may not encompass the full suitability range for different crops. The system is mainly centered on biophysical attributes of land, neglecting essential socioeconomic and infrastructure factors.

Additionally, its focus is on inherent soil characteristics for crop production rather than dynamic qualities of soil health. Factors like soil biodiversity, structure, and nutrient cycling were not considered. The data relies on standard soil surveys, which provide limited information on key indicators like organic matter levels, microbial biomass, and biology. ALISH emphasizes soils for commodity crop production and does not address biological function beyond basic fertility and drainage. As a result, ALISH is a static classification system not designed to assess changes in quality over time.

Opportunities for Improvement

The ALISH report (Baker, 1979) states that "classification of agriculturally important lands does not in itself constitute a designation of any area to a specific land use." Subsequently, however, the Important Agricultural Lands Act 183 of 2005 incorporated ALISH into what is now Hawaiʻi Revised Statutes §205-44 *Standards and criteria for the identification of important agricultural lands*.

Furthermore, the ALISH report noted that new "knowledge and changes in land use will necessitate the periodic review and revision of the classification system and lands identified in the various classes." Despite this, no revision or updates have been made. Thus updating the ALISH system has direct value to ongoing efforts to protect agricultural lands. Several areas present potential for improvement.

It is essential to ensure that the maps are reflective of present realities. The ALISH maps need to be revised to reflect urbanization and to illustrate the present and potential conditions of crops, as highlighted by Yamamoto (1999). The Statewide Agricultural Land Use Baseline (SALUB) (2015) and Update (2020) Project, produced for the Hawaiʻi Department of Agriculture by the University of Hawaiʻi at Hilo's Spatial Data Analysis and Visualization Lab, used a combination of satellite imagery, geospatial datasets, and statewide farm interviews to produce a GIS layer that identified and mapped commercially grown agricultural crops across the State. SALUB and Update's use of satellite imagery and ground truthing offers a method to update agricultural land use mapping and identify currently cultivated areas. Revised mapping with the incorporation of new crops would ideally also trigger a review of the extent of 'Unique' and 'Other' classification areas. These categories, however, also require revision.

The classification process warrants refining. The 'Unique' category in ALISH doesn't have a clear, standardized criterion, which Yamamoto (1999) noted makes it challenging for consistent replication. This category, alongside the 'Other' classification, introduces variability, detracting from the system's consistency. Addressing these issues would bring about increased clarity, precision and reproducibility.

Finally, the inclusion of quantitative productivity data can strengthen the ALISH system's robustness. By incorporating quantitative productivity measures and yield data, the rating system can be made more effective and precise. The consideration of socioeconomic factors also warrants attention. For example, expanding the system to include criteria that assess essential elements like water supply, labor trends, and market accessibility would provide a more complete understanding of the agricultural landscape.

Prior Reports and Studies

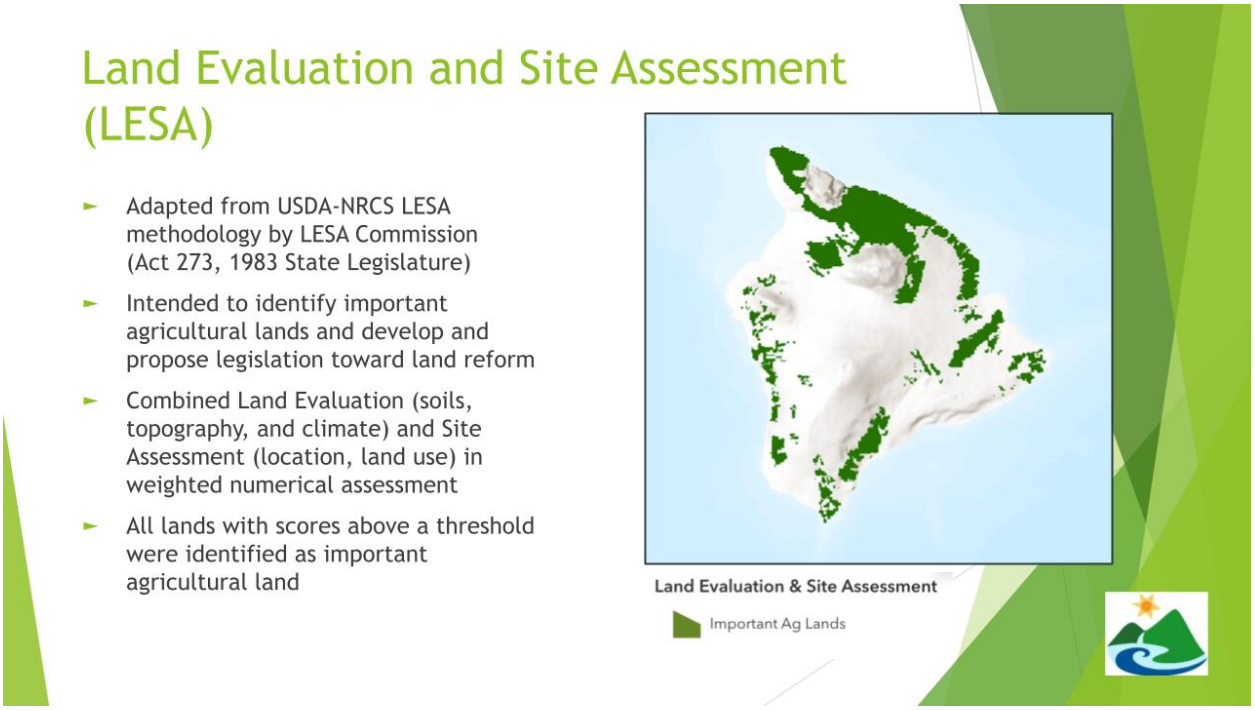
The primary ALISH reports are:

- Agricultural Lands of Importance to the State of Hawaii (Revised). (1977).
- Baker, H. L. (1979). Agricultural Lands of Importance to the State of Hawaii. Circular - Hawaii University Cooperative Extension Service (USA), 496. https://scholarspace.manoa.hawaii.edu/server/api/core/bitstreams/dc06a8a4-af6f-410a-837d-d6c5393b693d/content
- ALISH GIS Layer Metadata. (n.d.). Retrieved September 2, 2023, from https://gis.hawaiicounty.gov/public/downloads/plhyperlinks/MetadataFiles/ALISH%20(Statewide).pdf

Selected Other Reports referencing ALISH:

- Mark, S. M., & Lucas, R. L. (1982). Development of the Agricultural Sector in Hawaii (p. 40).
- Plasch Econ Pacific, LLC. (2011). Oʻahu Agriculture: Situation, Outlook and Issues. The Department of Planning and Permitting, City and County of Honolulu.
- Suryanata, K., & Lowry, K. (2016). Tangled Roots: The Paradox of Important Agricultural Lands in Hawaiʻi. In Food and Power in Hawaiʻi: Visions of Food Democracy (pp. 17–35). University of Hawaiʻi Press. https://doi.org/10.1515/9780824858612-003

LAND EVALUATION AND SITE ASSESSMENT (LESA)



Background and History

The Land Evaluation and Site Assessment (LESA) system was initially developed in response to national concerns about urban sprawl and farmland loss.

A 1975 Potential Cropland Study focused concerns about protecting agricultural lands, creating momentum for nationwide study of agricultural land loss (Schnepf, 2008). In 1978, the United States Secretary of Agriculture commissioned the National Agricultural Lands Study (NALS) to investigate concerns about the conversion of agricultural land to non-agricultural uses. Findings from the study prompted Congress to enact the Farmland Protection Policy Act (FPPA) of 1981, which aimed to reduce unnecessary agricultural land conversion by federal programs. Multiple state and local governments also initiated their own farmland protection efforts, creating a demand for a land and site evaluation tool.

In response, the federal Soil Conservation Service (SCS, now NRCS) expanded and revised a land classification system developed in Orange County, New York. Site assessment criteria were added based on information from NALS and the Compact Cities report, reflecting urban sprawl impacts. A pilot project to test the draft Land Evaluation (LE) and Site Assessment (SA) system was conducted in 12 counties across six states. The model LESA system was presented to NRCS staff in 1982, and the first National Agricultural Land Evaluation and Site Assessment Handbook was produced in 1983. LESA gained visibility when it was included in the proposed rule for the FPPA in 1984, requiring federal agencies to use LESA to review the impact of their programs on agricultural land.

Hawai'i's rapid economic development meant that similar urbanization and development pressures, and similar concerns about the use and loss of agricultural lands, faced the State. Rapid development had illustrated the ineffectiveness of statewide zoning to protect agriculture. In 1978, Hawai'i's State constitution was amended (Article IX, Sec 3) to emphasize the heightened commitment of the State to conserve and protect agricultural lands, promote agricultural self-sufficiency, and ensure the availability of agriculturally suitable lands. The amendment, alongside the new constitutional mandate to identify and protect important agricultural lands, called for a system to objectively rate agricultural land.

Hawaiʻi was the first to adopt LESA for statewide assessment. The LESA Commission, formed in 1983 by Act 273, was charged with developing standards, criteria, and procedures to identify important agricultural lands (IAL), to establish the initial IAL inventory, and develop standards, criteria, and procedures for the redesignation of IAL parcels to urban or to other uses. Following input from public hearings, the Commission also worked to determine standards, criteria, and procedures for the reclassification of other or conservation parcels as IAL. In short, mechanisms to move lands out of a protected status or from one protected status to another.

Act 273 included criteria to frame the identification of important agricultural lands, directing the LESA Commission to consider and build upon existing systems including LSB (1965-1972) and ALISH (1977). Hawaiʻi's LESA system also pulled data from the Soil Conservation Service's (SCS) Soil Potential Index and LSB's Modified Storie Rating Index (MSRI) to gather soil productivity and physical and chemical land characteristic information. As well, it integrated Site Assessment scoring with the Hawaiʻi Natural Resource Information System (HNRIS)-GIS, an existing GIS at the University of Hawaiʻi that had been developed for water resources and later expanded to include land use, soils, and vegetation (Chapman, 1996). Hawaiʻi's integration of LESA with GIS was later used as a prototype for other areas who looked to automate their LESA scoring process (Ferguson & Bowen, 1991).

The LESA system developed by the Commission is composed of two parts. The first part consists of standards, criteria, and procedures to identify "important agricultural lands," and to establish the initial IAL inventory. The second part consists of (a) standards, criteria, and proce-dures to redesignate parcels which had been classified as "Important Agricultural Lands" to "Urban" or to "Other Uses"; and (b) standards, criteria, and procedures to designate "Other" or "Conservation" lands as "Important Agricultural Lands."

Following its study, the LESA Commission recommended the creation of a new State Land Use Agricultural District, excluding poor agricultural land and placing poor agricultural lands under county control. Unique Lands were also suggested to be included in the new district, with a greater role for the Hawaiʻi Department of Agriculture (HDOA) and the Land Use Commission (LUC) in administration. Legislation was introduced based on these recommendations, but never passed.

Legislative attempts to implement LESA in Hawaiʻi were revisited in the 2000 legislative session but faced challenges from competing interests; a compromise bill was proposed but was never signed into law, leaving the issue unresolved. The stalemate reflects the economic, social, and political tensions that emerged from myriad and sometimes conflicting beliefs about land and land use, including use for tourism, conservation, and/or affordable housing, with agriculture.

Methodology and Components

The Hawaiʻi LESA system contains two main components:

Land Evaluation (LE) - 5 factors related to the physical productivity of agricultural lands based on soil properties:

- Land Capability Classification (LCC via SCS)
- Agricultural Lands of Importance to the State of Hawaiʻi (ALISH)
- Soil Potential Index (via SCS)
- Modified Storie Rating Index (MSRI via LSB)
- Overall (Master) Productivity Rating (via LSB)

LE Factor	Weight	Data Normalization to 0-100 Scale	Source
Land Capability Classification	1	Class I = 100; Class II = 87.5; Class III = 75; Class IV = 62.5; Class V = 50; Class VI = 37.5; Class VII = 25; Class VIII = 12.5	SCS
ALISH	1	Prime = 100; Unique =75; Other Im-portant Lands = 50; Remaining residual group= 25	ALISH
Soil Potential Index	1.5	N/A, already 0-100 scale	SCS
Modified Storie index	1	N/A, already 0-100 scale	LSB
Overall productivity rating	1.5	A = 100; B = 80; C = 60; D = 40; E = 20	LSB

Site Assessment (SA) - 10 weighted factors covering the economic, social, policy aspects:

- County plan conformity
- Irrigation availability
- Proximity to urban infrastructure
- On-site farm facilities
- Conformance with State agricultural programs
- Access to agricultural services
- Farm parcel size and layout
- Compatible agricultural land uses
- Adequacy of drainage
- Impacts of non-agricultural nearby land uses

SA Factor	Criteria	Weight
County Plan	Conformity with county plan, policy	15
Irrigation	Availability of irrigation facilities/services	10
Urban Facilities	Proximity to urban infra- structure, services	7
Farm Facilities	Presence of on-site agricultural improvements	7
State Programs	Conformity with state agricultural programs, projects	7
Agricultural Services	Access to agricultural facilities, services	4
Farm Layout	Economical parcel size, location, configuration	4
Compatible Use	Compatible agricultural land uses within region	4
Drainage	Adequacy of off-site drainage	1
Non-agricultural Use	Impact of nearby non-agricultural land use	1

To determine final values, the LE rating and SA scores were calculated individually, and then combined into a final LESA rating.

LE factors were normalized to a 0-100 scale, weighted, and then averaged to produce the LE rating. The Soil Potential Index and MSRI were already in 0-100 format, but the LCC, ALISH, and LSB Overall (Master) Productivity Rating required conversion. For example, LCC was adjusted so that Class I equaled 100; Class II, 87.5; Class III, 75; Class IV, 62.5; Class V, 50; Class VI, 37.5; Class VII, 25; and Class VIII, 12.5. ALISH was adjusted so that Prime equaled 100; Unique, 75; Other Im-portant Lands, 50; and the remaining residual group, 25. For LSB Overall Ratings, a numerical rating of 100 was assigned to "A"; 80 to "B"; 60 to "C"; 40 to "D"; and 20 to land types in the "E" category.

Viewed as more direct measures of productivity, LSB's Overall (Master) Productivity Rating and the Soil Potential Index were each weighted at one and one-half. LCC, ALISH and MSRI were each weighted at one.

The SA score was determined by rating, weighting, and summing the SA factors. A given parcel or area would receive a 1-10 (low to high) rating for each SA factor based on how well it met the factor criteria. Overall each SA factor was assigned a weighting, from 1-15 (low to high), based on their relative importance. The SA factor listing above is in order of that weighting, with County plan conformity weighted at 15 and Impacts of non-agricultural nearby land uses weighted at 1. The SA factors weighted ratings would be summed to produce an SA score.

The 0-100 scale LE rating and SA score are then combined at a 1:1 ratio into an overall LESA rating.

(LE rating + SA score) divided by 2 = LESA rating

This aimed to complement the physical productivity measures of LE with the SA factors capturing other important determinants of agricultural viability.

Mapping Approach and Extent

The LESA identification method is divided into three distinct phases, each led by the LESA Commission:

First, the LESA Commission gathered and integrated Land Evaluation (LE) data from five distinct land classification and rating systems, subsequently integrating this data producing LE ratings for each island, except for Niʻihau and Kahoʻolawe. LESA's LE facets, in using inputs from both the SCS and LSB, therefore drew upon both the Territorial soil survey released in 1955 and the later soil surveys released in 1972 and 1973. Second, the Site Assessment (SA) phase collected map information on the ten SA factors from county planning departments, the Land Use Commission, HDOA, SCS, the Federal Emergency Management Agency, and internal GIS work. Finally, LE ratings with the SA scores were then merged, based on the approaches of mainland governmental entities modified for local application. The Commission experimented with several combinations of LE ratings and SA scores and settled on one that best represents agricultural and farming activities in Hawaiʻi: (LE rating + SA score) divided by 2 = LESA rating.

LESA scores were mapped statewide for the major Hawaiian islands. The maps delineated LESA scores, subsequently the polygons were drafted onto 1:24,000 USGS quadrangle maps, then digitized by State Office of Planning staff.

Strengths and Limitations

Strengths

LESA provides a standardized system for numerically rating the agricultural suitability of lands, allowing for consistent evaluation. The system can be applied for various purposes, including assessing the impact of proposed projects on agricultural land, property tax assessment, delineating agricultural districts, zoning decisions, and ranking applications for agricultural conservation programs. LESA is a flexible tool that can be adapted to address local conditions and concerns, making it versatile for different regions and communities. Importantly, LESA systems explicitly consider and integrate the broader social and economic context of a parcel, site, or area, ensuring that land use decisions reflect not only agricultural potential but also the surrounding community's needs and priorities.

LESA promotion materials tout that developing a LESA system encourages community members to engage in discussions and planning for multiple use-cases, and can thus aid in planning, helping communities manage growth, ensure food security, achieve agricultural sustainability, and direct farmland preservation programs.

Limitations

Analyses by CTAHR in 1990 and 1991 identified several technical and practical limitations of the LESA system. Vague definitions for some Site Assessment factors made consistent statewide mapping difficult, requiring substitute proxy measures that altered the original intent (Ferguson et al., 1990; Ferguson et al., 1991). The high cost of mapping all Site Assessment factors was problematic given data constraints. Additionally, the system lacked provisions for periodic review and updating to maintain relevance as conditions changed over time. Most critically, core premises around the importance of sugar and pineapple became outdated as those industries declined. These studies highlighted deficiencies that would constrain real-world application and ongoing utility of the LESA framework in Hawaiʻi.

TABLE 2. SITE ASSESSMENT COMPONENTS OF HAWAIʻI LESA-GIS MODEL ADAPTED FROM FERGUSON ET AL. (1991)

Factor	Original LESA Commission Criteria	Mapping Definition	Problems
County Plan	Conformity with county plan, policy	Land use designation in county development plan	
Irrigation	Availability of irrigation facilities/services	General irrigated areas	Low resolution map
Urban Facilities	Proximity to urban infra-structure, services	Linear distance from Urban District	
Farm Facilities	Presence of on-site agricultural improvements	Intensity of 1982 agricultural land use	Uncertain quality, dated map used
State Programs	Conformity with state agricultural programs, projects	State government land ownership	Original criteria vague/unclear; proxy mapping definition alters intent
Agricultural Services	Access to agricultural facilities, services	Linear distance from harbor	Oversimplified mapping definition
Farm Layout	Economical parcel size, location, configuration	Parcel size	Original criteria vague/unclear; proxy mapping definition alters intent; oversimplified mapping definition
Compatible Use	Compatible agricultural land uses within region	Similarity of crops in contiguous 100 acres	Original criteria vague/unclear; proxy mapping definition alters intent
Drainage	Adequacy of off-site drainage	Flood hazard areas	Low resolution map; proxy mapping definition alters intent
Non-agricultural Use	Impact of nearby non-agricultural land use	Size of coincident non-agricultural use special permit	Original criteria vague/unclear; proxy mapping definition alters intent

Since its initial development in the 1980s, support and usage of Hawaiʻi's LESA system has steadily declined. Despite early enthusiasm, various legislative proposals in the decades since have failed to implement reforms integrating LESA into land use policy and regulation. LESA does not appear to play a major role guiding land use and development decisions in Hawaiʻi at present. Overall, the current usage and application of Hawaiʻi's LESA system seems limited, only referenced twice in Administrative Rules (see Appendix F), likely due to the combination of technical deficiencies, outdated premises, and lack of political will to adopt the LESA-based land use evaluation system.

Opportunities for Improvement

While pioneering for its time, various analyses revealed areas needing refinement in the Hawaiʻi LESA system from both a technical and policy perspective. Considering the limitations above, potential ways to improve Hawaiʻi's LESA system include clarifying and simplifying the Site Assessment factors, focusing on the most important/mappable ones; designating a government agency or process for periodic review and updating of the system; incorporating improved spatial data as available (e.g. Census TIGER system); automating parts of the LESA analysis through use of the GIS system; and drawing lessons from more recent agricultural land classification systems and evaluation tools. The suggested improvements could support an enhanced system better aligned with current agricultural conditions and land use information needs.

Statistical sensitivity analysis of the impact of the various input factors determined that reducing SA to include only four factors (county plan, irrigation, urban facilities, and farm facilities) at equal weights would produce similar outputs ratings (Ferguson & Bowen, 1990). Further, the study recommended a government agency maintain the LESA system, via legislative authorization, and update the system in concert with the five-year state land use district boundary review process.

The LESA Ratings have not been actively used for the past 30 years or so. However, many of the criteria considered through LESA were incorporated into the HRS §205-44 standards, as demonstrated in the following table.

TABLE 3. IAL AND LESA CRITERIA COMPARISON

IAL HRS §205-44 Standard	LESA Factor
(1) Land currently used for agricultural production;	ALISH (LE)
(2) Land with soil qualities and growing conditions that support agricultural production of food, fiber, or fuel- and energy-producing crops;	Land Capability Classification (LE); Modified Storie Rating Index (LE); Overall productivity rating (LE)
(3) Land identified under agricultural productivity rating systems, such as the agricultural lands of importance to the State of Hawaiʻi (ALISH) system adopted by the board of agriculture on January 28, 1977;	ALISH (LE)
(4) Land types associated with traditional native Hawaiian agricultural uses, such as taro cultivation, or unique agricultural crops and uses, such as coffee, vineyards, aquaculture, and energy production;	ALISH (LE; Unique lands category)
(5) Land with sufficient quantities of water to support viable agricultural production;	Irrigation (SA)
(6) Land whose designation as important agricultural lands is consistent with general, development, and community plans of the county;	County Plan (SA)
(7) Land that contributes to maintaining a critical land mass important to agricultural operating productivity; and	Farm Layout (SA)
(8) Land with or near support infrastructure conducive to agricultural productivity, such as transportation to markets, water, or power.	Farm Facilities (SA); Urban Facilities (SA)

Prior Reports and Studies

Primary reports on Hawaiʻi's LESA system

- Land Evaluation and Site Assessment Commission. (1985). Progress report of the State of Hawaii Land Evaluation and Site Assessment System to the Thirteenth Legislature, State of Hawaii. Legislative Reference Bureau. https://library.lrb.hawaii.gov/cgi-bin/koha/opac-retrieve-file.pl?id=9068b6dd8eb1ac2f6bbd1ae5e3e29ae5
- Land Evaluation and Site Assessment Commission. (1986). A report on the State of Hawaii Land Evaluation and Site Assessment System. Legislative Reference Bureau. https://library.lrb.hawaii.gov/cgi-bin/koha/opac-retrieve-file.pl?id=2ab4548904659709bef621771ec5ff3a
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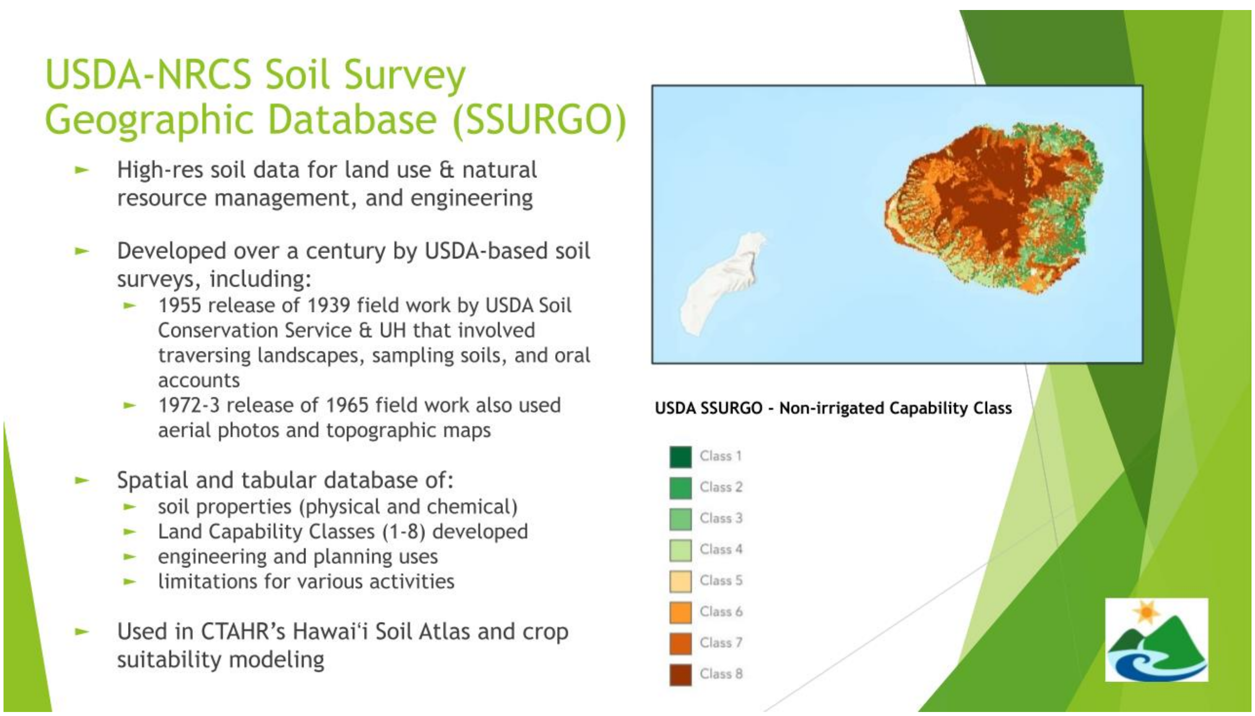
- Ferguson, C. A., & Bowen, R. L. (1991). Statistical evaluation of an agricultural land suitability model. Environmental Management, 15(5), 689–700. https://doi.org/10.1007/BF02589627
- Ferguson, C. A., Bowen, R. L., & Kahn, M. A. (1991). A statewide LESA system for Hawaii. Journal of Soil and Water Conservation, 46(4), 263–267.

USDA-NRCS Soil Survey Geographic Database (SSURGO)



As clarified at the outset, the report uses the terms “soil classification” and “land evaluation” interchangeably, to maintain the convention established in Act 189 (SLH 2022) and the project solicitation and contract. SSURGO, unlike LSB, ALISH, and LESA, however, is a soil classification system, with measurements of the physical and chemical characteristics of soil. In this section, therefore, *soil classification* specifically refers to intrinsic soil properties—not broader land evaluation frameworks. To distinguish between usage, soil classification will be referred to in this section as soil properties, or soil properties database where appropriate.

Background and History

The development of the soil survey system, including the USDA-NRCS Soil Survey Geographic Database (SSURGO), can be traced back to the early 20th century when the United States government began conducting soil surveys. Soil surveying involved the collaborative efforts of various organizations and individuals, primarily under the oversight of the United States Department of Agriculture (USDA) and via the leadership of the Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (SCS), an agency within the USDA.

Surveys were initially done on a county-by-county basis, to acquire knowledge about the distribution and characteristics of soils in various regions. This knowledge was crucial for understanding the suitability of soils for agriculture and other land uses, and to support land-use and natural resource planning and management, especially in the context of agriculture. It also helped farmers and land planners make informed decisions about crop selection, irrigation, and soil management, critical to attempts to maximize agricultural productivity at a time when agriculture functioned as a pillar of the United States economy.

Over the decades, as soil surveys were conducted across the country, the information was compiled and digitized, leading to the creation of the SSURGO database. The database contains both spatial and tabular data, with the spatial data representing the geographic distribution of soil types and the tabular data providing detailed information about each soil type's properties and characteristics. SSURGO represents the most detailed level of soil geographic data available in the United States today. The database contains information that can be used in land-use planning, agricultural management, environmental research, and other applications.

The first comprehensive soil survey of Hawaiʻi was a cooperative effort between the USDA and the University of Hawaiʻi Agricultural Experiment Station. This initial soil survey field work covered the six major islands of the Territory of Hawaiʻi–Oʻahu, Hawaiʻi Island, Kauaʻi, Lānaʻi, Maui, and Molokaʻi–and was completed in 1939. However, due to circumstances related to World War II, the results of this soil survey were written up in 1947-48 and published in 1955 (United States Soil Conservation Service, 1955).

With its unique geology and climate, Hawaiʻi presented specific challenges for soil mapping. The islands' volcanic origins and the State's diverse microclimates meant a wide range of soil types. Areas were sampled and mapped at different intervals, depending on their importance. Detailed surveys were completed using data from traverses at ⅛ - ½ mile intervals; semi-detailed surveys at ¼ to 1 mile intervals; and reconnaissance surveys from 1-10 mile intervals. In areas of less concern, data was compiled from maps, reports, and oral accounts of foresters, ranchers, and other sources not trained as soil surveyors. This survey served as the foundation for understanding the soils of Hawaiʻi at that time.

The second major soil survey for the Hawaiian islands was conducted cooperatively by the Soil Conservation Service and the University of Hawaiʻi Agricultural Experiment Station in the mid-1960s, and released in the early 1970s. Soil scientists studied the landscape, dug soil pits to examine profiles, classified and named the soils, and delineated soil boundaries on aerial photos to create the soil maps. The main units of mapping are soil series (soils with similar profiles) and soil phases (specific varieties within a series). Complexes and associations are used where areas contain intermingled or complex patterns of soils. Laboratory data was collected on soil properties and crop yield data was also reviewed. This was used along with field experience to group the soils into classes for interpretive purposes. The goal was to organize the detailed soil data to make it most useful for various applications like agriculture, forestry, and engineering. In summary, this second survey, released in 1972 for the islands of Kauaʻi, Oʻahu, Maui, Molokaʻi, and Lānaʻi (United States Soil Conservation Service et al., 1972), and in 1973 for Hawaiʻi Island (United States Soil Conservation Service, 1973), involved field study, laboratory analysis, and data organization to characterize, map, and classify the soils for practical land use purposes.

With the evolution of soil science, soil properties databases have changed over time. The system used in the 1955 survey was based on soil genesis, while the 1972-73 surveys adopted the new Soil Taxonomy System, which focuses on quantifiable soil and provides a more uniform classification by a group of scientists. It considers properties like soil depth, moisture, temperature, texture, structure, cation exchange capacity, base saturation, clay mineralogy, organic matter content, and the presence of oxides of iron, aluminum, and salts to classify soils (McCall, 1975).

The statewide surveys and later updates incorporated into SSURGO remain the most extensive resources for soil properties in Hawaiʻi to date.

Methodology and Components

Soil samples from various locations within survey areas are collected and analyzed to determine key soil properties, including soil texture (proportions of sand, silt, and clay), organic matter content, pH, drainage characteristics, cation exchange capacity, and more. Results are used to delineate soil map units, where each map unit represents an area with similar soil characteristics. The boundaries of these units are drawn based on observed changes in soil properties. Originally hand-drawn in a manual cartographic process, these boundaries are now stored in a geographic information system (GIS) for management and further analysis. Aerial and satellite imagery supplement soil survey data, as the images can provide valuable information about land cover, topography, and other factors that influence the classification of soils. SSURGO soil data are based on the Soil Taxonomy System developed by the USDA, and rely on specific soil properties and their measured values to classify and categorize soils.

SSURGO includes data that rates soils for various land uses, including agriculture, urban and infrastructure planning, conservation and environmental management, and forestry. Within agriculture, assessments can be made regarding the suitability of soils for various crops with consideration of soil drainage, texture, and erosion risk. These tools can help farmers make decisions about crop selection and soil management practices.

A commonly used SSURGO data facet are the Land Capability Classification (LCC) system ratings. The capability classes (I to VIII) are determined based on the severity and number of limitations. Class I soils have the least limitations and are suitable for a wide range of crops, while Class VIII soils have severe limitations that make them unsuitable for commercial production.

The subclasses (e, w, s, and c) are determined based on the primary limitation for agricultural use. Subclass e represents soils with limitations due to the risk of erosion, subclass w represents soils with water-related limitations, subclass s represents soils with limitations due to shallow, droughty, or stony conditions, and subclass c represents soils with limitations due to climatic conditions.

Land capability classes and subclasses for both irrigated and non-irrigated lands are generated based on an assessment of the soil's physical and chemical characteristics, climate, and landscape features. These factors determine the limitations of the soil for agricultural use.

For irrigated lands, the assessment includes factors such as the soil's water-holding capacity, permeability, depth, texture, structure, salinity, and alkalinity. The availability and quality of irrigation water, as well as the effectiveness of the irrigation system, are also considered.

For non-irrigated lands, the assessment focuses on the soil's natural moisture availability, which is influenced by factors such as rainfall, evaporation rate, and the soil's ability to store and transmit water. Other factors such as the soil's fertility, erosion risk, and limitations for mechanization are also considered.

For a given soil map unit (concept described below), the classification may differ between irrigated or non-irrigated land capability classifications. For example, the 3,500 acres of Makaweli silty clay loam at 0 to 6 percent slopes (map unit MgB), has a non-irrigated land capability classification of IVc (severe limitations with climatic constraints) but an irrigated classification of IIe (minor limitations with erosion risk).

Mapping Approach and Extent

SSURGO provides detailed soil mapping coverage for most of the United States, including 48 contiguous states, Alaska, Hawaiʻi, and the Territories, Commonwealths, and Affiliated Pacific Islands served by USDA-NRCS. The mapping scales range from more detailed, large-scale maps at 1:12,000 scale to smaller-scale maps at 1:63,360. Areas with 1:12,000 scale maps have more precise delineation of soil types and variation compared to the general overview provided by 1:63,360 scale maps (Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture, 2015).

Soil map units are the foundational components of SSURGO maps and represent areas dominated by a particular soil type or set of characteristic soil components. Map units are defined and delineated based on exhaustive fieldwork and sampling by experienced soil scientists who traverse the landscape observing variations in topography, vegetation, drainage, parent material, and land use. After digging soil pits and analyzing soil profiles, scientists determine the soil series, phases, and components present to delineate the extent of map units with similar composition (United States Department of Agriculture, 2017).

Each distinct soil type has a particular combination of physical, chemical, and biological characteristics. These inherent soil properties have significant implications for engineering constraints, agricultural productivity, natural hazard risk, hydrologic functioning, and the distribution of native plant and animal communities. The integration of soil types with climate and terrain can serve as a general indicator of land suitability for various purposes including engineering, agriculture, and wildlife habitat.

Each soil map unit is assigned a unique symbol or color on the soil map and is accompanied by a correlated set of tabular data describing the key physical, chemical, and biological properties of the soils within that delineated geographic area. Map unit names reflect the major soil components along with slopes, textures, frequency, or other features. This provides valuable localized information on the diversity and distribution of soils for land use planning and management.

SSURGO data is updated on an annual basis through the Annual Soils Refresh (ASR) process carried out by the USDA-NRCS and released on October 1st of each year. Both tabular attribute data and spatial map data are updated through the ASR. For tabular SSURGO data, the entire database is refreshed annually to publish new data, update existing data, and add new soil interpretations. For spatial SSURGO data, only areas with new maps or updates to existing maps are refreshed through the ASR process, which equates to approximately 10% of total SSURGO maps each year (Natural Resources Conservation Service, United States Department of Agriculture, n.d.). Updates depend on various factors such as significant changes in the landscape, advancements in soil science methodologies, and/or increased available resources to support detailed mapping.

Hawaiʻi participates in the ASR process to ensure regular annual updates to SSURGO datasets. However, more extensive spatial revision projects in Hawaiʻi require additional prioritization and support. In 2012, there was a major revision of SSURGO data for the entire island of Hawaiʻi that updated both spatial mapping data as well as tabular attributes. Since then, SSURGO updates in Hawaiʻi have focused more on correlation of map units across islands and taxonomic changes rather than large-scale spatial revisions. For example, in 2018 SSURGO spatial and tabular data was updated and added following new lava flows in Puna, Hawaiʻi. Many older "miscellaneous land types" still exist in Hawaiʻi SSURGO which warrant an update with more detailed spatial data (A. Koch, personal communication, September 29, 2023). While regular ASR updates continue, Hawaiʻi NRCS is engaging partners to identify needs and advocate for support to enable more extensive spatial revision projects in the future. Accelerated update work would help SSURGO data to provide current, high-quality standardized soil data that meets modern user needs.

Strengths and Limitations

Strengths

SSURGO remains the most extensive available statewide resource for soil properties. While small-scale testing is done on various parcels or regions for the purpose of research or agricultural development, this private data is not systematically made public.

SSURGO data is also georeferenced, which allows SSURGO data to be organized in multiple layers in a GIS to understand soil properties, land capability, erosion risk, and other relevant information of an area, enabling analysis of soil characteristics in relation to land use and management. SSURGO data integrated in a GIS enhances the utility of soil data by enabling spatial analysis, mapping, visualization, and informed decision-making across various sectors. This integration helps land managers, researchers, policymakers, and other stakeholders better understand and manage soils in a geospatial context.

The USDA Web Soil Survey is an online tool that provides access to the largest natural resource information system in the world, the SSURGO database. The USDA Web Soil Survey provides a wealth of data and interpretations that can be used for a wide range of applications, from construction and land management to disaster planning and soil health assessment.

Attributes from SSURGO data valuable for assessing soil health encompass:

- Water Permeability: Reflects the soil's drainage ability.
- pH (Acidity): Influences numerous biological, physical, and chemical soil processes.
- Organic Matter: Represents the non-mineral content of soil, derived from living organisms, however SSURGO estimates are not regarded as an accurate source of values.
- Soil Carbon: Provides values for total carbon. It's important to note these values do not specify the carbon's condition (whether stable or labile).
- Soil Structure: Pertains to the organization of soil aggregates.
- Nutrient Holding Capacity: Details how much and how well the soil can retain nutrients.
- Taxonomy: Classifies soils based on quantifiable soil properties.
- Soil Order: The broadest category, distinguishing soils by factors like parent material and age.
- Soil Series: A highly detailed category that takes into account a wide range of soil properties.

The Web Soil Survey also includes data on a variety of other soil health aspects like soil response to biochar application, soil fragility, limitations for aerobic soil organisms, organic matter depletion, compaction, and salt concentration.

Limitations

Limitations include the reliability and lack of dynamic soil qualities available in the SSURGO dataset. For example, while SSURGO essentially has all common intrinsic (such as physical and chemical) properties available in its database, these properties have been found to be inaccurate in many locations, particularly regarding soil carbon content. Furthermore, the SSURGO values for soil carbon are a measure of total carbon and are not indicators of the state of the carbon (stable or labile). Dynamic soil qualities and biological soil data values in SSURGO are often missing and/or outdated. Thus, while soil health can be approximated by using a combination of values provided within SSURGO, the margins of error throughout parameters limit the ability for this information to be extrapolated with high confidence. This gap in biological data is particularly important, as soil health depends heavily on dynamic biological activity, a growing focus of concern for scientists and policymakers alike.

NRCS provides access to SSURGO in a database format with a related GIS spatial layer, as well as through a Web Soil Survey online portal. The Hawaiʻi Open Data portal provides the SSURGO spatial map unit layer but requires potential users to download tabular soils data separately, county by county, from the NRCS Web Soil Survey. The spatial and tabular data would then need to be joined by a user. Thus while SSURGO has the most detailed information on soil ratings with and without irrigation, slope, depth of soil, permeability, available water capacity, pH, shrink-swell potential, and chemical components, the readability of the information by those who are not proficient in database or GIS systems may limit its use. For example, awareness that SSURGO contains ratings and yield estimates for sugarcane, pineapple, pasture, and commercial timber is limited. That said, most commercial crops in Hawaiʻi do not have any ratings and yield estimates provided in SSURGO.

The manual cartographic process described in the Soil Survey Manual (United States Department Of Agriculture, 2017) has three notable limitations. First, soil delineations are heavily dependent on features visible in the aerial photographs used as base maps. Second, there is a limit to the minimum mappable size of soil areas; and third, soil boundaries are depicted as sharp breaks rather than gradual transitions (Brevik et al., 2016). As SSURGO, or its precursors, are the soils datasets used in all classifications, this limitation thus extends across all of the systems reviewed in this report.

Last, SSURGO's slow update cycle fails to keep pace with landscape changes and scientific advancements. Although the national Annual Soil Refresh program allows for incremental updates, large-scale remapping of SSURGO data remains resource-intensive and infrequent. Significant changes in land use, new scientific findings, and evolving user needs drive demand for more frequent updates, but limited resources constrain the ability to respond to these needs. With sufficient funding and personnel, SSURGO could be modernized at state and regional levels, reducing reliance on annual updates and establishing an update cycle of 10-20 years.

Opportunities for Improvement

In addition to physical and chemical properties, soils harbor an immense diversity of microorganisms and organic matter that interact and transform the soil over time. Shifts in climate, vegetation, soil amendments, management practices, and other environmental factors can alter biological activity and processes within soils. These transformations can occur over periods ranging from days to centuries, with short-term shifts responding to environmental changes and long-term changes shaped by stable organic matter accumulation and ecosystem development. Soil scientists indicate that more frequent remapping and updates could capture changes in soil biology and processes missed by widely spaced mapping intervals, and that dense, high-resolution temporal data on soil biota and soil organic carbon would greatly advance understanding of soil change trajectories. Overall, increased resourcing for regular mapping updates using the latest science and technology would yield benefits for monitoring and managing dynamic soil resources. This lack of regularly updated data on soil biology and organic matter is thus an issue across all the soil classification systems reviewed in this report, as each system, either directly or indirectly, utilizes SSURGO or its predecessor data sets.

Prior Reports and Studies

Major Soil Surveys

- United States Soil Conservation Service. (1955). Soil Survey, Territory of Hawaii: Islands of Hawaii, Kauai, Lanai, Maui, Molokai, and Oahu (1955). http://archive.org/details/usda-hawaii_territory1955
- United States Soil Conservation Service. (1972). Soil Survey of the Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. United States Government Printing Office. http://archive.org/details/usda-islandsHI1972
- United States Soil Conservation Service. (1973). Soil Survey of Island of Hawaii, State of Hawaii. United States Government Printing Office. http://archive.org/details/usda-hawaii_state1973

Selected Other Reports

- McCall, W. W. (1975). Soil classification in Hawaii (Circular 476). Cooperative Extension Service, University of Hawaii. http://hdl.handle.net/10125/53628
- Uehara, G., & Ikawa, H. (2000). Use of Information from Soil Surveys and Classification. Plant Nutrient Management in Hawaii's Soils, Approaches for Tropical and Subtropical Agriculture. Honolulu: College of Tropical Agriculture and Human Resources, University of Hawaiʻi at Mānoa, 67–77.

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IV. System Comparison

The following comparative analysis of Hawaiʻi's soil classification systems evaluates their strengths, weaknesses, and overall effectiveness in identifying and classifying agricultural lands. This assessment focuses on four major systems: the Land Study Bureau (LSB), Agricultural Lands of Importance to the State of Hawaiʻi (ALISH), Soil Survey Geographic Database (SSURGO), and Land Evaluation and Site Assessment (LESA). Key factors such as accuracy, adaptability, transparency, and the incorporation of non-soil elements are examined. The evaluation is informed by a comprehensive review of existing literature, expert consultations, and public input. The overall aim was to identify areas for improvement and guide the development of more robust agricultural land evaluation tailored to Hawaiʻi's unique conditions.

Criteria for System Comparison

Evaluation criteria were developed through a comprehensive process incorporating initial factors identified in the project scope and local planners' presentations comparing existing systems (Yamamoto, 1999; Chillingworth, 2009; and Souki, 2013), contractor team discussions, interviews with Steering Committee Members, and legal and technical subject matter expert input during early outreach activities. The assessment focused on eight key criteria:

1. **Accuracy in identifying quality agricultural lands**: How well the system classifies and delineates the most productive agricultural lands based on soil properties, soil health, topography, climate, etc.
2. **Adaptability to changing conditions and crop production**: The ease and feasibility of updating the system to account for new crops, technologies, soil data, etc.
3. **Transparency, understandability, and documentation**: How clear and accessible the methodology and rationale of the system are.
4. **Incorporation of non-soil factors**: Extent to which non-soil factors (e.g., access to markets, land use plan alignment) are considered.
5. **Geographic coverage**: Completeness of geographic coverage across the State and areas excluded from analysis.
6. **Productivity & Agricultural Value**: The extent to which the system accounts for the economic value of agricultural lands based on productivity.
7. **Irrigation Infrastructure**: The degree to which the system considers the presence, access, and need for irrigation infrastructure and water systems.
8. **Cultural & Indigenous Considerations:** The incorporation of Hawaiian indigenous knowledge, land classifications, and cultural factors into the methodology.

The rubric can be found in Appendix B’s Comparison Criteria Table, and more information on the rubric can be found in the Interim Report.

Criteria Based Comparison of Soil Classification Systems in Hawaiʻi

The following analysis highlights selected strengths and weaknesses of each system based on the set of assessment criteria. This allows comparison across critical dimensions relevant to supporting agricultural planning and policymaking. See Appendix B’s Comparison Rubric Table for additional review information.

Accuracy in Identifying Quality Agricultural Lands

- SSURGO provides detailed soil data and interpretations to identify lands suitable for cultivation, but lacks key indicators of overall quality like soil biology.
- LSB is based primarily on soil properties so has limitations in identifying all productive lands.
- ALISH relies mainly on soil properties but tries to expand beyond just prime lands.
- LESA incorporates both soil and other factors that influence agricultural viability but has outdated data quality issues.

Adaptability to Changing Conditions and Crop Production

- SSURGO has an annual update process that allows incremental improvements over time. However, extensive remapping requires significant resources and has not occurred comprehensively since initial mapping efforts in the 1970s.
- LSB, ALISH, and LESA have not been updated since their initial development, limiting their accuracy and relevance under modern conditions.

Transparency, Understandability, and Documentation

- SSURGO has robust documentation available online detailing methodology and rationale, however database and GIS skills are required to fully access some of the data.
- LSB's methodology is published in hardcopy but lacks easily accessible documentation.
- ALISH has published reports that provide an overview but details are lacking.
- LESA details are available in government reports but not consolidated/online.

Incorporation of Non-Soil Factors

- SSURGO emphasizes soil factors directly related to productivity.
- LSB focuses narrowly on inherent soil productivity.
- ALISH mainly examines inherent soil characteristics.
- LESA specifically includes socioeconomic, policy, and other non-soil criteria.

Geographic Coverage

- SSURGO provides detailed statewide coverage.
- LSB mapped all major islands except Niʻihau and Kahoʻolawe, and excluded urban areas.
- ALISH and LESA were criteria based and thus have the most limited spatial coverage.

Productivity and Agricultural Value

- SSURGO contains crop yield data to estimate productivity potential.
- LSB provides general productivity ratings but lacks economic valuation.
- ALISH has no economic analysis, just broad productivity classes.
- LESA has no monetary valuation, just qualitative productivity factors.

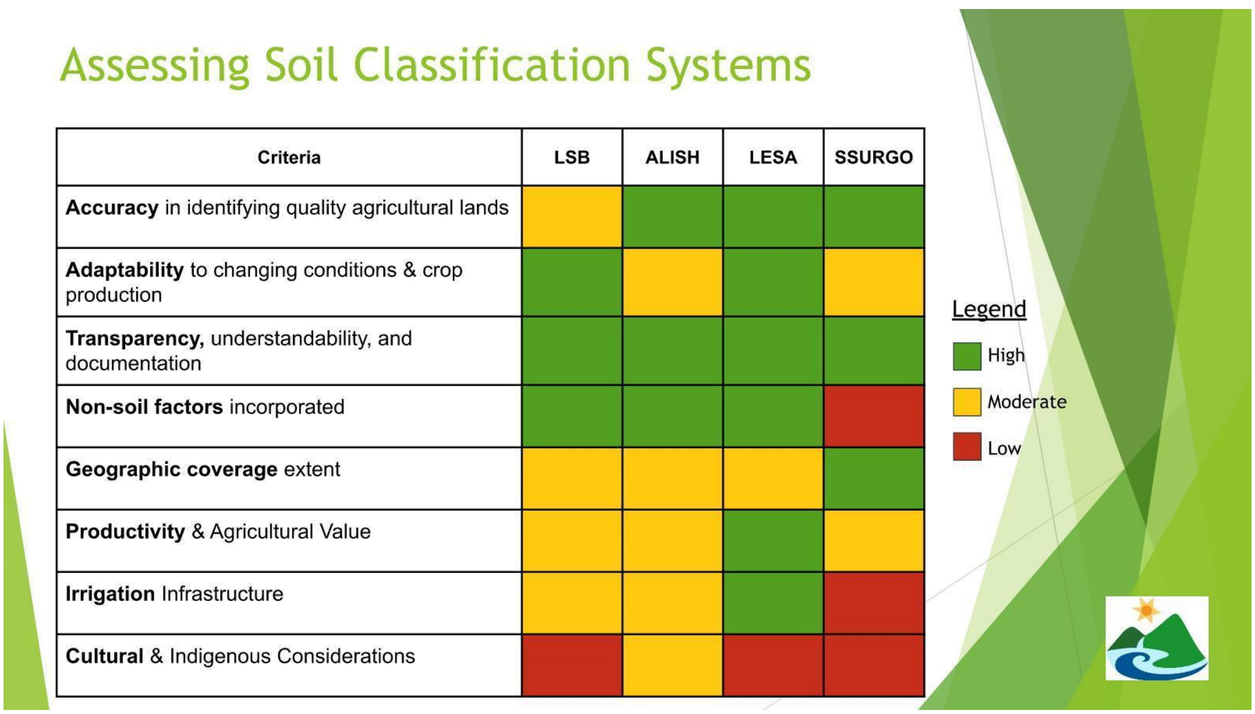
Irrigation Infrastructure

- SSURGO indicates generalized irrigation needs but does not include infrastructure data.
- LSB accounts for presence/absence of irrigation but data is outdated.
- ALISH notes irrigation availability but information not updated.
- LESA includes a basic but outdated assessment of irrigation potential.

Cultural and Indigenous Considerations

- LSB does not incorporate traditional Hawaiian knowledge or cultural factors.
- ALISH considers the traditional Hawaiian crop taro in identifying Unique lands.
- LESA has no documentation of cultural considerations beyond the incorporation of ALISH's Unique lands category.
- SSURGO does not address traditional Hawaiian systems or crops.

The systems were graded into high, medium, or low for each criterion, as compiled Appendix B's Comparison Rubric Table. Based on those grades, criteria and systems were presented visually during Phase II outreach, as displayed in the slide below.



Criteria	LSB	ALISH	LESA	SSURGO
Accuracy in identifying quality agricultural lands	Moderate	High	High	High
Adaptability to changing conditions & crop production	High	Moderate	High	Moderate
Transparency, understandability, and documentation	High	High	High	High
Non-soil factors incorporated	High	High	High	Low
Geographic coverage extent	Moderate	Moderate	Moderate	High
Productivity & Agricultural Value	Moderate	Moderate	High	Moderate
Irrigation Infrastructure	Moderate	Moderate	High	Low
Cultural & Indigenous Considerations	Low	Moderate	Low	Low

Additional Comparison of Soil Classification Systems in Hawaiʻi

Comments provided by OPSD and SC members identified additional areas of consideration for comparing the four major soil classification systems. Using additional criteria identified, strengths and weaknesses of each system were analyzed with respect to:

Robustness to Changing Conditions

- SSURGO has an annual update process that allows incremental improvements over time. However, extensive remapping requires significant resources and has not occurred since the 1970s.
- LSB, ALISH, and LESA have not been updated since their initial development, limiting their accuracy and relevance under modern conditions.

Flexibility for Transitions Between Crops

- SSURGO provides generalized crop suitability ratings but lacks specificity for most of Hawaiʻi's current diverse crops.
- LSB and ALISH have fixed crop assumptions that may not match current cultivation.
- LESA could likely be adapted for new crops more readily.

Focus on Plantation vs Diversified Agriculture

- LSB reflects aspects of large-scale plantation agriculture systems as those operations were a major source of yield data.
- ALISH reflects aspects of large-scale plantation and diversified agriculture systems.
- LESA offers flexibility to incorporate diversified agriculture factors.
- SSURGO provides only limited diversified crop suitability data in its yield estimates.

Consideration of Land Access and Tenure

- None of the systems directly address land ownership patterns or tenure arrangements.

Accounting for Management Practice Impacts

- Management practices are not explicitly incorporated in LSB, ALISH or SSURGO.
- LESA includes management-related factors like farm facilities, farm parcel size, and services.

Incorporating Cultural Factors

- No systems comprehensively address cultural aspects related to traditional cultivation.
- ALISH incorporates traditional crop lands for taro.

Legal Frameworks Enabling Regulation

- LSB and ALISH are embedded in Hawaiʻi statutes governing agricultural lands.
- SSURGO and LESA currently lack regulatory standing but can inform policymaking.

Overlay Mapping

An interactive overlay map was created using a web mapping tool and embedded into the project website (see Figure 1. Overlay Map Screenshot). The map displays various the soil classifications, agricultural land use assessments, and agricultural land designations used in Hawaiʻi. This visualization tool allows stakeholders to explore and compare different land classification systems across the state.

The overlay map serves as an exploratory data analysis tool, enabling visual spatial analysis without producing summary spatial statistics. It aims to provide a flexible visualization and enhance understanding of the coverage and differences between various land classification systems. In the digital map users can toggle layers on and off, customizing the information displayed. The overlay map includes:

- LSB's Overall (Master) Productivity Ratings
- Agricultural Lands of Importance to the State of Hawaiʻi (ALISH)
- Land Evaluation and Site Assessment (LESA) Commission's Important Agricultural Lands
- Statewide Agricultural Land Use Baseline (SALUB) 2020 update details crop types and acreages
- Important Agricultural Lands (IAL) designated by State Land Use Commission (as of October 2020)

SSURGO data was not included due to its numerous layers and lack of regulatory use of LCC in Hawaiʻi.

All data were sourced from the Hawaii Statewide GIS Program Geospatial Data Portal (https://geoportal.hawaii.gov/). For more information on the soil classification systems, refer to Section III, Evaluation of Existing Soil Classification Systems.

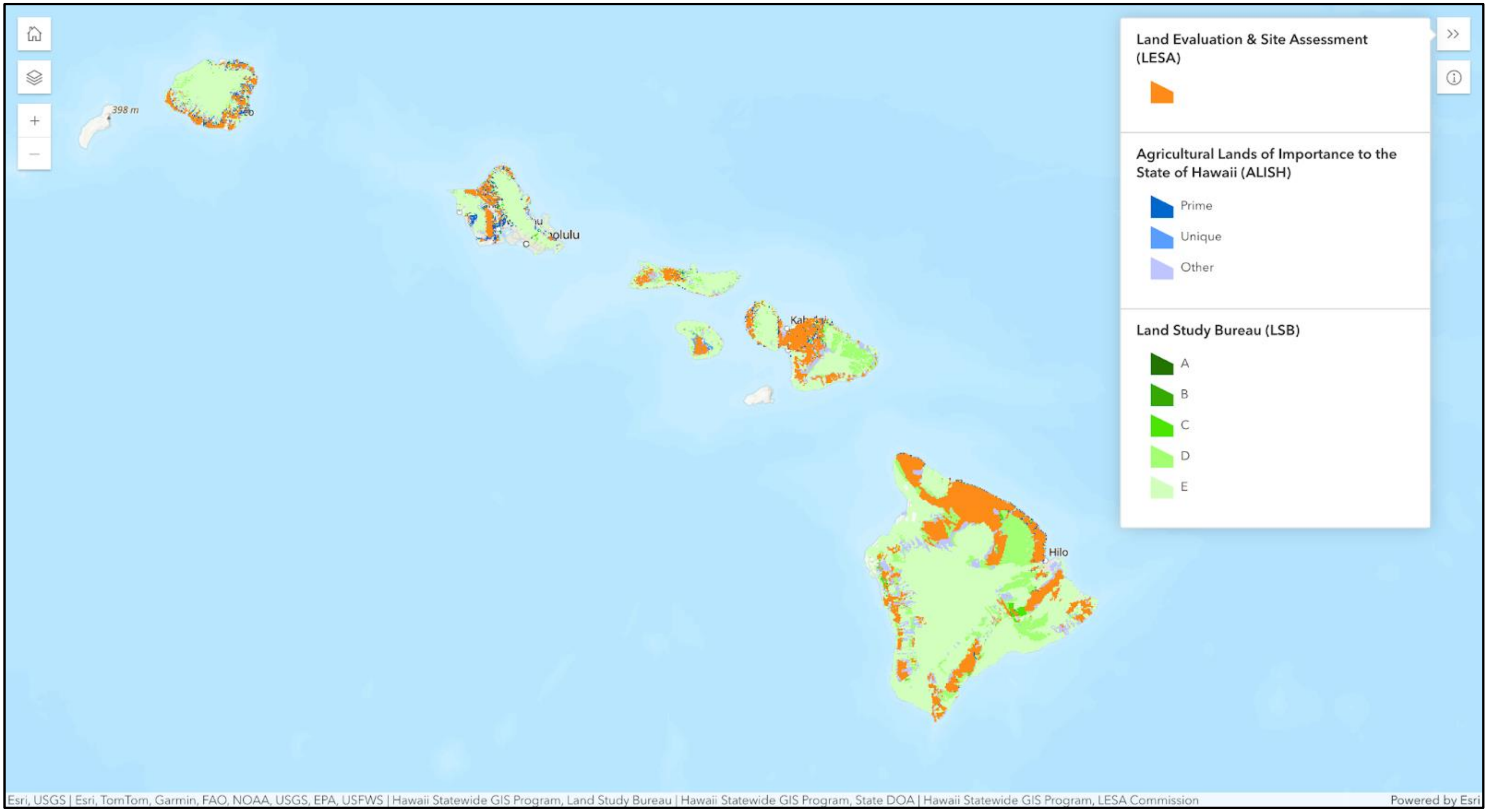
System Comparison Conclusions

In summary, the evaluation reveals distinct approaches and capabilities across Hawaiʻi's agricultural land classification systems. While all systems have limitations, the more recent systems appear more robust. This is due in part to later systems inputs being composed of outputs of earlier systems. As demonstrated in Section III LSB and ALISH focus primarily on inherent soil productivity potential, SSURGO provides comprehensive soil survey data, and LESA extends beyond these to incorporate economic and social factors. Each system presents unique strengths and challenges:

SSURGO offers the most robust and frequently updated soil dataset, serving as a foundation for other systems. However, its technical complexity limits accessibility, and it requires significant updates to meet current needs. Since all systems rely on SSURGO data or its precursor, its limitations affect the entire classification framework. LESA represents the most modern approach, demonstrating flexibility and comprehensive integration of diverse factors relevant to contemporary agriculture. However, its lack of implementation in Hawaiʻi policy has limited its practical impact. LSB and ALISH, while embedded in state statutes and widely used, rely on outdated methodologies aligned with past agricultural practices. ALISH attempts to incorporate cultural considerations through its treatment of taro lands, but both systems struggle to reflect the diversity of modern agriculture. Their regulatory standing provides authority but also complicates updates to their outdated frameworks.

Looking forward, agricultural land classification in Hawaiʻi would benefit from several key improvements. These include updating systems to reflect current agricultural conditions and needs, improving documentation of system methods beyond those included in the State’s GIS metadata, and integrating modern soil science and land evaluation practices. Additionally, developing more user-friendly interfaces for system access and interpretation, along with creating more responsive frameworks for agricultural land suitability assessment, would enhance the overall utility of these classification tools. The development of a next-generation system that combines these existing approaches' strengths while addressing their limitations could significantly enhance agricultural planning and policymaking in Hawaiʻi.

FIGURE 1. OVERLAY MAP SCREENSHOT



V. Soil Classification Systems References in State and County Codes and Regulations

Overview

Hawaiʻi's regulatory and policy framework for agricultural lands and their use is framed in the State Constitution Article 11, Section 3, which states "The State shall conserve and protect agricultural lands, promote diversified agriculture, increase agricultural self-sufficiency and assure the availability of agriculturally suitable lands." This study compiles the various ways this framework is implemented in policies, such as HRS §205-4.5, which uses LSB productivity ratings as a key tool to regulate permitted uses on agricultural lands.

As part of the review, a detailed list of State and county laws, ordinances, and administrative rules in Hawaiʻi that cite soil classification systems for regulating land use and development permitting was compiled. This compilation includes not only the regulations themselves but also specific sections or subsections that reference or utilize the system. The aim of this task was to provide an understanding of the extent to which current systems are integrated into state and county regulation, the policy change impact of soil classification system recommendations from this project, and the implications of such changes to land use and development regulation. To wit, given the extent to which the various soil classification systems are integrated into state and county rules and regulations it may be practically quite difficult to implement changes without substantial effort and state level legislation.

Methodology

The process of compiling this list involved extended research and a systematic approach. We began by collating relevant databases and resources, including the Hawaiʻi Revised Statutes (HRS), Hawaiʻi Administrative Rules (HAR), and each county's ordinances and rules. We also reviewed administrative rules for various departments at both the state and county levels.

To ensure a thorough search, a list of search terms based on the soil classification systems was created. These terms were used in a Boolean search string to locate any mentions of soil classification systems or related terminology in the identified databases and resources.

Relevant sections or subsections were recorded in a structured manner, noting the specific policy provision, full statute or rule language, a web link to the resource, the soil classification system(s) cited, notes about the finding when statute or rules language was unclear, and basic coding of the type of regulation. This information was consolidated into a searchable and filterable database, which can be viewed on the project website (https://arcg.is/1T99X0).

A truncated table of the data can be found in Appendix F.

Findings

The regulations identified span a diverse range of policy areas beyond just agriculture. The research compiled 40 references from state and county jurisdictions, encompassing laws (26) and administrative rules (14). These citations relate to zoning, land use districting, subdivision, development permitting, agricultural parks, solar facilities, environmental review, and other facets of land use planning and regulation at both the state (18) and county (22) levels. While many of the regulations specify particular soil classification systems by name, some are unclear and only generally reference soil classification without noting an exact system.

FIGURE 2. SOIL CLASSIFICATION POLICY REFERENCES BY JURISDICTION

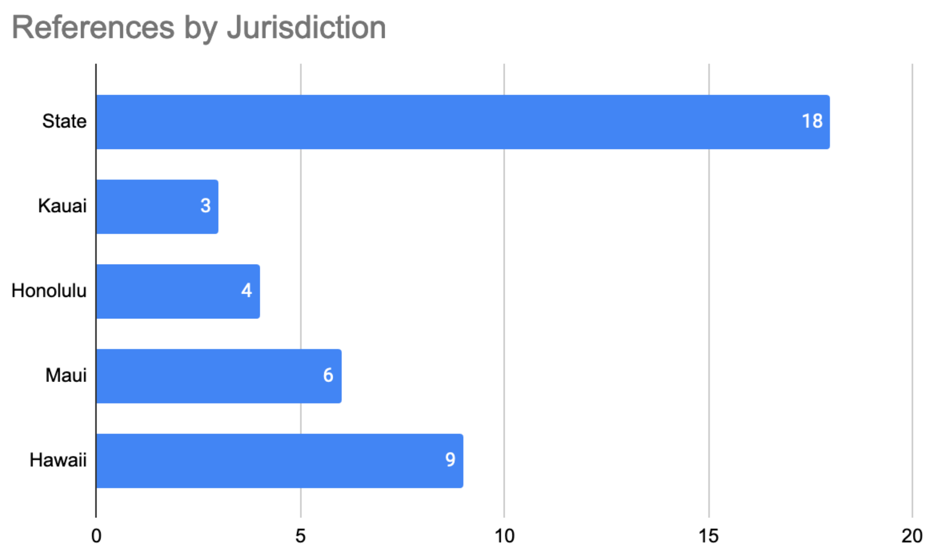


Figure 2 illustrates the soil classification policy references by jurisdiction, illustrating the number of codes and regulations that reference soil classification systems across the state and in each county. The most frequently referenced system across the regulations is LSB's Overall (Master) Productivity Rating, followed by ALISH and policies that didn't specify which system should be employed. The LESA system is only referenced in Administrative Rules.

FIGURE 3. SOIL CLASSIFICATION POLICY REFERENCES BY SYSTEM & JURISDICTION

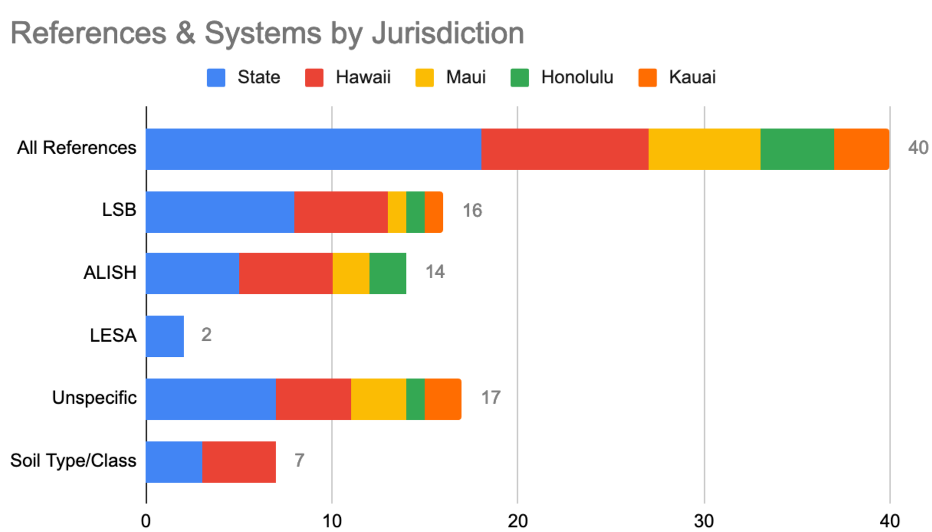


Figure 3 focuses on the soil classification systems referenced by system and jurisdiction, revealing that LSB's Overall (Master) Productivity Rating is the most frequently cited system, followed by ALISH. The LESA system is mentioned only in administrative rules. Many policies do not specify which system should be used.

The breadth of entities involved runs the gamut from state agencies like the Department of Land and Natural Resources (DLNR), Department of Business, Economic Development and Tourism (DBEDT), and the LUC to the individual counties and their departments.

The findings reveal a diverse range of regulations that cite soil classification systems. These regulations span various aspects of land use and development permitting, and real property tax, reflecting the roles that soil classification systems play in shaping Hawaiʻi's land use policies and practices.

FIGURE 4. SOIL CLASSIFICATION REFERENCES BY FOCUS AREA

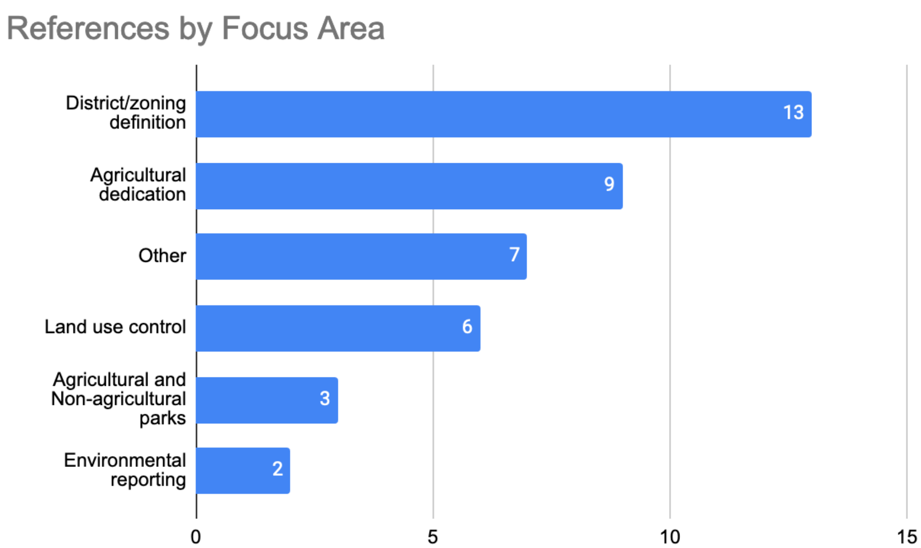


Figure 4 highlights the focus areas of these regulations, emphasizing their relevance to various aspects of land use and development permitting. The findings underscore the significant role that soil classification systems play in shaping Hawaiʻi's land use policies and practices.

CHALLENGES AND LIMITATIONS

Even with the systematic approach, there were some challenges and limitations. For one, the different approaches between the state and counties in their compiling, digitizing, and hosting of statutes and administrative rules on the web posed difficulties.

At the state level, the HRS are listed on the capitol website across thousands of individual pages, whereas the HAR are linked from the Lieutenant Governor's webpage, but are stored and listed differently at each state department. These issues with state level data access were overcome by the use of the Westlaw Edge program, an online proprietary database, to enable searching across the entirety of the HRS and HAR.

At the county level, there were significant differences in how the codes of ordinances and administrative rules and regulations are provided online. Honolulu, Maui, and Kauai counties each, unlike the state HRS, provide an online full text database of ordinances. Hawaiʻi County provides multiple PDF format documents, including an unofficial 2016 document of all ordinances that was searchable using a PDF reader. For county administrative rules and regulations, no cross-department compilation of rules was found for any county. Instead, many counties provided digital access for some of their departments' administrative rules. Numerous county administrative rules, when findable, were also not provided in a searchable format.

Due to these issues, while there is confidence in the state level data and county ordinance data, it is possible that some county administrative rules and regulations may have been overlooked due both to the sheer volume of files and the lack of digitally shared administrative rules data for many county departments.

Despite these challenges, the compilation provides an overview of the regulations that cite soil classification systems in Hawaiʻi. This serves as a valuable resource for understanding the application of soil classification systems on land use and development in the State. Furthermore, the compilation clarifies how deeply these systems are embedded in regulations, offering insight into the potential scale of changes needed if modifications to the structure or usage of the current systems were pursued.

Outcomes & Utility

The compilation of regulations that cite soil classification systems was a critical step in our research. It provided a solid foundation for our subsequent analysis and helped inform the development of recommendations for improving land use and development practices in Hawaiʻi. These regulations were analyzed in greater detail to understand their implications for land use and development. This will involve a closer examination of the specific provisions and requirements, as well as the broader context in which they are applied. Based on recommendations developed in Phase II, examples of state and county statutes, ordinances, and rules that would need to be amended or revised are included below.

1. Update Outdated Soil Classification Systems

Regulations should be updated to replace outdated classification systems such as the LESA and ALISH with an updated LSB system where relevant. This update is necessary to reflect more current and accurate data, which will strengthen decision-making in land use, especially for housing, agriculture, and development projects.

- **Example: LESA and HHFDC §15-307-26** – The Hawaiʻi Housing Finance and Development Corporation's (HHFDC) regulation cites the use of LESA in the minimum requirements for a project proposal. Other than DLNR using LESA as an example and not a directive, this HHFDC rule is the only one that specifically uses LESA. HHFDC may want to consider revising §15-307-26 with a replacement of LESA or addition of LSB.

2. ALISH Use in County Regulations

ALISH is still referenced in several county regulations, including those from Honolulu and Maui counties, which use ALISH to identify important agricultural lands (AG-1, AG-2). If the state transitions to the LSB model, counties may need to revise these regulations.

- **Example: Honolulu County ROH 21-3.50 and 21-3.60** – These regulations currently use ALISH for identifying agricultural and country lands. Updating this to the LSB system, or at least clarifying its relation to modern soil classification, would streamline consistency between state and county regulations.
- **Example: Maui County Title 19** – ALISH is used for determining agricultural priorities. Similar to Honolulu, updating the reference to include LSB, or transitioning fully to LSB, would provide a clearer framework for land designation and preservation.

3. Handling ALISH/LSB Intersections

There are situations where both ALISH and LSB are cited together, such as in DBEDT boundary amendment petitions and Hawaiʻi County's criteria for determining Family Agriculture (FA) lands. Since ALISH is intertwined with LSB in these instances, and also used frequently with IAL (see below), it may not be prudent to eliminate ALISH outright.

4. Use of ALISH in IAL Designations

In some regulations, ALISH is used as an example of a criterion in identifying Important Agricultural Lands (IAL) (DBEDT), or just as an example of an agricultural productivity rating system (LUC). In both of these instances, ALISH is used as an example, and therefore doesn’t necessarily need to change.

- **Example: DBEDT §15-15-120(c)(3)** - The date that the ALISH system was adopted by the board of agriculture is stated here, and could be something that is revised in regulations that use the updated LSB hereafter. For example - “The land's classification or identification under agricultural productivity rating systems, such as the Land Study Bureau (LSB) system as adopted by the board of agriculture on January 28, 2026, and so amended thereafter.”
- **Example**: **HRS §205-44 and DBEDT §15-15-120** – These regulations refer to ALISH for use in determining IAL. All of the other statutes that refer to IAL do not include reference to soil classification systems, and were not included in this analysis.

5. Use of LSB in State and County Regulations

LSB plays a significant role in several state and county regulations with regard to permissible uses or allowable lands for transfer.

- **Example: Honolulu County Golf Course Development (§24-1.14)** – This regulation utilizes LSB as one of several criteria for determining the siting of golf courses. The inclusion of LSB alongside other factors demonstrates how soil classification can be integrated as part of a broader decision-making process, which could be a model for other regulatory updates.
- **Example: Solar Development in Kauai and Maui Counties** – The use of LSB in criteria for solar development aligns with state priorities for renewable energy projects and land use sustainability.

6. Vague and Unclear Soil Classification References

Several regulations reference soil quality or agricultural productivity without specifying the classification system being used. This ambiguity creates inconsistencies in land evaluation and regulatory application.

- **Example: Defining Classification Terms** – It’s important that terms like LSB or ALISH are explicitly defined within regulations to provide clarity. For example, regulations that reference soil productivity without a defined system risk misinterpretation, leading to inconsistent land use decisions across counties and projects.
- **Example: State Planning Act** – The act refers to maintaining agricultural lands of importance but does not clarify whether this is based on ALISH, LSB, or another system.
- **Example: Hawaiʻi County §25-5-80 and §25-6-50** – Terms like "important agricultural lands" are further defined in the Hawaiʻi County General Plan as Productive Agriculture and Extensive Agriculture, which are further defined using ALISH and LSB. These regulations could benefit from explicit references to specific soil classification systems within the rules themselves.

7. Parcel-Level Classification Adjustments

Honolulu County's Department of Budget and Fiscal Services has a process in place for petitioning changes to land productivity ratings (§4-11-5 Findings of Fact). This existing framework allows landowners to request reevaluations based on changing conditions or updated classification systems, which could be expanded to ensure alignment with state-level updates like the transition to an updated LSB. Other Counties may want to consider having similar legislation if they do not have it already.

CONCLUSION

The analysis suggests that some of Hawaiʻi's state and county regulations related to soil classification need updates and clarifications to reflect modern data and align with best practices. Outdated systems such as LESA and ALISH should be phased out in favor of the LSB system, where appropriate. Regulations also need clearer definitions of classification terms to ensure consistency across counties and regulatory bodies. For those instances where ALISH and LSB intersect, careful consideration should be given to whether both systems need to be retained, modified, or transitioned entirely to LSB. These changes will streamline the regulatory framework and improve land use and development decisions across the state.

In closing, it is clear that embedding classification systems into regulatory structures is a political activity, as it governs land use and can have significant economic impacts. A prime example is the current use of the LSB system to regulate solar energy development, a purpose for which it was not designed. Further, LSB has not been updated for over half a century, based on the politics of the era leading to defunding of the effort. This misalignment not only subverts the original intent of the LSB system but also underscores the necessity for a modernized land evaluation model that can effectively address current agricultural practices and has an explicit relationship with emerging land use demands, such as renewable energy development.

VI. Phase I Outreach and Stakeholder Perspectives

Summary of Outreach Activities

A stakeholder engagement process was undertaken to understand the current usage of soil classification systems and to collect recommendations for enhancing their role in agricultural land regulation. This process involved engaging stakeholders through interactions with the Steering Committee, consultations, meetings, and outreach activities aimed at gathering input and feedback. Stakeholder comments and perspectives were gathered through focus groups, meetings held at the county level, and a digital forum, ensuring understanding of insights and suggestions.

Stakeholders were identified in Act 189 (2022), through recommendations from the Project's Steering Committee, and from the Project Team's previous experience. The diverse group of stakeholders included individuals from private, non-profit, State, and county organizations, representing varied backgrounds in technical-legal matters, agriculture, land use, energy, development, and large land ownership. They offered valuable insights into the utilization of systems across Kauaʻi, Oʻahu, Maui, Hawaiʻi, and Statewide. This list of stakeholders included the Hawaiʻi Farm Bureau, Hawaiʻi Farmers Union United, Hawaiʻi's Thousand Friends, Ulupono Initiative, Hawaiʻi State Energy Office, county planning departments, elected State and county officials, Soil and Water Conservation Districts, county resource conservation and development councils (RC&Ds), Hawaiʻi Agriculture Research Center, associated non-profit organizations, extension agents, farmers, landowners, local community members, and additional relevant parties identified during the course of the project. Stakeholder representation was meant to ensure that diverse perspectives and expertise are considered, leading to well-informed and inclusive outcomes.

To gain a preliminary understanding of stakeholder perspectives and recommendations, four one-on-one or small group meetings were held with individuals who have substantial exposure to soil and land classification systems and/or with related procedural, legal, social, cultural, and community issues. These included representatives from CTAHR, HDOA, LUC, and OPSD. Through these meetings, deeper understanding of the systems, as well as the positions, sentiments, perspectives, and attitudes regarding soil classifications, was obtained.

As an ancillary benefit of the engagement process, the team was able to assess stakeholders' familiarity with soil classification systems, their methodologies, and their application in regulatory contexts. Based on preliminary observations, it was anticipated that detailed knowledge of these systems and their intersection with land use policy might be concentrated among a small group of specialists. With this in mind, outreach activities were designed to include information sharing about the systems and their regulatory use. This approach revealed that while stakeholders possess extensive expertise in agriculture, planning, soil sciences, and related fields, the intricacies of soil classification systems and their specific regulatory applications in Hawaiʻi are indeed specialized knowledge. These findings highlighted an opportunity to broaden understanding and enhance accessibility of information regarding soil classification systems and their intersection with land use policy, which could benefit stakeholders across various sectors.

Two types of formal stakeholder meetings were held: Focus Group and County Group meetings. A total of three Focus Group meetings were held, inviting a) individuals with technical-legal expertise (e.g., LUC, LURF, State/private planners, land use lawyers, etc.); b) agricultural and land use stakeholders (e.g., HDOA, Hawaiʻi Farm Bureau, Hawaiʻi Farmers Union, CTAHR, HILT, etc.); and c) other impacted groups and other stakeholders identified in earlier focus groups (energy, additional developers, large landowners, etc.) to participate. Three County Group meetings were also held, and included county planners, elected officials, and other appropriate stakeholders including Soil and Water Conservation Districts, select farm and ranch entities, community groups, and farm organization leadership. The goal of these meetings was to understand how soil classification systems are being used, to gather input on systems' strengths, limitations, and potential improvements, and to learn of different approaches to utilizing soil systems in agricultural land use regulation. County Group meetings were similar to Focus Group meetings, but included additional information and solicited additional feedback about regulation utilizing soil classification systems at the county level.

Meeting invitations included a link to the project website, which provided an overview of agriculture and land use planning in Hawaiʻi, soil classification systems, and overlay maps of the systems. Further insights into each system were elaborated upon during the meetings (refer to Appendix C), and ample time was allotted for questions and clarifications.

In order to gather stakeholder feedback in a way that would both encourage participation over Zoom and facilitate analysis, the Polis survey tool was used. Polis is an open-source, online platform that facilitates understanding of group opinion and enables collective decision-making. Participants can submit short text opinion or position statements, which enter the system and are queued for moderation. From the administrative interface of the Polis system, a moderator can accept, reject, or leave the statement unmoderated. Accepted statements are added to a statement deck which participants can flip through and agree, disagree, or pass on the statements. The platform aggregates votes in real time and illuminates areas of agreement and disagreement among all participants.

Overview of Stakeholder Feedback

This overview of Stakeholder feedback includes feedback received from the Steering Committee, a summary of six total Focus Group and County Group meetings, and an enumeration opinion and position statements expressed through the Polis survey.

Steering Committee

The Steering Committee as a group and in one-on-one discussions provided valuable suggestions in gaining stakeholder perspectives. To better grasp the historical context of soil classification systems, the Steering Committee recommended investigating whether original intentions behind systems like LSB and ALISH were geared towards large-scale plantation agriculture, and how the shift from plantation systems to diversified agriculture impacted aspects like land access and tenure. The Committee also emphasized the importance of documenting legal and procedural developments that facilitated the regulatory use of productivity ratings, understanding how systems like LESA and LSB are utilized in land use regulations and decision-making, and when and how linkages to land valuation and taxation policy were established. Moreover, they recommended investigating if there were early intentions to incorporate Hawaiian cropping systems and cultural connections to land, which might have been overlooked.

With regard to obtaining stakeholder feedback, the Steering Committee recommended compiling a diverse community from whom to draw feedback, including agricultural, Hawaiian, environmental, and other groups. They were interested in assessing participant opinions on ease of understanding and use by different users, the balance of rigor and simplicity for regulatory purposes, and pressures and rationales for updating or replacing systems to meet emerging needs. They also commented that it would be helpful to analyze perspectives on how well systems aligned with actual agricultural viability and land use over time.

Focus and County Groups

Stakeholder comments received during the general discussion and breakout rooms from the three Focus Groups and three County Group meetings tended to generally fall under the following categories: Productivity as a Factor in Agricultural Land Regulation, Solar Farms and other Non-agricultural uses on Agricultural Land, Observations and Recommendations for Current Soil Classification Systems, Soil Classifications in Regulation, and Important Agricultural Lands (IAL).

As expected, diverse views were shared during the meetings. Oftentimes, views and their converse were expressed. For example, some participants felt that soil classification systems have protected agricultural land and have helped with regulating land uses, while others felt that these systems have not been and may not be the best tool for determining agricultural land use, given systems' biases toward large plantation systems, their lack of particular data (e.g., soil biology), and errors in the data they contain, especially relating to soil health (carbon). Likewise, many agreed that soil classification systems should be updated, while others were wary of updates, voicing concern that changes to the system would provide an opportunity for lawmakers to do away with existing safeguards and/or introduce new and harmful regulations, ultimately eliminating agricultural land protections under the current system. Or the affirmation by some agricultural producers of their use of land classification systems to determine productive potential, counterpointed by the belief that the farmer's ability to cultivate or remediate soil, and not the inherent nature of soil or conditions of land, determine land's agricultural productivity.

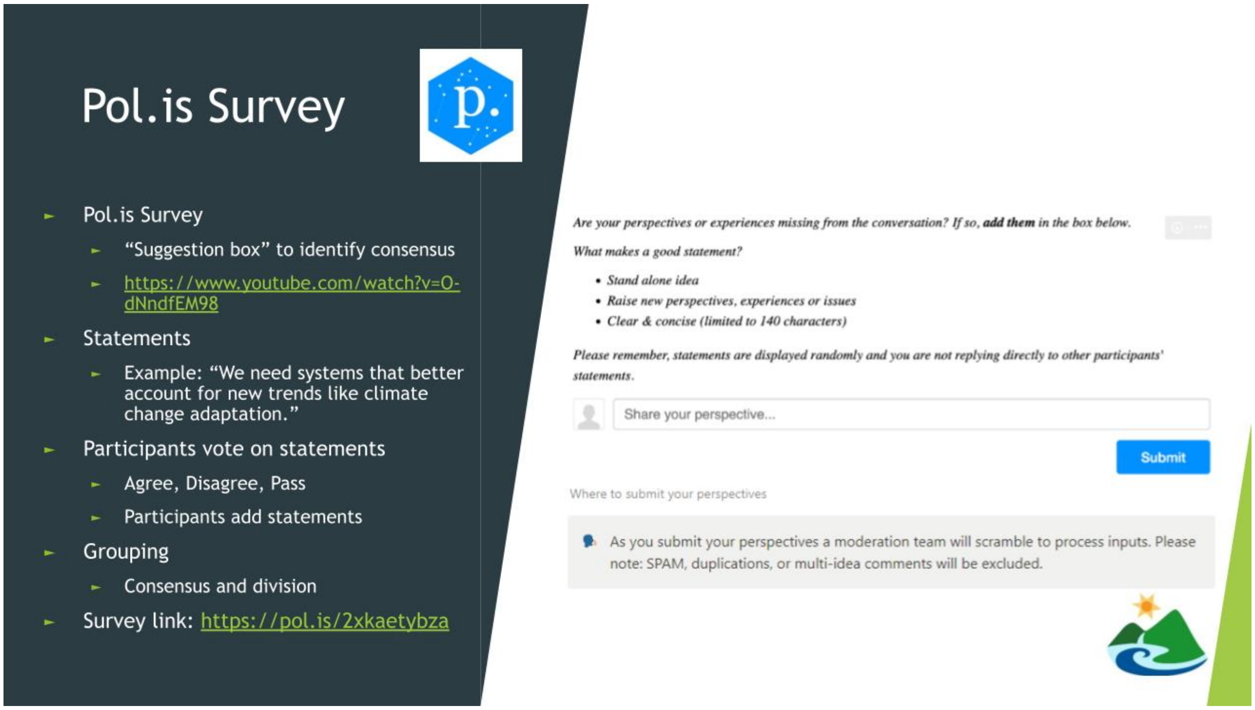
A few opinions shared more agreement, but showed variation in participants' considerations around the statement. For example, participants tended to agree that updates to soil classifications should consider factors other than productivity, and suggested a variety of facets to examine: geology, land use, land position (mauka/makai), distance to services, previous and potential uses, and economic considerations. Participants remarked that updates should also take into account soil changes, identifying these changes as a result of a variety of factors: erosion and deposition of soils, availability of water/irrigation infrastructure, sea level rise and other climatic changes, and invasive species impacts. Relatedly, there were concerns by participants around the accuracy of soil systems' measurement of productivity, given the potentials of land from the perspective of ecosystem services, and the potentials that are produced by utilizing (bio)remediation or other measures to increase the health of soils.

A need to determine criteria for allowing non-agricultural uses (especially solar power generation) on agricultural land also emerged.

Although not a soil classification system nor part of this study, the current Important Agricultural Lands (IAL) law was suggested for review multiple times, especially regarding how IAL relates to regulation. Some felt IAL was a better indicator than current soil classification systems of important and productive lands; others felt that IAL allowed landowners to claim agricultural lands that are not productive, upzone up to 15% of their lands as urban, and ultimately urbanize some of Hawai'i's most productive lands.

POLIS SURVEY

Polis is a digital engagement platform that facilitates large-scale public consultation through a unique voting and commenting system. Unlike traditional surveys or forums, participants can both submit statements and vote (agree/disagree/pass) on others' statements, creating a dynamic map of public opinion. The platform uses machine learning algorithms to analyze voting patterns and cluster participants into groups with similar viewpoints, visualizing these relationships through an interactive interface. This approach helps identify areas of consensus and division among diverse stakeholder groups while reducing the noise and conflict often present in traditional comment systems. By allowing participants to engage asynchronously and see real-time results of collective thinking, Polis enables more inclusive and constructive public dialogue, particularly valuable for complex policy discussions with multiple stakeholder perspectives.



A Polis survey was administered from the period that Focus and County Group meetings began in October 2023 until Phase I outreach was concluded in December 2023. Participants voted only on statements that were moderated into the conversation ("Accepted" statements). Statements were moderated in real time during the meetings, and reviewed following each meeting; moreover, the Polis platform remained open for voting and statement input throughout this period. For these reasons, some of the accepted statements, such as those that were input near or on the date of survey closure, have received fewer votes (see Appendix D). In other cases, statements that were initially accepted during the meetings may have been moderated out of the conversation after closer review, and thus may have received votes not accounted for in the final tallies.

Along with an initial set of 10 statements created by the Project Team to seed discussion (noted in Appendix D), 160 statements reflecting participant opinions and positions were generated throughout the survey period. Of these 170 statements, 103 passed moderation (Appendix D). Rejected statements can be found in Appendix E. Participation was anonymous throughout.

In total, 116 participants cast 6,575 votes, averaging 57 votes per participant, with an average around three statements contributed per author.

Number of voting participants: 116

Votes cast: 6,575

Average votes per participant: 57

Statements submitted: 170 (103 statements accepted)

Average statements per author: 3

Participant Prompt & Statement Categories

A participant prompt was designed to encourage reflection on both the positive and negative aspects of Hawaiʻi's soil classification systems, with the goal of gathering insights that can inform future improvements.

Prompting questions were provided in these categories:

- **Current Use:** Applications of soil classification systems like the Land Study Bureau (LSB) in current work, seeking examples of use in supporting operations, analysis, or decision-making.
- **Strengths & Weaknesses:** Identification of the primary strengths and limitations of Hawaiʻi's current soil classification systems, including effective aspects and areas needing improvement.
- **Recommendations for Improvement:** Specific updates or modifications that could enhance the relevance and usability of soil classification systems for today's needs.
- **Roles in Regulation:** The role of soil classifications in agricultural land use regulations and permitting decisions, and ways to improve the incorporation of soil data in policy.
- **21st Century System:** Vision for an ideal, modern soil classification system tailored to Hawaiʻi, including new methodologies, data sources, and technologies.

Statements submitted were categorized into themes, with the most discussion focused on **Recommendations for Improvement**, **21st Century Systems**, and **Strengths and Weaknesses**. Fewer statements addressed **Current Use** or **Roles in Regulation**.

Opinion Groups

Polis identified two opinion groups across 105 participants. There are two factors that define an opinion group. First, each opinion group is made up of a number of participants who tended to vote similarly on multiple statements. Second, each group of participants who voted similarly will have also voted distinctly differently from other groups.

Participants in Opinion Group A (35 participants) acknowledged the need for some system updates, though believe these systems should not be constantly updated. They are cautious about considering new factors and uses to current systems, as outlined in Appendix C. Participants in Opinion Group B (70 participants) are interested in considering other factors in soil classification systems (Appendix C). Most participants in Opinion Group B also believe that data should be updated to reflect how lands are currently being used. The views of Opinion Group B differ from Opinion Group A, as they support including new factors into the soil classification systems.

The following perspective calculations are based only on those participants who were able to be grouped by the Polis algorithm. Thus the overall count is for 105 participants, not the full 116 participants who cast at least one vote.

Group Informed Consensus

Group Informed Consensus is a measurement tool Polis uses to identify ideas with broad support across different groups, rather than just counting total votes. By multiplying the agreement percentages from each group together, it ensures that even small groups' opinions significantly impact the final score. This prevents larger groups from dominating the process - if even one small group strongly disagrees with an idea, the overall consensus score will be low, even if the majority supports it. This approach helps find solutions that work for everyone, not just the majority.

The statements with the greatest consensus were considered to have at least 75% of the participants (87 or more) voting with 75% either disagreeing or agreeing. These consensus statements were related to recommendations to improve the systems or described a '21st Century System', with one statement describing a weakness (Table 4).

TABLE 4. CONSENSUS STATEMENTS

STATEMENT	OVERALL
Protecting prime productive lands should remain a FACTOR in agricultural land regulation..	86% 2% 11% (87)
Protecting prime productive lands should remain a priority in agricultural land regulation..	84% 7% 7% (91)
Water infrastructure is needed to ensure IAL and similar lands are able to be utilized	81% 5% 13% (91)
Any system incorporating soils for land use decisions should be updatable, dynamic, and easily incorporated into land use decisions	81% 4% 13% (86)
Soil systems should be easy to use and understand	80% 5% 14% (91)
Periodic re-evaluation and stakeholder input would help keep existing systems relevant..	79% 6% 13% (94)
Data should be updated to reflect how lands are currently being used	78% 10% 11% (88)
Systems were designed to protect sugar and pine do not reflect current use, diversified use, agriculture on marginal lands or taro farming	76% 4% 19% (89)

% Agreed | % Disagreed | % Passed | % Didn't vote

Divisive Statements

Divisive statements may indicate areas of conflict. The statements most divided in opinion were categorized as either Recommendations for Improvement or under 21st Century system (Table 5). There was also some overlap in content, with two related to energy.

TABLE 5. TOP DIVISIVE STATEMENTS

STATEMENT	OVERALL
We need to release ag land for energy use.	26% 48% 25% (79)
Class A land should also be allowed for renewable energy use if there is an appropriate and approved agriculture plan for the land.	47% 37% 14% (67)
Indigenous values and water rights should be centered in the development of a classification system that may be used for land use regulation	47% 28% 24% (78)
The State should hold managers and owners accountable for fallow ag lands or crops that have little use in our lives (i.e., pineapple).	37% 32% 30% (81)
climate change effects on endangered species movement needs to be also addressed	33% 33% 32% (59)

% Agreed | % Disagreed | % Passed | % Didn't vote

Majority

Majority statements are those where "60% or more of all participants voted one way or the other, regardless of whether large amounts of certain minority opinion groups voted the other way." Protecting prime productive lands in agricultural regulation, the necessity of water infrastructure for using IAL and similar lands, and the ease of using soil systems, including in land use decisions, are all statements that the majority of participants agreed to (Table 6). 68% of participants also disagreed that the LSB system is fine because soils change over time. These statements may also indicate areas to develop recommendations.

TABLE 6. SELECTED MAJORITY STATEMENTS

STATEMENT	OVERALL
Protecting prime productive lands should remain a priority in agricultural land regulation..	84% 7% 7% (91)
Water infrastructure is needed to ensure IAL and similar lands are able to be utilized	81% 5% 13% (91)
Soil systems should be easy to use and understand	80% 5% 14% (91)
Protecting prime productive lands should remain a FACTOR in agricultural land regulation..	86% 2% 11% (87)
Any system incorporating soils for land use decisions should be updatable, dynamic, and easily incorporated into land use decisions	81% 4% 13% (86)
The LSB system is fine because soils don't change over time.	10% 69% 19% (56)

% Agreed | % Disagreed | % Passed | % Didn't vote

At least half the respondents (58) agreed in majority (60% or more) with these categorized statements:

Recommendations for Improvement:

- Any system incorporating soils for land use decisions should be updatable, dynamic, and easily incorporated into land use decisions. Data should be updated to reflect how lands are currently being used, and periodic re-evaluation and stakeholder input would help keep existing systems relevant. Classification maps and indexes must be modernized to optimize for those factors of value in Hawaiʻi today, i.e., not just productivity.
- Soil systems should be easy to use and understand.

21st Century Systems:

- There is need for a robust modern system that supports agricultural PRODUCTIVITY, and protecting prime productive lands should remain a priority in agricultural land regulation.
- Protecting prime productive lands should remain a FACTOR in agricultural land regulation.

- Distance to services and history of use are important considerations. Soil classifications should take into account ahupuaʻa and indigenous perspectives, justice, land access, and water access. Water infrastructure is needed to ensure IAL and similar lands are able to be utilized.

Strengths & Weaknesses:

- The LSB soil classification system feels outdated, as systems were designed to protect sugar and pineapple, and do not reflect current use, diversified use, agriculture on marginal lands or taro farming.
- A major limitation of current systems is the lack of regular updates to reflect changing conditions. Existing systems don't account for climate change or traditional Hawaiian land management.
- It's challenging to reconcile differences between multiple classification systems on the same land.

Current Use:

- Soil classifications are one tool in the toolbox, but may not be the best way to determine land use priorities.
- LSB classes C and lower are used to discount land quality and upzone, despite agricultural potential.

In all, a total of 170 statements were submitted by participants. In order to streamline voting, spam, duplications, or multi-idea comments were excluded by a moderator on the contractor team prior to voting. 67 statements were rejected by the moderator (Appendix E).

Areas of Uncertainty

Polis identified areas of uncertainty through statements where more than 30% of participants chose to 'pass' rather than vote, revealing potential knowledge gaps about soil classification systems. Most uncertainty stemmed from unfamiliarity with how these systems are used or what information they contain. Analysis showed that statements with particularly high pass rates (over 50%) centered around the practical applications of different classification systems, especially regarding technical capabilities and regulatory uses.

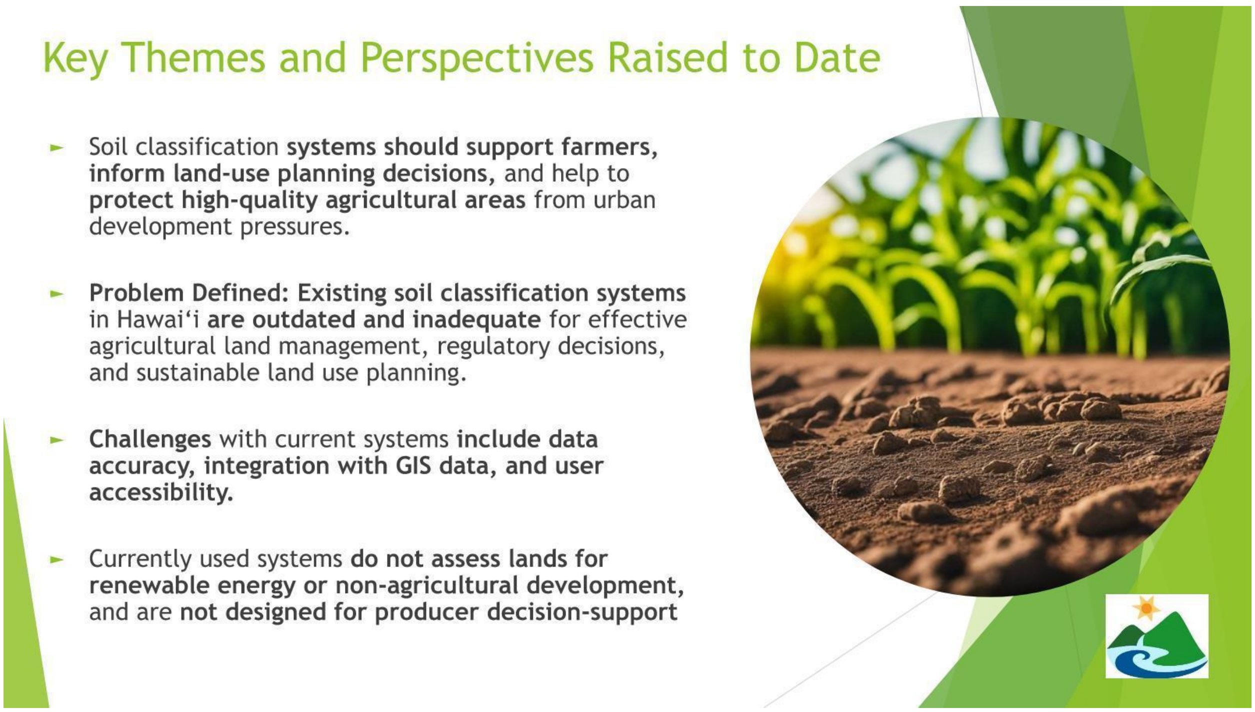
Key areas of uncertainty included whether site-specific soil studies contradict existing classifications, suggesting many stakeholders are unsure about the accuracy of current systems when compared to ground-truthing. Additional knowledge gaps emerged around the technical applications of SSURGO for waterflow/erosion analysis and economic feasibility assessment, LSB's utility for crop and animal yield estimates, and LSB's role in solar project siting decisions. The consistent pattern of high pass rates on these topics suggests that many stakeholders may be unfamiliar with both the reliability of existing classifications and their specific analytical capabilities and regulatory applications.

Detailed analysis of high uncertainty statements revealed divergent views among stakeholder groups. SSURGO's applications showed moderate overall support but varying levels of confidence between groups, particularly regarding its use for waterflow analysis and economic feasibility assessments. The LSB system generated the most mixed responses, with notably low confidence in its value for agricultural yield estimates but significant disagreement between groups about its role in solar project siting - Group A showing strong support (57%) while Group B expressed much lower confidence (22%). These patterns highlight not just knowledge gaps but also fundamental differences in how stakeholder groups view and understand these classification systems' capabilities and applications. This pattern of uncertainty highlights potential needs for targeted education about how these systems can be practically applied in both agricultural and development contexts, as well as their role in regulatory decision-making.

Summary of Polis Survey

Most participants want to protect prime agricultural lands. There also seems to be a general consensus for updating the current soil classification system. There is a desire for these systems to be easier to understand and use, and easily incorporated into land use decisions. However, the opinions for changing these systems vary, including how often these updates should occur. Opinion Group B seems to be more willing to incorporate other factors into the soil classification system. Group A appears more cautious about changes to current systems, though they acknowledge the need for some system updates. Group A also believes that system updates do not need to occur frequently.

KEY THEMES AND CONCERNS RAISED



Both the stakeholder meetings and the Polis survey indicate that there is interest by participants in updating the current soil classification systems. It is generally understood that the LSB system is outdated, having not been updated since it was originally produced in the 1960s and 1970s. There is a perception that LSB was developed with a focus on plantation agriculture and is outdated. Updates should make the systems easier to understand and use, and should take advantage of current data and soil technologies, including GIS mapping capabilities. However, there is disagreement as to the degree of the updates and how often the updates should occur. Some want updates to occur periodically with stakeholder input; others believe that constant updates are not necessary. Some believe that soil classification updates should incorporate indigenous values and perspectives. Others are more cautious about major updates and believe LSB should remain the foundation for any update.

Participants voiced a wide variety of factors to incorporate into soil classification systems and agricultural land use regulation. However, the line between soil classification system and agricultural land use regulation appears to be blurred for many participants. The areas of uncertainty from the Polis survey indicate unfamiliarity with the LSB and SSURGO soil classification systems. Additionally, participant recommendations for the changes to be made often conflate soil classifications and agricultural land regulation. It will be important to identify where updates are most appropriate to ensure soil classification systems are separate from agricultural land use regulation. Of note, this initial stakeholder outreach occurred two months after the Maui wildfires. This may have caused other factors (e.g. climate change, water, other factors) to be at the forefront of participants' minds.

Overall, there is a desire to protect prime agricultural lands. However, there is also a concern that updates to the soil classification systems could hurt agricultural land protections. This concern needs to be balanced against modern-day agricultural land uses.

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VII. Review of Best Practices in Other Jurisdictions

The purpose of researching best practices in other jurisdictions was to identify the most effective regulatory approaches that utilize soil and agricultural land quality in shaping agricultural land use policies. The research process was divided into two phases:

- **Initial Review of Multiple Jurisdictions:** A broad scan across several jurisdictions was initiated to gather a range of practices related to soil classification in agricultural land use regulation.
- **In-Depth Analysis of Selected Jurisdictions:** From the initial review, three (3) jurisdictions were selected in consultation with OPSD for in-depth analysis, focusing on their use of soil classification systems in agricultural land regulation.

This phased approach broadened the scope of review, enhancing understanding of diverse soil classification efforts and associated challenges. The focus remained on identifying the most effective practices relevant to Hawaiʻi's unique land use planning and zoning context.

This review of other jurisdictions' best practices bears some similarity in approach to the Hawaiian Government Survey of the 1870s. Responding to demands for land grants, but faced with little knowledge of available lands, the government allocated funds for a general survey that began with studying the methods of the U.S. Coast Survey, British Ordnance Survey, Great Indian Survey, and Australia and New Zealand surveys (Williamson, 1977). Similarly, this study echoes the government's historical efforts to assess land holdings, allocate public funds, and learn from elsewhere to inform its actions.

Jurisdiction Determination

The process for deriving the list of recommended jurisdictions to research was as follows:

Desk Research

Initial desk research was conducted to gain an understanding of state approaches for agricultural land classification via academic journals, white papers, government websites, and regulatory statutes. In developing a rubric to compare the long list of possible jurisdictions, the following sources were consulted:

- AFT's state-by-state Agricultural Land Protection Scorecard analysis of policies and programs that address the loss of farmland to development
- USDA NASS Agricultural Census data to identify states with similar farm sizes and volumes
- Solar and Wind Siting Authority Across the United States compiled by Michigan State University
- OPSD and SC comments related to jurisdictions

Consultation with Experts

Recommendations for jurisdictions were sought from the National Healthy Soil Policy Network. Meetings were held with experts from American Farmland Trust (AFT) including Tom Stein, California Regional Director, David Haight Vice President for Programs, and Julia Freedgood, Senior Fellow & Senior Program Advisor, as well as Amy Koch, Assistant Director for Soil Science at USDA NRCS Pacific Islands Area. Project Team member Dr. Bruce Plasch, Agricultural Economist at Plasch Econ Pacific, completed review of the draft long list.

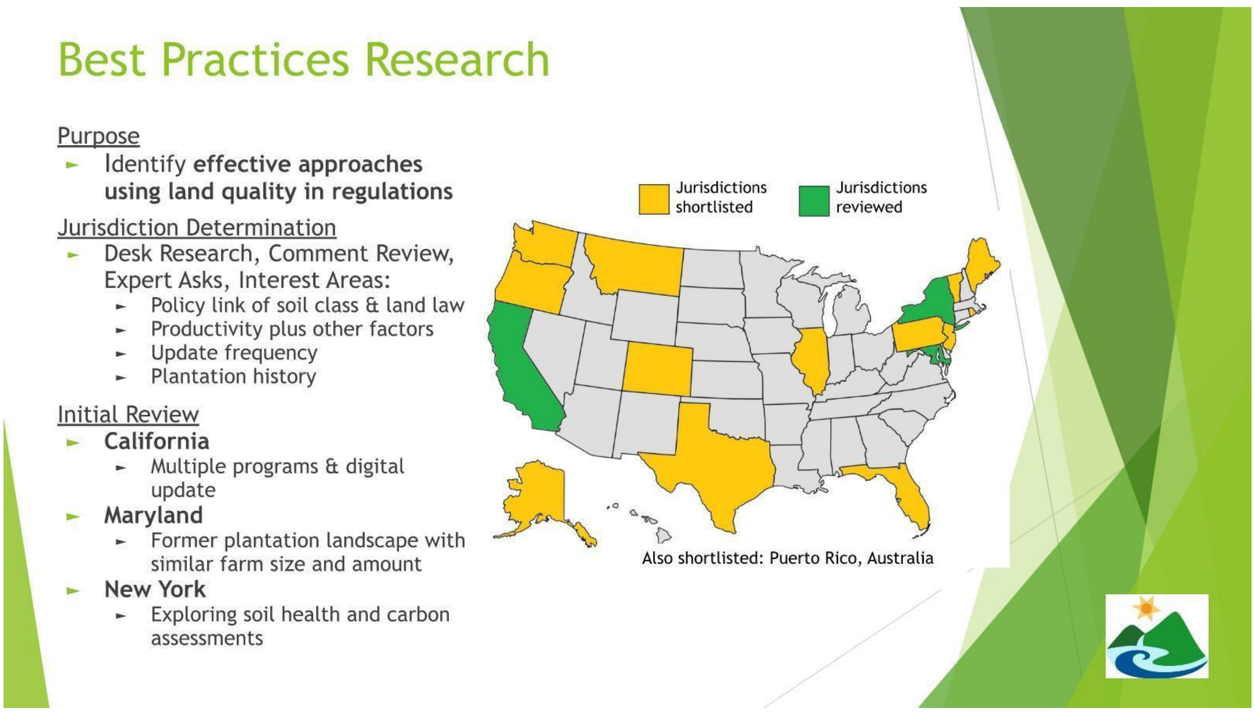
Consideration of Criteria

Based on discussion with OPSD and SC members, criteria considered included linkages between soil classification and land use policy, incorporation of factors beyond productivity in classifications, regularity of classification updates, and jurisdictions that had experienced shifts from plantation agriculture.

Shortlisting of Jurisdictions

After initial review, sixteen U.S. states, Puerto Rico, and three Australian states were identified as potential jurisdictions for deeper review. The list was forwarded to OPSD and the project Steering Committee for review and comment. Upon feedback and approval, research narrowed to focus on three final jurisdictions: California, Maryland, and New York.

Phase II: Best Practices Research



The process of conducting the best practices research that led to this report involved several steps and considerations:

- **Identification of Key Areas of Interest:** Publicly available documents, reports, policies, and regulations were reviewed to identify some key areas of interest in each jurisdiction, such as digitization of classification systems, use of multiple systems, and co-development of regulatory and classification systems.
- **Compilation of Findings:** Findings from each jurisdiction were compiled, including relationships of classification systems to land use policy and selected attendant policies and regulations.
- **Identification of Best Practices:** Based on the research findings, best practices with implications for Hawai‘i's agricultural land classification and regulation were highlighted.

Findings and Report Structure

Best Practices Findings

State	Takeaway
California	Base the soil classification system on **regularly updated data**
	Stack tools to serve multiple purposes
	Make data and maps available and accessible in digitized format
Maryland	**Integrate soil classification systems into existing state land protection** funding programming
New York	**Partner with a university** or similar institution to establish regular soil classification system updates.
	Provide sustained funding to support **regular soil classification system updates**
	Use Agricultural Land **Classification as an input for other tools**, not a replacement
	Carefully **select the crops used in productivity analysis**

Similar to Hawai'i, each of these jurisdictions operate various agriculture-related programs at the state and county levels. The effort is not intended as a census of agricultural programs or regulations. The preliminary research identified some key areas of interest in each jurisdiction: in California, the digitization of the long-utilized Storie Index is highlighted as a method to efficiently integrate annually updated soils data from the USDA into a single system; in Maryland, the Agricultural Land Preservation Program's use of both the USDA Land Capability Classification (LCC) and Land Evaluation and Site Assessment (LESA) approaches in their evaluation of lands for protection offer means to explore how multiple systems can articulate with one another; in New York, the complex of land evaluation, classification, and valuation demonstrates the manifold benefits of co-developing regulatory and classification systems. Collectively, these jurisdictions offer numerous approaches of import for Hawai'i's agricultural land classification and regulation. Within each jurisdiction section below is an explanation of the classification system(s), selected attendant policy and regulations, and best practices findings with implications noted for the islands.

I. CALIFORNIA

Excerpt of 1933 soil map of Contra Costa County, CA. USDA Bureau of Chemistry and Soils

Soil Classification for Land Use Decisions

California has long been at the forefront of efforts to preserve its valuable agricultural lands in the face of rapid urbanization and development pressures. This section examines the key programs, policies, and tools the state has implemented to identify, assess, and protect its most productive farmlands. From the landmark Williamson Act to the Farmland Mapping and Monitoring Program, California has developed an extensive framework to balance the needs of agricultural production and land conservation. Understanding the history, mechanics, and applications of these agricultural preservation initiatives is crucial for informing land use decisions and ensuring the long-term viability of California's vital farming sector.

Williamson Act & Agricultural Preserves

Similar to Hawaiʻi, urban expansion and suburban development led to rising concerns about the loss of agricultural land in post-World War II California. In response the California Land Conservation Act, better known as the Williamson Act, was established in 1965 (Onsted, 2010). The Williamson Act enabled counties to enter into contracts with owners of both farmland and open-space land and provide property tax relief, often known as a differential assessment, to those parties in exchange for minimum 10-year non-development agreements. Counties can also establish Farmland Security Zones, an enhanced version of Agriculture preserves with a 20-year automatically renewing contract, that offer an additional 35% reduction in taxable value.

The Williamson Act provides significant property tax reductions for agricultural landowners, ranging from 20% to 75% annually. Many counties provide Williamson Act calculators to assess the financial benefits of entering into a contract. Properties under the Williamson Act are assessed at the lowest of either their a) fair market value, b) factored base year value, or c) a specific Williamson Act value. The Williamson Act Value is calculated by subtracting 3% (for management and insurance) from the gross income and then dividing by a capitalization rate. The capitalization rate is composed of a yield rate based on the four-year average of long-term Treasury bond yields, an added risk component, and an additional 1% for property taxes. For properties located within a Farmland Security Zone, the calculation under the Williamson Act is applied, ensuring the property is assessed at either 65% of the base year value or 65% of the Williamson Act value, whichever is lower. For many decades annual payments were made by the State of California to local governments to help offset the property tax revenue losses resulting from the Williamson Act, a practice known as subvention.

Only areas within an Agricultural Preserve, more commonly known as an agricultural district, are eligible for Williamson Act funding. An Agricultural Preserve delineates an area wherein a city or county agrees to contracts with landowners to maintain the land for agricultural or open space use, established by the local board of supervisors or city council (Government Code ARTICLE 2.5. Agricultural Preserves [51230 - 51239]). Preserves are subject to specific rules set forth in their establishing resolution to ensure their intended use is preserved. For land to be designated as an agricultural preserve, it must encompass at least 100 acres, though this can be achieved by combining two or more contiguous parcels or parcels under common ownership. Smaller preserves can be authorized by a board or council if the nature of the agricultural operations in the area warrants smaller units and aligns with the General Plan.

Furthermore, to enter a Williamson Act contract, a parcel must be a minimum of either 10 acres of prime agricultural land, or 40 acres of non-prime or open space land. For the purpose of county establishment of an Agriculture Preserve, prime farmland is defined as any of the following (Government Code ARTICLE 1. General Provisions 51201):

1. All land that qualifies for rating as class I or class II in the Natural Resource Conservation Service land use capability classifications.
2. Land which qualifies for rating 80 through 100 in the Storie Index Rating.

3. Land which supports livestock used for the production of food and fiber and which has an annual carrying capacity equivalent to at least one animal unit per acre as defined by the United States Department of Agriculture.
4. Land planted with fruit- or nut-bearing trees, vines, bushes, or crops which have a nonbearing period of less than five years and which will normally return during the commercial bearing period on an annual basis from the production of unprocessed agricultural plant production not less than two hundred dollars ($200) per acre.

Overall, in this differential tax system, the Williamson Act only applies the Land Capability Classification and Storie Index rating systems in defining prime farmland. However, the broad parameters to qualify as prime farmland aligns with the statutory intent of the Williamson Act to conserve agricultural lands.

Thus minimal commercial agricultural activity is sufficient to redress any deficiencies in land ratings in the pursuit of participating in preservation and tax relief contracts.

California Environmental Quality Act Land Protection & LESA

In 1970 the California Environmental Quality Act (CEQA) was passed in response to the National Environmental Policy Act. CEQA established state policy to "create and maintain conditions under which man and nature can exist in productive harmony to fulfill the social and economic requirements of present and future generations." CEQA mandates that state and local agencies must identify and assess the significant environmental consequences of planned projects, as well as implement all practicable mitigation strategies to address those impacts. Among the impacts considered is the conversion of agricultural land, defined as prime farmland, farmland of statewide importance, or unique farmland, as determined by the United States Department of Agriculture (USDA) Land Inventory and Monitoring (LIM) criteria modified for California (Public Resource Code § 21060.1. AGRICULTURAL LAND).

In 1990, the California Department of Conservation launched a study to examine the effects of agricultural land conversion, prompted by concerns raised in the 1987 California Soil Conservation Plan. This study revealed a gap in CEQA regarding specific guidelines for assessing the impact of farmland conversion, leading to inadequate environmental impact analyses for many projects. In response, and pursuant to a 1993 legislative act, the California Land Evaluation and Site Assessment (LESA) Model was developed by the California Department of Conservation in concert with amending CEQA Guidelines (California Department of Conservation, 1997). This aimed to provide a systematic methodology for evaluating agricultural land conversion impacts in environmental reviews, ensuring such effects are quantitatively and consistently considered.

When assessing the significance of environmental effects on agricultural resources, lead agencies have the option to use the LESA model as a guideline for evaluating the impact on agriculture and farmland. Impact assessments specifically consider if the project would convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance, as identified by the Farmland Mapping and Monitoring Program (FMPP), into non-agricultural use, as well as whether the project would conflict with existing zoning designated for agricultural use or a Williamson Act contract (California Department of Conservation, 2023).

California's LESA model is designed to quantitatively and consistently assess the potentially significant environmental impacts of converting agricultural land, ensuring they are thoroughly evaluated during the environmental review process (Public Resources Code Section 21095). Like all LESA assessments, various Land Evaluation (LE) and Site Assessment (SA) factors are each rated, weighted, and aggregated into a singular numerical score for the project. This score then serves as the foundation for determining the potential environmental significance of a project: Potentially Significant Impact, Less Than Significant with Mitigation, Less Than Significant Impact, or No Impact.

The California LESA system's LE factors are the Land Capability Classification (LCC) and the Storie Index (SI). The SA Factors are project size, Water Resources Availability, Surrounding Agricultural Land, and Surrounding Protected Resource Land (California Department of Conservation, 1997).

Farmland Mapping and Monitoring Program

The **Farmland Mapping and Monitoring Program (FMMP)**, a non-regulatory initiative within the California Department of Conservation, was established in 1982 to continue the Important Farmland mapping efforts begun in 1975 by the USDA Natural Resources Conservation Service (NRCS), formerly known as the Soil Conservation Service (SCS). The NRCS aimed to produce agricultural resource maps based on soil quality and land use across the nation. As part of this nationwide mapping effort, the NRCS developed the Land Inventory and Monitoring (LIM) criteria, which classified land suitability for agricultural production based on both the physical and chemical characteristics of soils and specified land use characteristics. The FMMP's Important Farmland Maps are derived from NRCS soil survey maps using the LIM criteria (California Department of Conservation, 2004).

The FMMP's main deliverables include:

1. Important Farmland Maps
2. Land Use Conversion Statistics
3. GIS Data
4. Biennial Farmland Conversion Report
5. Tracking of Land Committed to Non-agricultural Uses

The FMMP prepares, maintains, and keeps current Important Farmland Series Maps and an automated map and database system to record and report changes in agricultural land use biennially. Searchable online maps, reports, statistics, interactive Important Farmland maps, geodatabases, shapefiles, and portals to report changes to use and related real estate reporting are available for 51 counties.

The program utilizes soil survey data from the USDA NRCS and current land use information from aerial imagery and field reconnaissance to categorize land into several Important Farmland categories: Prime Farmland, Farmland of Statewide Importance, Unique Farmland, Farmland of Local Importance, and Grazing Land. Prime Farmland, Farmland of Statewide Importance, and Unique Farmland must have been cropped within four years prior to the mapping date to qualify. The layering of data allows for land classification that includes social and other factors, with land quality and irrigation status underpinning the classification.

The criteria for each farmland category are based on factors like soil quality, growing season, moisture supply, and current/historical agricultural use. For example, Prime Farmland must have the best combination of physical and chemical features to sustain long-term agricultural production. It is important to note that in California, the term 'Prime' has two meanings when rating agricultural land. In California, the term 'Prime' has two distinct applications in the context of agricultural land. The FMMP is responsible for identifying and mapping 'Prime Farmland' based on soil characteristics and land use. In contrast, under the state's Williamson Act, landowners can enroll their property as 'Prime Agricultural Land' if it meets specific economic or production requirements, regardless of whether it is classified as 'Prime Farmland' by the FMMP.

The FMMP maps important farmland at a minimum mapping unit of 10 acres, incorporating smaller parcels into the surrounding classifications. This helps ensure the maps accurately reflect the USDA's digital soil survey data.

For environmental review under CEQA, five categories - Prime Farmland, Farmland of Statewide Importance, Unique Farmland, Farmland of Local Importance, and Grazing Land - are considered protected "agricultural land" in California (Public Resources Code Section 21060.1). The FMMP initiated in 1984 covering 38 counties, now maps

50.6 million acres across 51 counties as of 2024. FMMP data reveals over 1.2 million acres of irrigated farmland lost since 1984, including more than 800,000 acres of Prime Farmland, primarily due to urbanization and especially in Southern California counties (California Department of Conservation, 2024). In essence, FMMP's soil quality and land use-based classification and conversion tracking is California's primary tool for identifying and regulating important farmland resources.

Cropland Index Model & Revised Storie Index

The California Energy Commission (CEC) **Cropland Index Model (CIM)** is a suitability model that evaluates the relative importance of lands used for crop production in California. Its main function is to provide a numerically weighted index indicating the significance of croplands at a given location. This model is used in the CEC Land Use Screens for solar technology, where areas of high implication are excluded (California Energy Commission, n.d.).

The model incorporates several data components:

- California **Revised Storie Index (RSI)**: A soil rating based on properties governing a soil's potential for cultivated agriculture
- Electrical Conductivity (EC): A measure of water-soluble salt concentration in soils
- Sodium Adsorption Ratio (SAR): The amount of sodium relative to calcium and magnesium in the water extract from saturated soil paste
- California Important Farmland data: Statistical data analyzing impacts on agricultural resources, including Prime Farmland, Farmland of Statewide Importance, and Unique Farmland
- California Statewide Crop Mapping: Used to define the model's domain of analysis

The CIM relies on a few key data sources to evaluate the importance of croplands in California. These data sources include:

Gridded Soil Survey Geographic (gSSURGO) Database: Provided by the USDA NRCS, this database contains information about soil properties collected by the National Cooperative Soil Survey over the course of a century. The gSSURGO database is used to obtain the RSI, EC and SAR.

California Important Farmland: The FMMP, maintained by the California Department of Conservation, provides statistical data on Prime Farmland, Unique Farmland, and Farmland of Statewide Importance. This data is used to analyze impacts on California's agricultural resources and is updated every two years using a combination of computer mapping systems, aerial imagery, public review, and field reconnaissance.

California Statewide Crop Mapping (2019): Developed by the California Department of Water Resources, the 2019 California Statewide Crop Mapping dataset provides an overview of the spatial distribution of crops throughout the state. The footprint of this dataset is used as part of the mask for the CEC Cropland Index Model's domain of analysis, ensuring that the model focuses on areas relevant to agricultural production.

Each input layer is transformed onto a common scale and weighted according to its relative importance. This process ensures that the various data sources are standardized and can be effectively combined to generate a single, cohesive output. The final result is a single-gridded map that indicates areas of high and low implication for croplands.

California's RSI was developed in 2005 from the 1978 version of the Storie Index (SI) (O'Geen & Southard, 2005). It draws soil data from the National Soil Information System (NASIS), the database NRCS uses to generate SSURGO data products, in part to address the subjectivity and inconsistencies inherent to the traditional hand-generated SI ratings (O'Geen et al., 2008). The digital RSI model uses the SSURGO data to rapidly and reproducibly compute SI soil factors at scale. When new data SSURGO becomes available through the Annual Soils Refresh (ASR), the RSI model can easily be re-run to provide updated outputs. The Revised Storie Index plays a crucial role in CIM by providing a foundational assessment of soil's agricultural potential. This index assesses soils on several factors, such as profile development, surface texture, slope, and manageable characteristics like fertility and drainage. Each factor is scored from 0 to 100 percent, and the scores are multiplied to derive an overall soil productivity rating. The RSI directly influences the evaluation of land suitability for cropping by indicating the inherent agricultural value of the soil.

The CIM assesses the relative importance of croplands across California by integrating soil properties, farmland designations, and current crop distribution. This allows for an accurate evaluation of the potential implications of solar energy development on agricultural resources. However, the CIM has limitations. It does not include information for grazing lands or rangelands and is only applied to solar technology in the CEC Land Use Screens. The classified version of the model partitions the output into high and low implication areas, which may not capture the full spectrum of cropland suitability. The CEC makes the CIM output map publicly available in an open data GIS platform, serving as a valuable resource for decision-makers and planners to identify areas where solar energy development may significantly impact agricultural resources and to make informed land use decisions.

Policy and Regulation

The California Land Conservation Act, better known as the Williamson Act, was established in 1965 via Section 51200 of the California Government Code.

Under Public Resource Code § 21060.1. AGRICULTURAL LAND, CEQA mandates the identification and assessment of the environmental consequences of planned projects, including the conversion of agricultural land.

In light of findings that environmental impacts of farmland conversion were not being adequately assessed, California also passed a CEQA amendment (Section 21095) that allows for the development of an optional methodology for lead agencies to quantitatively and consistently evaluate the significant environmental effects of agricultural land conversions during the environmental review process. This amendment aims to improve the systematic consideration of agricultural land conversion effects under CEQA.

Pursuant to the California Environmental Quality Act (CEQA) and in accordance with Government Code Section 65570, FMMP is mandated to report biennially on the conversion of farmland and grazing land and to provide maps and data to local government and the public.

Subdivision (f) of Section 65560 of the Government Code requires FMMP to prepare, update, and maintain Important Farmland Series Maps (Maps) and prepare and maintain an automated map and database system to record and report changes in the use of agricultural lands every two years on even numbered calendar years. In preparing Maps, the Department considers all information collected or received on the amount of land converted to or from agricultural use, and between agricultural categories.

FMMP also reviews potential environmental effects of use of 'agricultural lands' under Public Resources Code Section 21060.1, and changes in land use as required for FMMP's biennial farmland conversion report.

FMMP now uses NRCS' digital soil data (SSURGO) to compile the Important Farmland Maps.

The Department shares changes to Maps with counties, which have 90 days to request corrections of discrepancies or errors in the classification of agricultural lands on the maps. The Department makes corrections of discrepancies or errors requested by counties, as required by statute (see Gov. Code, § 65570, subd. (c)). Corrections need to be supported with evidence of land use or irrigation status.

Although the Department will always accept and independently consider all information regarding land use and conversion from any source, the Department will not discuss Map designation changes with non-county parties whose interest it is to seek changes to the Maps.

Best Practices

Base the soil classification system on regularly updated data

Basing a soil classification system on regularly updated data ensures accuracy, consistency, adaptability, efficiency, and informed decision-making. By utilizing the most current data available through the Annual Soils Refresh (ASR), the Revised Storie Index (RSI) maintains the accuracy and relevance of the classification system over time. The use of digital SSURGO data allows for rapid, reproducible, and consistent computation of soil factors at scale, minimizing subjectivity and inconsistencies. Consistent updates enable the RSI to capture changes in soil properties and characteristics, ensuring the system remains relevant and reflective of current conditions. The efficiency and scalability of the RSI model streamlines the process of maintaining an up-to-date soil classification system, providing decision-makers with the most accurate and current information about soil suitability for cropping, and thus enabling informed land use planning and management decisions that optimize agricultural productivity and sustainability.

Currently, the Land Study Bureau's (LSB's) classification system relies on static data that would be costly and difficult to update. Digitizing the system and utilizing data tied to ASR would streamline maintenance and provide decision-makers with current information for informed land use planning. However, while regularly updated data enhances the accuracy and relevance of a soil classification system, it is important to clarify that such updates do not imply that detailed, continuous changes in soil characteristics are essential for the system to be legitimate or functional. Hawaiʻi's soils, as classified by the LSB, offer a stable and reliable foundation for agricultural land use decisions. The primary value in updating the system lies in reflecting changes in land management practices, environmental conditions, and advances in technology—rather than frequent recalculations of soil properties.

Voluntary participation in an agricultural preserve

Voluntary participation in agricultural preserves, as exemplified by the Williamson Act in California, is a best practice that allows landowners to make informed decisions about the long-term use of their property, balancing their financial interests with the broader goal of preserving agricultural land. By entering into contracts with local governments, landowners receive property tax relief in exchange for committing to maintain their land in agriculture. This approach encourages active engagement in conservation efforts, supports the viability of agricultural operations, and can be tailored to local conditions and priorities.

In contrast, Hawaiʻi's State Land Use District for agriculture and Important Agricultural Lands (IAL) program takes a more top-down approach. The State Land Use District for agriculture is a statewide zoning system that designates land for agricultural use, regardless of landowner preferences or the specific characteristics of the land. Similarly, the IAL program aims to identify and protect high-quality agricultural lands but has faced challenges in implementation due to its reliance on state-led initiatives and limited incentives for landowner participation. While these programs have similar goals, their top-down approach may limit their effectiveness in comparison to the voluntary, incentive-based model of the Williamson Act, which has helped to protect over 16 million acres of agricultural and open space land in California since its inception in 1965.

Nonregulatory FMPP type program to compile data used by departments for regulatory and other activities

A nonregulatory program like the Farmland Mapping and Monitoring Program (FMMP) in California, which compiles data used by various departments for regulatory and other activities, is a best practice that provides a consistent, standardized, and regularly updated source of information on agricultural land resources across the state. By combining soil survey data from the NRCS with current land use information from aerial imagery and field reconnaissance, the FMMP creates a thorough and accurate picture of the state's agricultural landscape. The program's nonregulatory nature encourages collaboration and data-sharing among different agencies and stakeholders, reducing duplication of efforts and promoting efficiency in data collection and analysis.

In contrast, Hawaiʻi's relative lack of comprehensive agricultural land use mapping and regular tracking of agricultural trends, as evidenced by the limited scope of the Statewide Agricultural Land Use Baseline (SALUB) studies in 2015 and 2020, highlights the challenges of not having a program like the FMMP. Without a consistent and frequently updated source of agricultural land use data, decision-makers in Hawaiʻi may struggle to make informed choices about land use planning, resource allocation, and policy development. Furthermore, the absence of regular tracking of agricultural irrigation extents and cropland loss makes it difficult to assess the state of the agricultural sector, identify trends over time, and develop targeted policies and programs to support farmers, conserve agricultural resources, and ensure the long-term viability of the agricultural industry. Relatedly, the ongoing subdivision of agricultural lands, including through condominium property regimes and other methods, is occurring without sufficient information or effective regulatory oversight. This lack of control is negatively impacting the affordability and availability of land for agricultural production, contributing to the decline of agricultural businesses and reducing the profitability of those still operating. Unlike the reclassification of agricultural lands for urban development, these partitions are happening with significantly less scrutiny and evaluation of their impact.

Stack tools to serve multiple purposes.

The Cropland Index Model (CIM) developed by the California Energy Commission is a powerful tool that integrates multiple data sources, including the Revised Storie Index (RSI) and the Farmland Mapping and Monitoring Program (FMMP) products, to assess the suitability of land for agricultural purposes. The RSI provides a detailed assessment of soil agricultural potential, while the FMMP contributes vital data on the distribution and characteristics of farmland in California.

In contrast to the CIM's approach, Hawaiʻi's Land Study Bureau (LSB) classification system is used for regulating agricultural lands for various purposes, such as energy projects, golf courses, or other developments. While the LSB system provides a basis for land use decision-making, it lacks the focus that CIM offers the energy industry. The CIM's stacking approach exemplifies the value of scaffolding classification tools and evaluation programs to develop novel and targeted analyses to govern land uses in agricultural areas.

Make data and maps available and accessible in digitized format.

The FMMP is a current, digitized inventory of agricultural resources across the state. The data enables planning and decision-making by various stakeholders. Similarly CIM is made readily available by the CEC.

Updating LSB so that outdated irrigation and yield data are not being used to make land use decisions today is an important first step; digitizing data and maps can make information accessible to more parties, and increase transparency of system ratings.

Technology and Regulation should develop together towards targeted applications.

Developing technology and regulation in tandem towards targeted applications is a best practice that ensures the effective and responsible use of innovative tools and data sources. The Cropland Index Model (CIM) in California exemplifies this approach by integrating advanced technological tools with regulatory frameworks designed to support informed decision-making and sustainable agricultural practices. By aligning technological advancements with regulatory objectives, the CIM enables data-driven decisions that optimize land use, promote conservation, and support the long-term viability of the agricultural sector.

In contrast, when technology and regulation develop independently or without clear targeted applications, as seen in Hawaiʻi's Land Study Bureau (LSB) classification system, the resulting disconnect can lead to inefficiencies and missed opportunities for effective resource management. To foster the effective development of technology and regulation towards targeted applications, policymakers and stakeholders should prioritize collaborative partnerships, iterative design and adaptation, transparent communication, and ongoing monitoring and evaluation to optimize performance and outcomes.

II. Maryland

Excerpt of 1922 soil map of Garret County, MD, USDA Bureau of Soils

Soil Classification for Land Use Decisions

The Maryland Agricultural Land Preservation Program (MALPP) is a comprehensive and multi-faceted approach to protecting the state's valuable agricultural resources. Administered by the Maryland Agricultural Land Preservation Foundation (MALPF), the program combines various tools and strategies to incentivize farmland preservation and support the long-term viability of the agricultural sector. This section will explore the key components of MALPP, including the easement acquisition process, the use of the Land Evaluation and Site Assessment (LESA) system and the USDA Land Capability Classification (LCC) to prioritize land for protection, the role of Agricultural Preservation Districts, and the interaction of complementary programs such as the Agricultural Use Assessment, Transfer Taxes, and Certification of Local Agricultural Land Preservation Programs. Additionally, we will delve into the methods used to determine easement values, agricultural values, and the application of the Soil Productivity Index in the context of the state's farmland preservation efforts.

Maryland Agricultural Land Preservation Program

The Maryland Agricultural Land Preservation Program (MALPP), overseen by the Maryland Agricultural Land Preservation Foundation (MALPF), is a leading model for protecting agricultural land in the United States. Established in 1977, the program's primary goal is to preserve sufficient farmland to support current and future food and fiber production needs for Maryland residents. This is achieved through the Purchase of Agricultural Conservation Easements (PACE) that prevent the conversion of farmland into residential, commercial, or industrial sites. The MALPF is managed by a thirteen-member Board of Trustees, which includes four ex-officio members and nine at-large members appointed by the Governor. At least six at-large members are farmers, ensuring strong representation of the agricultural community's interests.

To be eligible for the MALPP easement acquisition program, properties must meet several criteria, including (MALPP, 2008):

Size - Minimum size of 50 contiguous acres (with some exceptions for smaller, highly productive properties)

Productivity - At least 50% of the land classified as USDA Land Capability Class I, II, or III soils or Woodland Group 1 or 2 soils

Location - Location outside of 10-year water and sewer service area plans (with exceptions for extraordinarily productive land)

Conservation Plans - Approved soil conservation, water quality, and forest stewardship plans

Commitment - Commitment from the landowner not to subdivide or develop the property while the application is pending

Local Criteria - Counties may impose additional or more stringent criteria beyond the state requirements and prioritize applicants using their own ranking systems approved under State guidelines.

Section 2-510 of the Maryland Agriculture Code outlines the process for the sale of agricultural land preservation easements to the MALPF. MALPF determines the maximum number of applications it will accept from each county per offer cycle. MALPF ranks applications and approves offers to buy easements within the allotted funds for each county. Upon approval, the landowner is presented with an offer specifying the terms of the purchase.

MALPF ranks applications based on criteria such as the ratio of the asking price to the appraised value, soil productivity, contribution to agricultural markets, and local government recommendations (COMAR Section 15.15.01.20). Applications are assigned a ratio that is the proportion obtained by dividing the asking price for the agricultural easement by the State's appraised easement value. This ratio is used to categorize and prioritize the applications for MALPF to purchase agricultural easements.

For applications with an asking price to appraised value ratio of 1.0 or lower, MALPF ranks them solely based on this ratio, with ties broken by factors like soil productivity (LCC), development pressure, and parcel size. For applications with ratios above 1.0, a point-based priority formula is used, with points assigned for soil capability, size of the preservation area and district, development threat, proximity to sewer service and suburban areas, and the priority recommendation of the local government.

MALPF can only approve applications that have received local governing body approval, typically from a county. MALPF has established a Land Evaluation and Site Assessment (LESA) based system for counties to rank easement applications. Counties must use at least the MALPF LESA standards but can also include additional considerations, such as whether the property is owner-operated. Counties may adjust their ranking systems over time to improve the quality of applications forwarded to MALPF and better reflect changing priorities and development pressures. The MALPF Board approves these county ranking systems. Easement applications are submitted to the county, which uses its MALPF-approved LESA ranking system to prioritize the applications. The highest-ranked applications are then submitted to MALPF for easement consideration.

MALPP and similar efforts have been incredibly successful in protecting private agricultural lands. For comparison, in 2009, MALPP protected over 20% of Maryland private agricultural lands, while the California Farmland Conservancy Program (CFCP) and related California-based efforts were successful in protecting about 0.38% Cali-fornia private agricultural lands during the same period (Onstead 2010).

Land Evaluation and Site Assessment (LESA) & USDA Land Capability Classification (LCC) Systems

The MALPF uses the **Land Evaluation and Site Assessment (LESA)** system, adapted for Maryland by the United States Department of Agriculture, to assess farmland for conservation. The LESA system combines a Land Evaluation (LE) score based on soil characteristics with a Site Assessment (SA) score of non-soil factors that affect the site's importance for agriculture and to identify farms at greatest risk of conversion. Together the LESA system provides a structured, objective approach for ranking properties for easement acquisition.

The Land Evaluation (LE) component assesses the inherent productivity of farmland soils based on soil characteristics. It accounts for up to 80 points of the total LESA score. The LE rating is determined by evaluating each soil mapping unit on the parcel for two factors: soil productivity and Land Capability Classification. Soil productivity, worth up to 40 points, is measured by comparing the corn yield or forest site index of each soil to the highest in the county. The land capability classification, also worth up to 40 points, rates soils from Class I to VII based on their suitability for cultivation, with points awarded on a descending scale. The individual soil scores are calculated, weighted by acreage, and combined to determine the overall LE score for the parcel.

The Site Assessment (SA) component evaluates non-soil factors affecting a site's agricultural importance. It considers three main categories: Farm Quality and Potential, Priority Preservation Area Status, and Development Pressure and Potential. Each category includes several specific indicators, some required and others optional, that counties can adapt to their local priorities. Farm Quality and Potential measures factors like farm size, production levels, conservation practices, and ownership. Priority Preservation Area Status assesses the site's protection from development based on surrounding land uses, zoning, and preservation plans. Development Pressure and Potential gauges the risk of the site being converted to non-agricultural use by looking at road access, allowable lot density, environmental constraints, and local development trends. Counties are allowed to include, with MALPF approval, factors such as location in a formal Priority Preservation Area, discount bidding, participation in the Critical Farms program, and eligibility for federal funding, though these are not explicitly listed in the ranking criteria. The SA score combines the weighted scores from these indicators to rank the site's overall agricultural significance and vulnerability.

LE and SA scores are totaled and used to rank properties. The highest possible LE score is 80 points. LESA offers a structured, objective approach to assessing farmland for conservation, combining land evaluation based on soil characteristics with site assessment of other agricultural attributes.

The MALPF also uses the USDA **Land Capability Classification (LCC)** system as a key criterion in application eligibility, easement prioritization and determining agricultural value. The LCC system classifies soils into eight classes (I-VIII) based on their suitability for agricultural production, with Class I-IV soils considered suitable for cultivation. Properties must have at least 50% Class I-III soils or Woodland Groups I and II to be eligible for the MALPF program, and higher priority is given to properties with a higher percentage of Class I-III soils (Sec. 15.15.01.20. Determination by Foundation of Applications To Be Approved). LCC is also used in the determination of soil productivity in calculating agricultural value for easement pricing.

Agricultural Preservation Districts

When the MALPF was established in 1977, farmers were required to be part of Agricultural Preservation Districts to be eligible to sell easements, allowing counties to direct where easements were purchased (MALPP, 2015). Agricultural Preservation Districts were established voluntarily by farmers who petition the county government to have their land designated as a district for a minimum of 5 years (15.15.01.03 - Agricultural Preservation Districts). District eligibility required that a parcel be at least 100 acres, have soils in LCC classes I, II, or III, and be actively used for agriculture (Nielsen, 1979). This system created a pre-approved pool of lands for easement sales. However, by 2007, the mandate for farms to be within these districts for easement sales was removed, and the state ceased accepting new districts in 2008, leading to the termination of all state-level MALPF districts by 2012.

Despite the discontinuation of state-level Agricultural Preservation Districts, counties retain the option to implement their own district requirements to regulate easement sales. Initially, these districts served as valuable planning tools for counties, designating eligible areas for easement acquisition and helping to focus preservation efforts. Over time, however, their utility was questioned, and they were viewed more as an impediment to farmland preservation. Nonetheless, they played an important role in the early years of MALPF by providing counties with a mechanism to influence the location and extent of farmland preservation.

Agricultural Use Assessment, Transfer Taxes, and Certification of Local Agricultural Land Preservation Programs

Maryland employs several other interconnected programs to preserve agricultural land, including the Agricultural Use Tax Assessment, Agricultural Transfer Tax, and Certification of Local Agricultural Land Preservation Programs. These programs work in conjunction with the Maryland Agricultural Land Preservation Foundation (MALPF) to incentivize landowners to keep their land in agricultural use and encourage local governments to develop effective farmland preservation strategies. The determining factors for these programs are the actual current and planned future use of the land, rather than ratings from land and soil classification systems.

The Agricultural Use Tax Assessment, a form of differential assessment, allows eligible farmland to be assessed based on its current agricultural use value rather than its full market value, resulting in lower property taxes for landowners (Section 8-209 - Assessing of Farm or Agricultural Use Land). If the land is later removed from agricultural use and transferred, the Agricultural Transfer Tax is imposed, with rates ranging from 3% to 5% based on the assessed use and size of the land (Subtitle 3 - Agricultural Land Transfer Tax). Revenue from this tax is distributed to various entities, including the MALPF and local agricultural land preservation programs. Exemptions are available for certain transfers, such as those for residential use by the owner or if the transferee agrees to continue farming the land for at least five years.

The Certification of Local Agricultural Land Preservation Programs, administered by the MALPF, provides incentives for counties to develop effective farmland preservation programs. Certified counties can retain 75% of the Agricultural Transfer Tax revenue, compared to only one-third for non-certified counties. To be certified, counties must submit biannual reports detailing their preservation efforts and progress. This additional revenue encourages local governments to establish and maintain active farmland protection programs.

Determining Easement Value, Agricultural Value & Soil Productivity Index

Maryland Agriculture Code Section 2-511 outlines the process for determining the value of an agricultural easement to be purchased by MALPF. The maximum easement value is the lower of the asking price or the difference between the land's fair market value and its agricultural value. However, MALPF cannot purchase an easement for more than 75% or less than 25% of the land's fair market value, with an exception if the owner's asking price is less than 25% of the fair market value.

COMAR Section 15.15.02.05 explains the formula for calculating the agricultural value of land for landowners applying to sell an easement. The formula assesses farm productivity to estimate the capitalized value of renting the farm, based on the premise that cash rents reflect agricultural value. Key factors influencing rent—and thus agricultural value—include soil types and farm location.

Soil productivity, indicated by a **Soil Productivity Index**, directly correlates with rent: higher natural productivity leads to higher rents. Location also affects rent, with farms closer to Baltimore and Washington (up to 100 miles) commanding higher rents. The formula developed from these observations, Rent = -53 + (160 X productivity index) + (0.11 X average distance from Baltimore and Washington, up to 100 miles), captures how these factors influence rent. However, it applies only when estimated rents are above $25 per acre, setting this as the minimum rent value for determining agricultural value according to Maryland regulations.

COMAR 15.15.02.07 establishes the **Soil Productivity Index**, a numerical scale that reflects the relative agricultural productivity of different soil classes. This index is a critical component used by the MALPF in determining the agricultural value of land for the purposes of the state's farmland preservation program.

The Soil Productivity Index is a numerical scale that expresses the relative productivity of different soil classes for agricultural purposes.

The approach assigns the Soil Productivity Index values to Land Capability Classes (termed soil classes) I-VI:

- Class I soils: 1.00 (highest productivity)
- Class II soils: 0.72 (28% less than Class I)
- Class III and IV soils: 0.50 (50% less than Class I)
- Class V and VI soils: 0.18 (82% less than Class I)

These Soil Productivity Index values are based on the USDA Land Capability Classification (LCC) of each soil group to produce crops under “average management”, as determined by the Maryland Agricultural Statistics Services, USDA, and the University of Maryland's Agricultural Resource Economics Department.

Policy and Regulation

The Maryland Agricultural Land Preservation Foundation is governed by the Agriculture Article, §§2-501-2-515 of the Annotated Code of Maryland and COMAR 15.15.01 - 15.15.03 (source).

COMAR Section 15.15.01.03 outlines the conditions and procedures for establishment of Agricultural Preservation Districts.

COMAR Section 15.15.02.02 explains the formula for calculating the agricultural value of land for landowners applying to sell an easement.

COMAR Section 15.15.02.07 establishes the Soil Productivity Index, which reflects the relative agricultural productivity of different soil classes.

COMAR Section 15.15.01.20 regulates the determination of applications to be approved by MALPF.

Section 8-209 - Assessing of Farm or Agricultural Use Land outlines the valuation and assessment of property taxes for agricultural and farm lands.

Subtitle 3 - Agricultural Land Transfer Tax governs the Agricultural Transfer Tax for occurrences when land is removed from agricultural use and transferred to use for other purposes.

Maryland Agriculture Code Section 2-510 outlines the process for the sale of agricultural land preservation easements to MALPF.

Maryland Agriculture Code Section 2-511 outlines the process for determining the value of an agricultural easement to be purchased by MALPF.

Best Practices

Establish a state program focused exclusively on the purchase of agricultural conservation easements.

A state program dedicated to the purchase of agricultural conservation easements, like the Maryland Agricultural Land Preservation Program (MALPP), is considered a best practice for several reasons. First, it provides a focused, targeted approach to preserving agricultural land, with specific criteria and a dedicated funding source. This allows for a more effective and efficient use of resources compared to a broader, multi-purpose conservation program.

In contrast, Hawaiʻi's Legacy Lands Conservation Program (LLCP) has a broader mandate that includes protecting lands with exceptional aesthetic, cultural, archaeological, and ecological value, as well as agricultural lands. While the LLCP does give some priority to "unique and productive agricultural lands," this is just one of six criteria used to evaluate potential acquisitions. The other criteria, such as protecting threatened or endangered species, cultural sites, and lands in imminent danger of development, may take precedence over agricultural considerations. As a result, the LLCP has not been as effective as MALPP in preserving a critical mass of agricultural land and supporting the long-term viability of farming.

Involve local governments and farmers in purchase of conservation easement programming.

Involving these parties in PACE programs is a best practice because it ensures that the program is tailored to the specific needs and circumstances of each agricultural region. Local governments have a deep understanding of the land use patterns, development pressures, and economic conditions in their area, and can provide valuable input on which lands should be prioritized for protection. Farmers, as the primary stewards of agricultural land, have intimate knowledge of the challenges and opportunities facing their industry, and can offer insights on the types of support and incentives that would be most effective in preserving farmland. By engaging these stakeholders in the process, MALPP can develop a more targeted and effective approach that reflects the unique characteristics of each county and the goals of the agricultural community. In contrast, Hawaiʻi's LLCP does not have a formal mechanism for involving county governments or the producer community, which may lead to a more diffuse easement acquisitions thus less effective use of limited funding resources. Without input from these key stakeholders, the LLCP may struggle to address the specific factors driving the erosion of agricultural areas in each region of the state.

Integrate soil classification systems into existing state land protection funding programming.

Integrating soil classification systems into existing state land protection funding programs is a best practice for several reasons. First, it provides a standardized, science-based approach to evaluating the agricultural potential of lands being considered for conservation. The LCC system classifies soils based on their suitability for cultivation, taking into account factors such as soil depth, texture, drainage, and slope. By incorporating this information into the LLCP's selection criteria, the program can more effectively identify and prioritize the most productive and valuable agricultural lands for protection. This can help ensure that limited conservation funds are directed towards the lands that have the greatest potential to support long-term agricultural viability.

Second, integrating soil classification systems into the LLCP can help to create a more transparent and objective process for evaluating agricultural lands. The LLCP's Form 2 Fiscal Year 2024 Property Information Worksheet allows applicants to note if a parcel is in the Agricultural Land Use District or is classified as Important Agricultural Land. However, unlike the MALPP, the LLCP does not delineate an agricultural land size threshold or provide a definition or scale for assessment of agricultural productivity. By adopting a standardized system like the LCC, the LLCP can establish clear, measurable criteria for what constitutes "unique and productive agricultural lands," reducing the potential for subjectivity or bias in the selection process. This can help to build trust and credibility with stakeholders, including landowners, farmers, and the public, by demonstrating that the program is using a fair and evidence-based approach to prioritizing lands for conservation. Incorporating soil classification systems into the LLCP, similar to how the MALPF uses the LCC and LESA systems, could help to strengthen the program's effectiveness in protecting Hawaiʻi's most valuable agricultural resources.

Establish rules for agricultural easement purchase.

Establishing clear rules for agricultural easement purchases is a best practice that can help to ensure the effectiveness, fairness, and transparency of farmland conservation programs. These rules should cover key aspects of the easement acquisition process, such as eligibility criteria, application procedures, ranking and prioritization methods, and the terms and conditions of the easement itself. For example, the Maryland Agricultural Land Preservation Foundation (MALPF) has established detailed regulations governing easement purchases, including minimum requirements for land size, soil quality, and location; a standardized Land Evaluation and Site Assessment (LESA) system for ranking applications; and provisions for landowner payments, easement duration, and permitted land uses. By codifying these rules in statute or regulation, programs like MALPF provide clarity and predictability for landowners, local governments, and other stakeholders. This can help to encourage participation in the program, reduce administrative burdens and legal challenges, and ensure that easement purchases are consistent with the program's goals and public interest. Establishing clear rules for agricultural easement purchases also promotes accountability and allows for better monitoring and evaluation of program outcomes over time.

Require soil conservation plans and encourage healthy soils practices for acquired easements.

Incorporating soil conservation plans and encouraging healthy soils practices for acquired easements is a best practice that promotes the long-term productivity and sustainability of protected farmland. By requiring landowners to develop and maintain current soil conservation and water quality plans, programs like MALPP ensure that properties are managed in a way that preserves and enhances soil health. These plans, developed in collaboration with local Soil Conservation Districts, provide a roadmap for implementing best management practices, such as cover cropping, crop rotation, and nutrient management, that can improve soil structure, fertility, and water-holding capacity. MALPP requires these plans to be updated every 10 years, or upon new ownership of the land. Maryland's Department of Agriculture established a Healthy Soils Program which provides technical assistance and financial incentives for conservation agriculture practices like cover cropping and conservation tillage. Regularly updating plans allows for the incorporation of new technologies and approaches, such as those promoted through healthy soils initiatives. By integrating soil health components into easement requirements and complementary programs, conservation efforts can support the long-term viability of agriculture while contributing to broader environmental goals, including improved water quality, air quality, and carbon sequestration.

Establish an agricultural transfer tax connected to agricultural dedications.

The Agricultural Use Assessment, Agricultural Transfer Tax, and Certification of Local Agricultural Land Preservation Programs work together to create a comprehensive and effective approach to farmland preservation in Maryland. By providing financial incentives for landowners to keep their land in agricultural use and encouraging local governments to develop and maintain robust preservation programs, these initiatives support the overarching MALPF goals. The Agricultural Use Assessment reduces the property tax burden on farmers, making it more economically viable for them to continue farming. If landowners decide to convert their land to non-agricultural uses, the Agricultural Transfer Tax serves as a deterrent and generates revenue for farmland preservation efforts. The Certification Program incentivizes counties to establish strong local preservation programs by allowing them to retain a larger portion of the transfer tax revenue. Hawai'i's agricultural land market, particularly on Oahu, offers little support for purchasing land intended for agricultural production. To address this, the transfer tax could be made more effective by applying it not only to the conversion of agricultural land for non-agricultural uses but also to the subdivision of dedicated land. This approach may help deter land partitions that do not guarantee productive agricultural use. Together, these programs create a multi-layered approach that addresses the financial pressures faced by farmers and the need for coordinated preservation efforts at both the state and local levels.

One of the key strengths of these programs is their focus on the actual current and planned future use of the land, rather than relying solely on land and soil classification systems. This approach ensures that the programs are responsive to the real-world conditions and challenges faced by farmers and local communities. By considering factors such as the landowner's commitment to continuing agricultural activities and the county's preservation priorities, these programs can more effectively target resources to the areas where they will have the greatest impact. The Certification Program, in particular, encourages local governments to take an active role in shaping their farmland preservation strategies, allowing them to tailor their efforts to the unique needs and characteristics of their communities. This collaborative approach, which involves landowners, local governments, and the MALPF, is essential for building a strong and sustainable farmland preservation system that can adapt to changing conditions over time.

III. NEW YORK

Excerpt of 1913 soil map of Oneida County, NY. USDA Bureau of Soils

Soil Classification for Land Use Decisions

New York State's agricultural land classification and taxation system has evolved significantly since its inception, incorporating both economic and technological advancements to better assess land productivity and value. Historical methods like the Cornell System of Economic Land Classification laid the groundwork for understanding land based on economic viability and physical characteristics. Later, technological advancements like aerial photography and digital mapping facilitated the classification of 50 some land use types in the New York State Land Use and Natural Resources Inventory (Anderson, 1976). The shift towards an income capitalization approach in 1980 marked a significant development, allowing for a more nuanced valuation of agricultural land for taxation purposes. This approach, supported by the New York Department of Agriculture and Markets and Cornell University, utilized soil productivity assessments and economic profiles for crops, providing a flexible and fair system that encouraged sustainable agricultural practices statewide.

Agricultural Land Classification System

New York State has a strong agricultural sector. It utilizes soil classification to evaluate and group soils according to productivity and capability, primarily for use in land assessment and taxation. The use of soil maps for taxation purposes are believed to mitigate biases and provide valid assessments of land productivity potential, and thus have achieved wide acceptance by farmers across the state (Olson 1984).

Historically, New York approaches have often held economic factors as central in classification and analysis. The Cornell System of Economic Land Classification, in use since at least the 1930s, was a method of dividing lands into categories based on such attributes as morphology and performance characteristics, without the cost of detailed and repeated farm management surveys (Conklin, 1959). Economic classification approaches like these use many of the same factors used in other soil classifications but, instead of using economic factors as parameters along with physical characteristics in soil suitability analyses, economic factors that relate to farming (such as relative prices of products, cost of labor and fertilizers) are central to economic land use classifications (Vink, 1958). The centrality of economic factors enables an “income appraisal” per farm or groups of farms. The result of such classifications could thus be viewed as groupings of farm business units.

As technology developed, the Center for Aerial Photographic Studies at Cornell University established a classification system for the New York State Land Use and Natural Resources Inventory. The system digitally stored various land use data derived from interpreting aerial photos from 1967-1970, as part of New York's Land Use and Natural Resources (LUNR) Program. This system allowed for both updating as new data arrived as well as computer-generation of maps (Anderson, 1976).

In 1980, New York State passed laws changing how farmland value was calculated for taxes. Instead of market value, they started using an income capitalization approach, which reflects the land's agricultural use value (Knoblauch & Milligan, 1981). The New York Department of Agriculture and Markets (NYSDAGM) was tasked with developing a land classification system in consultation with New York State College of Agriculture and Life Sciences at Cornell University; the State Division of Equalization and Assessment was to calculate land values for each soil group within this system (Agricultural Land Classification System for New York, n.d.). This new approach was put into effect in 1981, using economic profiles based on crops like corn and hay.

The taxation of agricultural lands is based in part on an assessed productivity of soil map units. Yield estimates for corn and hay from the soil survey report and Soil Conservation Service (SCS) Form 5 were converted into total digestible nutrient (TDN) values. This conversion was based on a recommended crop rotation and took into account soil loss estimates. The resulting TDN yields were then categorized into mineral soil groups (MSG) using index numbers calculated as the ratio of the maximum potential TDN yield to the actual TDN yield for each soil map unit, multiplied by 100. Economic profiles for each mineral soil group, organic soil group, and woodland group are estimated based on this yield data and expected cost of adding agricultural lime.

Agricultural value was calculated differently for high- and low-lime soils, and between upstate New York and Long Island, and annual adjustments were made to reflect prevailing conditions and taxation budget goals. Basing the tax structure on assessments based on the productivity of soil map units allowed for flexibility and persistent potential to improve land use, as incentives could be offered to cultivate specific crops or for attaining higher yields, and penalties imposed if management practices were deemed unsatisfactory, for instance, in cases of severe soil erosion (Olson 1984).

Today, NYSDAGM still administers the **Agricultural Land Classification System**, which provides the basic soils information needed to calculate agricultural assessments for individual farms. The New York Agriculture & Markets Law § 304-A Agricultural assessment values outlines this classification system and the assessment valuation approach. The system and its application are further outlined in the New York Codes, Rules and Regulations Chapter IX Agricultural Districts Part 370 Land Classification System.

The land classification system currently includes ten primary MSG, with additional subgroups to accurately represent variations in lime content. There are also four distinct groups for organic (also known as muck) soils. This system is established through a formal rule promulgation process that involves reviewing feedback from an advisory council on agriculture, holding public hearings, and potentially revising the system with input from county agricultural and farmland protection boards, district soil and water conservation committees, the cooperative extension service, other state agencies, appropriate federal agencies, municipalities, the New York State College of Agriculture and Life Sciences at Cornell University, and farm organizations. The soil list developed in accordance with the land classification system, along with any revisions, is certified to the Department of Taxation and Finance. Materials are prepared as needed for the system's utilization, and assistance is provided to landowners and local officials in its application.

NYSDAGM releases an annual update of the State Agricultural Land Classification (e.g., NYSDAGM, 2024) along with a separate file detailing changes (e.g., NYSDAGM, 2023). These data are provided as tables in portable document format (i.e., pdf).

The American Farmland Trust (AFT) studied the relationship between MSG's and the USDA's farmland classes (Levy et. al, 2022). The figure below (from Levy et. al, 2022) shows the percentage of lands some of USDA's commonly used farmland classes by MSG statewide:

FIGURE 5. CROSSOVER BETWEEN NYS MINERAL SOIL GROUPS AND USDA FARMLAND CLASSIFICATIONS

USDA Farmland Class	Mineral Soil Groups									
	1	2	3	4	5	6	7	8	9	10
All areas are prime farmland	6%	46%	34%	10%	3%	0.1%	-	-	-	-
Farmland of statewide importance	-	-	4%	13%	27%	36%	18%	2%	-	-
Not prime farmland	-	-	0.1%	0.2%	5%	21%	23%	34%	13%	0.2%
Prime farmland if drained	-	0.3%	0.1%	10%	74%	15%	1%	-	-	-

Soil Productivity Index

The **Soil Productivity Index** system, outlined in § 370.6 - Soil productivity index system, is used to classify soil map units into the ten Mineral Soil Groups. First created by the Cornell University Department of Agronomy in cooperation with the USDA Soil Conservation Service, this system assigns a productivity index to each soil map unit based on its capacity to produce total digestible nutrients (TDN) per acre annually. TDN is a measure of the combined digestible organic nutrients in an animal feed, including carbohydrates, fats, and proteins (see § 370.2 - Definitions).

The key points of the Soil Productivity Index system are as follows:

- The soil map unit with the highest TDN production capability per acre per year is assigned a productivity index of 100 and serves as the base soil map unit.
- For other mineral soil map units, the productivity index is calculated by comparing their TDN production capability to that of the base unit and adjusting the value accordingly, as outlined in § 370.8 - Ranking of mineral soils.

To determine a mineral soil map unit's TDN production capability, the following steps are undertaken:

1. Selection of one or more crops based on their agricultural significance in New York State
2. Use of the universal soil loss equation to derive a maximum rotation for these crops, incorporating management practices essential for maintaining soil productivity
3. Estimation of yields for the selected crops, considering their importance in the crop rotation and expressing these yields in tons (or other units) per acre per year
4. Development of TDN factors for each selected crop
5. Calculation of the total TDN production per acre annually by multiplying the weighted yield of each crop by its TDN factor and summing the totals

This approach ensures that soil productivity indices accurately reflect the agricultural potential of different soil map units, facilitating targeted and effective land use planning and management.

The **Soil Productivity Index** as applied in the **Agricultural Land Classification System** incorporates measures of productivity based on the TDN of corn and hay crop rotations. The decision to use a rotation of corn and hay for soil comparison was made due to their widespread cultivation across various regions and soil types within the state.

Additionally, this rotation was chosen to address erosion control concerns across the majority of soils in the state. Typically, alternating between corn and hay can effectively minimize soil loss to acceptable levels, especially when limiting the consecutive years of corn cultivation (NYSDAGM, n.d.). Estimates based on these two crops in rotation allowed for comparable yield tests. Initial economic profiles for corn and hay were developed by Cornell University as part of the implementation of the 1980 laws that shifted the approach of the Agricultural Land Classification System (Knoblauch & Milligan, 1981).

Knoblauch and Milligan (1981), detail the fourteen economic profiles developed across eight soil groups, utilizing enterprise budgets reflective of an average farm's characteristics within the state. For each crop, two iterations of enterprise budgets were created: one for the year 1980 and another representing the average from 1976 to 1980. This approach of using a five-year average aimed to mitigate the impact of price and cost variability on net returns. Additionally, it corresponds with the average five-year interest rate of new Federal Land Bank loans, serving as the capitalization rate. The determination of agricultural assessment values thus leverages the data derived from these economic profiles.

Agricultural Assessment Values & the Agricultural Districts Program

Agricultural Assessment Values and the Agricultural Districts Program are closely related and rely on the Agricultural Land Classification System. Agricultural Assessment Values are determined using two factors: the Agricultural Land Classification and a base agricultural assessment value.

As detailed above, the Agricultural Land Classification System is administered by NYSDAGM and classifies farmland based on soil productivity. It divides soils into two main groups: mineral soils, which are ranked in 10 groups with groups 1-6 further divided into high-lime and low-lime subgroups, and organic soils, which are ranked in 4 groups, A-D.

The base agricultural assessment value is calculated annually by the Commissioner of Agriculture and Markets, using data from the USDA including farm real estate value, farm structure value, interest on mortgage debt, net farm income, production expenses, realized gross income, taxes on farm real estate, acres harvested, and value of production. The base value is assigned to the highest grade mineral soil (1a), and other soil groups are assessed as a percentage of this base value according to their productivity (see §304-a. Agricultural assessment values). Farm woodland is assessed the same as mineral soil group 7, with a maximum of 50 acres per parcel. Orchards, vineyards, and aquaculture are also considered in the assessment.

Agricultural assessment values are central to the Agricultural Districts Program, which allows for the creation of agricultural districts to limit unreasonable local regulation of farm practices and construction of development-encouraging facilities. The Program provides reduced property taxes for farmers by assessing farmland based on its agricultural production value (determined by the Agricultural Assessment Values) rather than its development value. Landowners owning at least 250 acres can submit a proposal to the county legislative body for the creation of an agricultural district. The county legislative body, after a public hearing and considering factors such as farming viability and county developmental needs, may adopt the proposal. Adopted plans are submitted for approval to the New York State Commissioner of Agriculture and Markets, who certifies that the plan is eligible, consists predominantly of viable agricultural land, and serves the public interest.

Farmland located outside an agricultural district may still qualify for an agricultural assessment, following the same requirements and application process. However, such land must remain in agricultural use for eight years (compared to five years within an agricultural district) or face a payment for conversion to non-agricultural use.

The Cornell University's Institute for Resource Information Sciences maintains the Agricultural Districts geospatial data at the Cornell University Geospatial Information Repository (CUGIR). CUGIR provides free and open access to data, focusing on natural features important to farming, ecology, and natural resources for New York State and federal agencies.

In summary, the Agricultural Land Use Classification System forms the basis for calculating Agricultural Assessment Values, which in turn enable the reduced property taxes for farmers within Agricultural Districts created under the Agricultural Districts Program. These interconnected components work together to support and maintain viable agricultural industries in New York State.

Large-Scale Renewable Energy Programs

The New York State Energy Research and Development Authority (NYSERDA) annually releases geospatial soils data for use in responding to requests for proposals to its Renewable Energy Standard (RES) and NY-Sun programs.

Energy developers involved in RES or NY-Sun projects may be required to make Agricultural Mitigation Payments if their solar facilities overlap with designated Agricultural Districts and prime agricultural soils, classified as Mineral Soil Groups (MSG) 1-4. If a developer impacts these soil groups, they may be required to contribute to a fund managed by NYSERDA, which is used to support regional agricultural practices and soil conservation, in consultation with NYSDAGM. Soils data thus plays a key role in protecting agricultural lands from large-scale renewable energy development by discouraging solar project development on these high-quality agricultural soils and promoting the retention of agriculturally productive lands.

Two data sets are used in the creation of NYSERDA's geospatial data layer. New York State Agricultural Land Classification's master list of soils, compiled by NYSDAGM and released annually as tables are provided with Map Units. These Map Units correspond to those in the NRCS SSURGO soils database, which when joined in a GIS allows for mapping. As data from NYSDAGM and NRCS are updated annually, NYSERDA also creates a new soil dataset on an annual basis.

Policy and Regulation

Since its enactment in 1971, Agricultural Districts Law, Article 25AA of the Agriculture and Markets Law (AML), known as the Agricultural Districts Law, has served as the foundational element of both State and county initiatives aimed at conserving, safeguarding, and fostering the growth and enhancement of agricultural lands for the production of food, fiber, and various other agricultural commodities.

Within the Agricultural Districts law is § 304-a. Agricultural assessment values which details the Agricultural Land Classification System.

The Agricultural Land Classification System rules are outlined in NYSDAGM regulations Chapter IX - Agricultural Districts § 370 - Land Classification System, including subsection § 370.6 on the Soil productivity index system and § 370.8 on the Ranking of mineral soils.

The Farmland Protection Working Group (FPWG) was created as a result of Chapter 55 of the Laws of 2021. The FPWG is a coordinated effort among the New York State Departments of Agriculture and Markets and Environmental Conservation, the New York State Energy Research and Development Authority, the New York State Office of Renewable Energy Siting, and the New York State Department of Public Service. These key state agencies convene with appointed representatives from County Agriculture and Farmland Protection Boards, as well as local government officials from across New York.

The goal of the FPWG is to consider and recommend strategies to the State on the siting process of major renewable energy facilities and to minimize the impact of siting facilities on productive agricultural soils on working farms. In accordance with Executive Law 94-c(8)(b), the statutory purpose of the FPWG is to "recommend strategies to encourage and facilitate input from municipalities in the siting process and to develop recommendations that include approaches to recognize the value of viable agricultural land and methods to minimize adverse impacts to any such land resulting from the siting of major renewable energy facilities."

Best Practices

Partner with the University of Hawaiʻi to establish regular soil classification system updates.

Through the decades, New York State, in collaboration with Cornell University, has driven innovative approaches to agricultural mapping and evaluation. As mentioned above, Cornell's Center for Aerial Photographic Studies developed a process to derive land use data from interpreting aerial photography and developed a classification system for New York's LUNR Program in the 1970s. The University also worked to database and store digitized database and map information during that time.

In the 80s, New York State College of Agriculture and Life Sciences at Cornell was the prime consultant for the development and administration of a land classification system for the New York Department of Agriculture and Markets. This relationship was signed into law in April 1980 (Senate Bill 8923-A and Assembly Bill 11551-A).

And, from 1995 to 2009, Cornell conducted the "Agricultural Land Classification System for New York" project (Delgoria, n.d.) which aimed to evaluate and maintain a system categorizing agricultural land based on soil productivity for the New York Department of Agriculture and Markets. The initiative focused on evaluating soils using available yield data, considering soil properties, climate, elevation, and location within the state to rank soil productivity and capability. New soil types and map units identified through soil survey programs were incorporated annually into the classification system, supported by a computer database for yields and soil ratings. The project's primary impact was the classification of soils into ten groups to facilitate agricultural exemptions for tax and evaluation purposes and inform land use decisions for non-agricultural purposes. Annual reports on the system's status were provided to the Commissioner of Agriculture pursuant to § 304-a(3)(a) Agricultural assessment values of the Agricultural and Markets law.

Hawaiʻi State could benefit from partnering with the University of Hawaiʻi (UH), as demonstrated by the mid-20th century work of the Land Study Bureau (LSB) attached to UH.

Provide sustained funding to support regular soil classification system updates.

Unlike Cornell's receipt of consistent state funding to maintain the Agricultural Land Classification System, the LSB was criticized during its time for repeating a previously completed study (Oʻahu classifications were released twice). This was a contributing factor in the Hawaiʻi legislature's decision to cut funding to the LSB.

Apply agricultural land classifications in determining differential assessments for agricultural land taxes.

The most common form of agricultural land tax relief across the country is known as a differential assessment. These programs enable land use tax authorities to evaluate farmland based on its value for agricultural purposes rather than its full fair market value, which is typically higher. Differential assessments are also referred to as current use assessment and use value assessment; in Hawaiʻi, they are commonly known as agricultural dedications. Each major county in Hawaiʻi provides some form of agricultural dedication to reduce the tax burden of commercial agricultural operations. These blanket assessments however may not often differentiate between the underlying agricultural capacity of lands and have been a mechanism for rent-seeking by residential or non-agricultural operators on productive lands. While the costs to county tax bases have not been studied, a more nuanced and use-based approach built upon a robust land classification and valuation system could ensure that agricultural operations are the prime beneficiary of these dedications.

Consider income value instead of market value in determining agricultural land taxes.

As noted above, Hawaiʻi's agricultural land assessments for county taxation often apply a differential assessment based on the market value of agricultural lands. This practice contrasts with the use of an income value approach which offers potential for improving land use. Olson (1984) notes that with an income value approach both incentives (e.g., toward certain crops or high yields) and penalties (e.g. for land degradation and soil erosion) can be implemented. In the case of Hawaiʻi, an income value approach could be implemented to address producing crops for import replacement or land banking.

Develop a voluntary county district zoning overlay with more stringent land use protections.

While New York's agricultural district program is a voluntary county-led process, the State Land Use District for agriculture has long been regarded as a "catch-all" district for lands that didn't fit neatly into other districts. While efforts like the Important Agricultural Lands (IAL) program have sought to incentivize agricultural land protections, adoption by landowners has been limited. The IAL program functions as a de facto transfer of development rights effort without the often accompanying payment for those rights (excepting tax benefits or other development opportunities not available to most agricultural operations). Establishing an agricultural district program tethered to an income value derived agricultural land classification system, like that of New York, could provide the mechanisms for many more agricultural operations to participate in durable land protection and outcome driven tax benefits.

Use Agricultural Land Classification as an input for other tools, not a replacement.

New York State Agricultural Land Classifications serves as a base layer input for determining agricultural assessment values and creating customized renewable energy tools. It does not, therefore, use the system output as the sole measure to consider when making decisions about land taxes, assessment, procurement, and development. NYSERDA also intends on creating new soils datasets for future procurements on an annual basis.

Strategically Select and Evaluate a Diverse Range of Crops and Agricultural Land Use Types

New York's TDN calculations for corn and hay embed the importance of these crops into state land use decisions and tax payments, and thus shape land use and management decisions. In other words, if a farm parcel's tax levy is based on corn and hay production but the operation instead focuses on a specialty crop without a similar yield of goods or income, the cleft between productivity (i.e., income) and tax dues could shape producer decisions.

While Hawaiʻi does not have an income-based land taxation system, the implications of crop selection should not be understated. The LSB's Selected Crop Productivity Ratings assigned values for pineapple, sugarcane, vegetable, forage, grazing, and timber, as well as a rating land for machine tillability. In so doing, these crops and practices define the land use types (i.e., plantation, diversified farming, ranching, forestry, etc.) that the system privileges. These ratings have been highlighted by agricultural planners and economists during the course of the study as part of the value of the LSB system, despite the numerous tools (e.g. LCC, LESA, etc.) produced subsequently. The crops and land use types and practices selected thus construct the ideals of use, and thereby project those uses into landscape by shaping agricultural decision-making processes. This is not necessarily accomplished via the direct review by farms determining what to grow, but more so is shaped by tools like LSB, as the predominant agricultural land evaluation, used in the assessment of land value for lease rate determination or allowance of alternative or non-agricultural use.

Consider soil quality and health.

Historically, post World War II agricultural development focused on technological fixes that increased food production but overlooked side effects and long-term consequences on soil health and environmental quality across the nation. Rapid adoption of soil and crop management practices without considering their impact on long-term productivity was common. The effects of the focus on production can be seen in soil survey interpretations like California's Storie Index or Land Inventory and Monitoring, which do not equate to evaluations of soil quality (Karlen et al., 1997). This distinction arises mainly because the interpretations typically overlook the biological aspects of soil composition.

New York State efforts to consider biological soil qualities and carbon as part of land classification work reflect the understanding that soil quality and soil management are critical to long term agricultural success. Ongoing research, education, and incentivization to develop standards for soil conservation and sustainable practices, and to enforce them through legislation, are important for cross-compliance.

In approaching soil quality as a classification factor, Karlen et al. (1997) proposed a relational perspective rather than an absolute one. They emphasized that soil quality assessments should consider the specific function being evaluated, recognizing that different soils may have varying qualities without necessarily being limiting factors. Karlen et al. (1997) suggested making trade-offs among various parameters depending on the assessment's function. They emphasized that any property or process evaluated should influence the assessed function, be measurable against a defined standard, and be sensitive enough to detect differences at specific scales in time and space.

Their framework involves point-scale evaluations and mechanisms, focusing on sub-disciplinary research into soil quality attributes and indicators. This approach aims to create an understanding of soil quality that considers its variability and relevance to specific functions.

Aligning somewhat with Karlen et al.’s (1997) recommendations, Cornell’s approach to the Comprehensive Assessment of Soil Health outlines various potential physical, biological, and chemical indicators (Moebius-Clune, 2016) that can be assessed at the field level.

Smart Solar Siting and tethering soil quality to energy development.

New York discourages renewable energy development on valuable agricultural lands by requiring payments on MSG 1-4, which are equivalent to the prime agricultural lands in the state. By establishing a fee structure requiring compensation for the loss of quality agricultural lands and routing funds to agricultural land conservation efforts, energy sector development can become a tool for enhancing the agricultural landscape.

As currently established, the sole use of LSB classes to determine the acceptability of energy development within the agricultural district is based on an assessment system originally designed to evaluate agricultural potential, not non-agricultural uses like energy projects. Therefore, applying the LSB rating to energy development does not align with the system's intended purpose. Unlike New York, Hawaiʻi does not require any payments into land conservation efforts as a result of renewable energy development on agricultural lands.

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VIII. DEVELOPMENT OF INITIAL RECOMMENDATIONS

The Contract and Work Plan outlined the development of initial recommendations to enhance the use of soil classification systems in regulating agricultural lands in Hawaiʻi. The key objectives and activities included:

1. Determining the appropriate soil classification system for the State and counties to use to inform agricultural land regulation, based on the evaluation of Hawaiʻi's existing systems and best practices from other jurisdictions.
2. Providing options for continued use or revisions to Hawaiʻi's existing soil classification systems and their integration into land use regulatory systems, considering the findings from the study's research and stakeholder engagement.
3. Identifying possible operational requirements for implementing improvements to the current soil classification system, assuming it can benefit from enhancements.
4. Referencing statutory and rule changes at the State and county levels that may be needed for implementation of the recommendations.
5. Developing additional recommendations based on the study's findings, stakeholder input, and guidance from OPSD and the Steering Committee.
6. Presenting the initial recommendations in a structured format, such as a Recommendations Matrix, that aligns the proposed actions with the study's identified strengths, weaknesses, and best practices.

The Project Team, including Supersistence and G70, collaborated to develop these initial recommendations. Additionally, Plasch Econ Pacific and Stantec provided selected early input based on their participation in the overall project. The process involved synthesizing insights from Phase I of the study, which included an in-depth review of Hawaiʻi's existing soil classification systems, stakeholder engagement, and research on best practices from other states. These components provided a foundational understanding of the current landscape and challenges related to soil classification in the state; on-the-ground perspectives and insights into how existing systems are being used, perceived effectiveness, and potential areas for enhancement; and a range of strategies and tools being used in related jurisdictions for consideration in crafting the initial recommendations.

Building on this foundation, the team reviewed stakeholder input from Polis, comments from focus group meetings, feedback from one-on-one meetings, and existing policies and related policy white papers to identify limitations and opportunities and to develop recommendations that respond to the unique needs and priorities of Hawaiʻi's agricultural community.

As the study proceeded it became apparent that project stakeholders from government, private, and community sectors held different opinions about systems, and the study's purpose and function. Stakeholders often responded to outreach based on their individual goals, seeking various benefits from a classification system. These included, but were not limited to, simplifying regulatory processes, identifying developable parcels for energy or housing, aiding farmers in crop selection, and supporting open space or farmland preservation. As a result, the initial recommendations list sought to encompass the manifold interests identified during Phase I outreach.

These initial recommendations covered various aspects of soil classification and agricultural land management, including data and technology improvements, policy and regulatory updates, integration with other planning tools, and strategies for enhancing collaboration and stakeholder engagement. Each recommendation was carefully considered in terms of its potential impact, feasibility, and alignment with the project's objectives of supporting sustainable agriculture and informed land use decision-making.

During the drafting of the initial recommendation list, a categorization system was developed to identify recommendations that might require potential statutory and rule changes for implementation at the state and county levels. The recommendation matrix was organized into a hierarchical framework with the following categories:

- **General Framework**: General Recommendations addressed the foundational aspects of land evaluation and regulation, focusing on enhancing clarity, relevance, and effectiveness of land classifications and regulatory frameworks. Recommendations aimed to make evaluations more demand-driven, to ensure that technologies and regulations would evolve together, and to update or replace outdated systems and criteria to reflect current data and stakeholder needs.
- **Soil Capability**: The Soil Capability category focused on recommendations to develop and refine a soil capability classification system that would be accurate, adaptable, and reflective of both historical and current land use practices. This would involve integrating detailed soil data, considering land use history, and selecting crops for economic analyses to support robust and relevant agricultural planning and decision-making.
- **Multifunctional Suitability**: The Multifunctional Suitability category contained recommendations advocating for a versatile and integrative approach to land use planning that encompasses environmental, economic, and social sustainability. The focus of recommendations in this category was on revising existing classification systems to include a wider range of factors such as soil health, crop suitability under climate change, and public values, aiming for a balanced consideration of multiple land uses.
- **Smart Solar Recommendations:** The 'Smart Solar' category developed out of a strong stakeholder interest in solar energy development on agricultural land. These recommendations aimed to strategically plan and manage solar energy development on agricultural lands, and included developing specialized classifications for renewable energy, establishing guidelines and financial mechanisms to protect prime agricultural land, and promoting dual-use approaches like agrivoltaics to optimize land use.
- **Ancillary Recommendations:** Finally, the 'Ancillary' category included strategic actions to integrate soil and land classifications into broader state initiatives such as land protection funding programs, tax assessments, and agricultural conservation efforts. It aimed to create dedicated programs and partnerships to ensure the long-term viability and accuracy of land classifications, leveraging these tools for effective land management and policy formulation.

The initial recommendation matrix contained several key columns to organize and explain the data. Each recommendation was assigned a unique ID for reference and tracking. Recommendations were grouped into broad categories (above) which reflected their thematic focus. A title provided a concise summary, while a detailed description outlined the full scope of the recommendation. The source column explained how the recommendation was developed, whether through stakeholder engagement, research, or policy analysis. The matrix also noted the resources required for implementation and identified any operational steps necessary to put the recommendations into action.

FOCUSING RECOMMENDATIONS

Initially, the consultant team compiled a set of approximately forty initial recommendations (5 General Framework, 5 Soil Capability, 11 Multifunctional Suitability, 8 Smart Solar, and 11 Ancillary) based on Phase I research findings and outreach. The initial recommendations addressed a broad range of considerations, including updating soil classification systems, improving regulatory frameworks, integrating historical and current land use data, establishing funding mechanisms, planning for renewable energy development, implementing agricultural land protection measures, and enhancing data sharing and accessibility.. Each recommendation was evaluated for its potential impact, feasibility, and alignment with the project's goal of promoting sustainable agriculture and informed land use decisions.

This initial recommendation matrix was reviewed by OPSD and the Steering Committee (SC). To ensure the study remained focused on its primary objective of improving soil classification systems for agricultural land regulation, the recommendations were refined. Broader policy topics like tax policy, climate change, and renewable energy, while important, were deemed outside the study's scope. This narrowing led to a core set of recommendations that offered clear, actionable suggestions for enhancing soil classification systems and their direct use in state and county agricultural land regulation, instead of also looking at technical systems and policy that could be built on top of such a model as well (e.g., NYSERDA building an energy siting model with their soil classification as an input layer). The scope focus on a baseline land evaluation model allowed for Phase II outreach to center on more detailed technical and policy recommendations and discussions. Selected recommendations not integrated elsewhere in this report are provided in Appendix I: Selected Initial Recommendations.

Following the initial review, recommendations were revised and presented to the Land Use Commission (LUC) and in follow-up outreach, detailed in Phase II Outreach activities section below.

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IX. Phase II Outreach and Stakeholder Perspectives

Summary of Outreach Activities

Phase II outreach followed a structured approach designed to progressively refine recommendations and model parameters through increasingly focused discussions. Beginning with a presentation to the Land Use Commission (LUC), the process then moved to small group meetings where regulatory experts and model specialists engaged in detailed technical discussions. These focused sessions established a shared understanding of baseline evaluation systems while addressing specific regulatory needs and model development challenges. Parameters for an updated land evaluation framework were presented and discussed, drawing from academic literature and existing classification systems.

The process then expanded through targeted follow-up meetings with key stakeholders before culminating in a larger general public meeting where refined recommendations were presented for broader community input. This tiered approach - moving from technical expertise to wider stakeholder engagement - ensured that both technical rigor and practical considerations informed the final recommendations for an updated baseline classification model. Throughout the process, recommendations evolved through continuous stakeholder feedback, helping to shape a classification approach better aligned with Hawai'i's current needs.

Land Use Commission

The Land Use Commission (LUC) received a presentation on the overall project and nine preliminary recommendations. After the presentation, commissioners engaged in discussion with OPSD and the Project Team about the limitations of current soil classification systems, particularly the Land Study Bureau (LSB) system, and its impact on agricultural land designations. Concerns were raised about the need to incorporate cultural considerations, the impact of changing agricultural practices, and the potential for soil classification to inform decisions on land use, including housing development. Suggestions were made for further outreach and collaboration with stakeholders, including agricultural and housing developers, to refine the existing soil classification system and ensure its relevance to current and future land use needs in Hawai'i.

This meeting, along with Phase I outreach, highlighted a need for clearer communication of the study's focus. Subsequently, the recommendations list was again refined to eight items, and it was determined that more detailed technical and policy discussions would further the recommendation refinement process and emphasize the study scope.

Defining Land Evaluation Parameters

With narrowed focus of scope came the opportunity to further detail technical and policy recommendations. Though not tasked with creating an updated classification model, a deeper review of academic literature on characterizing land evaluation frameworks was performed (see Section II's Development of Modern Land Evaluation Approaches). The review highlighted the importance of parameter specification in model selection or development.

Defining land evaluation parameters is crucial for creating a focused and effective classification system by clarifying the purpose of the evaluation, the specific land uses being assessed, and the data requirements, which ultimately ensures that the classification system is fit-for-purpose and aligned with the intended goals, whether they be regulatory compliance, land use planning, farm decision support, or other objectives. Informed by the history of land evaluation approaches, a set of twelve land evaluation model parameters were compiled, largely from Rossiter (1996) and Riveira & Maseda (2006). A referenced parameter table is provided in Appendix H, Land Evaluation Parameters Sources.

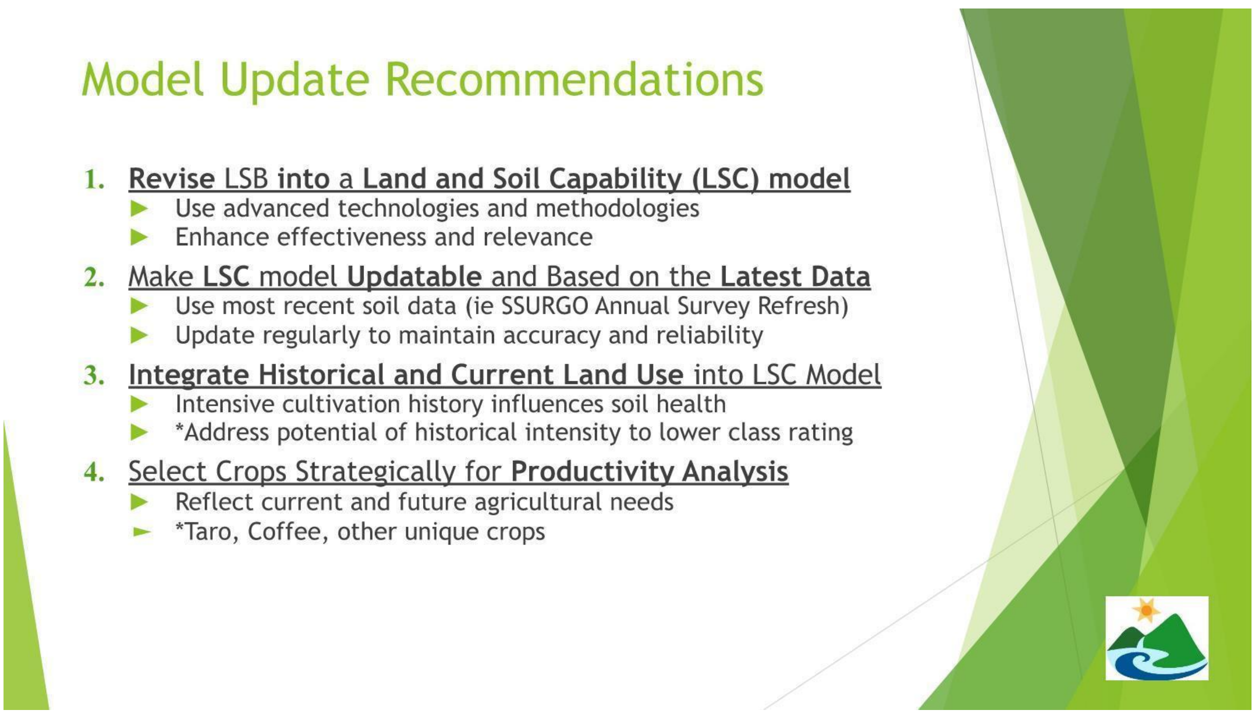
Once the parameters were selected, a typology comparing and contrasting the LSB, ALISH, and LESA systems was created. Informed by those systems' parameters and prior outreach, suggestions were developed for an updated model. At this point in Phase II outreach, the recommendation for an updated classification model was termed Land and Soil Capability (LSC) model to differentiate between it and the LSB system. (See Appendix H for the typology presented during Phase II outreach that occurred after the LUC presentation.)

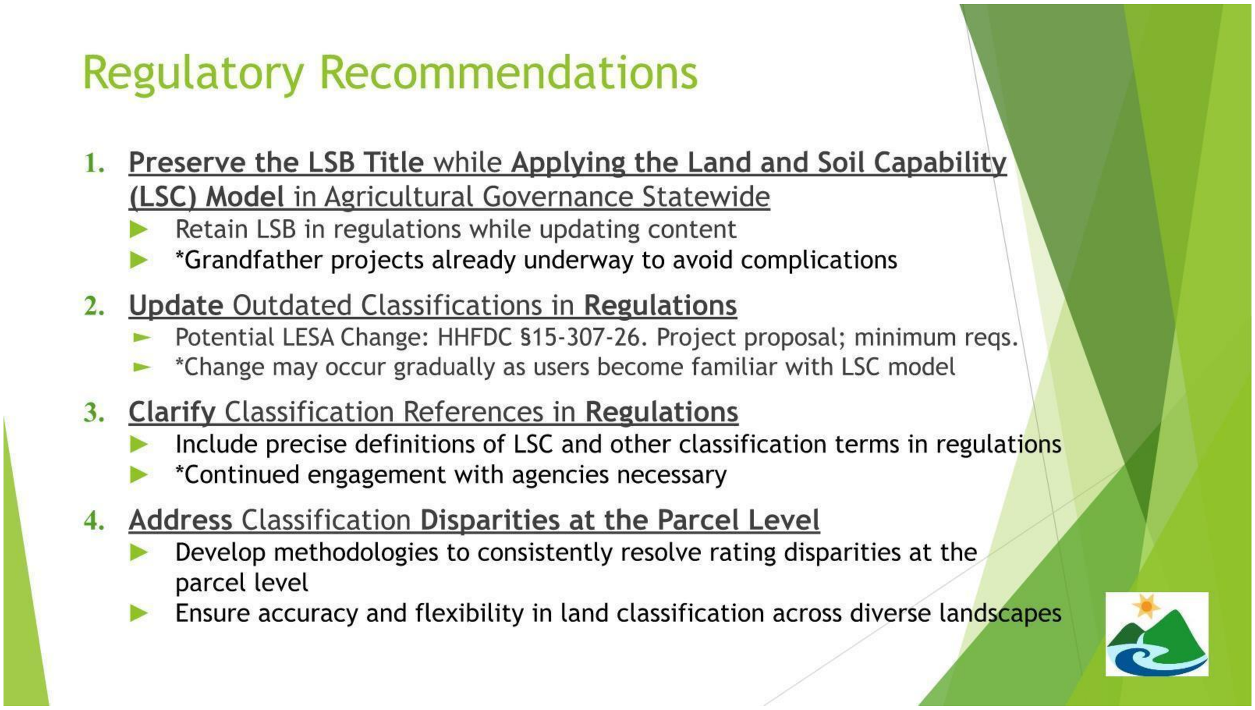
Model and Regulatory Expertise Outreach

The narrowed focus on a baseline land evaluation system, combined with insights from the LUC meeting and parameters research, provided an opportunity to engage stakeholders in detailed discussions about the potential model updates and regulatory changes recommended.

Focused small group meetings were held to refine eight recommendations (see slides below), with two sessions scheduled to maximize attendance flexibility. Key experts, including those who had previously provided feedback or possessed expertise in either soil classification or regulatory frameworks, were invited to assist in refining initial recommendations, ensuring their feasibility and identifying any gaps. Participants were asked to prepare by reviewing a pre-recorded video of the initial recommendations presented to the LUC, and were encouraged to submit feedback to the project email before the meeting.

The meetings aimed to share and validate preliminary recommendations, evaluate these recommendations through expert opinions, verify their feasibility while identifying any remaining technical needs, and ultimately generate actionable recommendations for legislative consideration.





After an overview and discussion of all recommendations, the groups were presented a detailed review of model parameters essential to Recommendation 1. This established a shared context for both technical and policy-driven considerations, setting a foundation for informed discussions. Table 7, Selected Land Evaluation Parameters, explains each selected parameter and provides a suggested approach for an updated model.

TABLE 7. SELECTED LAND EVALUATION PARAMETERS

Parameter	Description	Suggestion
Purpose	Capability systems evaluate land for broad, general uses like agriculture, while suitability systems assess land for specific purposes, like a given crop.	Capability
Land Uses Considered	Whether general agricultural land utilization types such as agriculture or grazing, or specific uses such as crops are being evaluated	General Agriculture
Geographic Coverage	Completeness of geographic coverage across the state	Statewide
Land Evaluation Unit (LEU)	The smallest unit for land suitability decisions, determines the granularity of land evaluation results and can be a grid cell, single map delineation (polygon), or set of delineations with common characteristics like a thematic map legend category, and may range from a field to a landscape unit.	Soil Map Unit
Spatial Analysis	Whether the model considers the geographic location and spatial relationships of the land areas being evaluated.	Spatial
Land Characteristics vs. Qualities	Whether the model uses directly measurable attributes (land characteristics) or complex attributes (land qualities) derived from those characteristics	Land Qualities
Single- vs. Multi-Area Suitability	Whether the model evaluates each area independently (single-area) or considers multiple areas together with interactions and constraints (multi-area).	Single
Static vs. Dynamic Resource Base	Whether the land characteristics are considered constant over time (static) or changing over time (dynamic).	Dynamic
Static vs. Dynamic Land Suitability	Whether the land suitability is considered constant over time (static) or changing over time (dynamic).	Dynamic
Homogeneous vs. Compound Land Utilization Type	Whether the model considers a single type of land use (homogeneous) or multiple, interacting land uses (compound).	Compound
Suitability Measurement	How land suitability is expressed. E.g., whether through physical constraints, crop yields, or economic value	Physical Characteristics, Crop Yields, and potentially other measures like Economic Factors
Results	How the output of the land evaluation model is classified and presented (e.g., discrete classes vs continuous scale).	A-E Classification

The first seven parameters were regarded as readily defined based on previous public input and research and thus, while presented during Phase II outreach, were not the focus of discussion. The remaining five parameters (Static vs. Dynamic Resource Base, Static vs. Dynamic Land Suitability, Homogeneous vs. Compound Land Utilization Type, Suitability Measurement, and Results) reflected important model design elements that would be enhanced through informed public input.

Following this contextual review, participants were split into breakout sessions focusing on either Regulatory or Model Updates. The regulatory group examined state and county regulations referencing soil classification systems, discussing how to streamline these references and which regulatory changes should be prioritized. Discussion included evaluating the effectiveness of different classification systems (LSB, ALISH, LESA) in guiding land use decisions and identifying potential legislative changes. The model update group assessed existing soil classification systems and databases that could serve as foundations for an updated system, while also exploring technical requirements such as development costs, computing infrastructure needs, and data management systems. This structure allowed each group to engage in targeted discussions aligned with their expertise, with particular attention to both implementation feasibility and future resource needs.

The combined findings from both groups highlighted key areas where the updated model could meet practical agricultural assessment needs while aligning with policy goals, fostering a collective vetting process and supporting actionable recommendations for legislative consideration.

Follow-Ups & General Meeting

Following the Model & Regulatory meetings, targeted follow-up one-on-one meetings were held with key stakeholders to address specific concerns and gather detailed feedback. These meetings included discussions with HDOA about technical concerns, UH CTAHR regarding potential partnership for model updates, and other stakeholders who had raised specific implementation questions. The follow-up meetings helped clarify outstanding issues and ensure thorough consideration of stakeholder perspectives before proceeding to broader public review.

After incorporating feedback from the smaller group and follow-up meetings, the revised recommendations were presented at a larger General Meeting for public review and input. This meeting aimed to share the refined recommendations with the broader community and gather additional stakeholder opinions on the proposed changes and proposed model parameters. Those invited to the General Meeting were also sent the link to the LUC presentation to review these initial recommendations prior to the meeting, and provide any initial feedback via email.

OVERVIEW OF STAKEHOLDER FEEDBACK

The following discussion presents the feedback received from the Land Use Commission, the two Small Group Meetings as well as the larger General Group, and several phone call and email communications on the regulatory recommendations, model updates, and potential model parameters.

General Discussion

The main discussion centered on the need to update Hawaiʻi's agricultural land classification system and its role in informing land use decisions. However, there was a tension between merely updating the soil classification system and addressing land use issues outside the scope of the study, such as urban development, housing, and renewable energy projects.

Outdated Classification: It was generally agreed that the LSB classification system, perceived as focusing on plantation crops like sugar and pineapple, does not reflect modern agricultural practices or the quality of today's agricultural lands. Discussions emphasized the need to account for new irrigation methods and technologies like hydroponics, suggesting that an updated system should reflect these contemporary realities. While considering modern agricultural practices is important, it was noted that the study's specific scope focuses on terrestrial agricultural output and the systems that regulate and protect these lands. However, this highlights the need for a reliable and up-to-date tool that policymakers can use to make informed decisions with confidence. An updated tool would help ensure land use decisions are based on accurate, current information, supporting effective planning and balancing agricultural preservation with development needs.

Scope of the Study: The discussion had to be redirected several times to the study's primary focus, which is to evaluate agricultural value rather than guide specific decisions on land use for housing, energy, or crop selection. It does not evaluate how much land is needed for agriculture or which lands are suitable for non-agricultural uses, though it acknowledges the need to protect prime agricultural lands from being repurposed.

Political and Regulatory Challenges: Stakeholders expressed concerns about the political challenges of updating the classification system, particularly due to development pressures. It was suggested that one way to help others understand the need for revisiting soil classification systems could be by citing an example of how prime productive agricultural areas (rated A&B) have been urbanized. Concerns were expressed about the potential for dynamic systems to be manipulated by wealthier and more powerful interests, affecting subsidies and land use policies. It was agreed that the process for reviewing and petitioning classification changes needs careful democratic consideration to prevent misuse and ensure fairness. However, it was noted by the consultant team that the term "dynamic" might be causing confusion, with some interpreting it as politically motivated decision-making rather than simply updating the soil classification itself.

Land Development and Agricultural Protection: There was a concern that the new system might devalue land previously considered high-value for agriculture, leading to increased justification for upzoning and development of agricultural lands, particularly in Maui. The worry is that the decision-making authority might shift to various bodies, including the Public Utilities Commission (PUC), potentially leading to land being identified as lower quality and thus suitable for non-agricultural uses. This could result in large tracts of land being urbanized or used for purposes other than agriculture. However, an intention for updating the soil classification systems is not to facilitate upzoning, but to protect high-quality agricultural lands. Other states' models which incentivize development on lower-quality lands and disincentivize it on higher quality lands, are mentioned as potential guides.

Clarification on the Role of Updating the Classification System: The updated system is meant to inform, not dictate, regulatory decisions. It aims to provide data on agricultural land capabilities, separating scientific assessments from political decisions on land use. There was a question on whether the exercise is aimed strictly at the preservation of agricultural lands and the reclassification of soils. It was clarified that the primary focus is on updating the soil classification systems, which includes some aspects of protection but is not exclusively about preservation. An updated soil classification system is not intended to be prescriptive but rather to inform regulatory decision-making. The system could influence policies, such as those governing land use for renewable energy or housing, but it would not dictate specific activities on the land. The limitations of soil classification systems were stressed, with an emphasis on ensuring that these systems inform, but do not dictate, regulatory decisions.

Concerns About Sustainable Agriculture: Questions were also raised about whether there would be a holistic evaluation of the state's goals for sustainable food production. The existing criteria and goals around increasing agricultural output were acknowledged, but it was noted that there is no comprehensive plan linking local consumption with local production.

Consideration of Housing Needs: Some participants suggested the study should also consider housing needs and propose more specific legislative recommendations. While housing isn't a primary focus of this study, it was suggested that a specific process for reviewing housing development would be more effective than relying solely on soil classification systems.

Legislative Approval and Funding: The focus of the study was narrowly defined by the legislature to analyze how soil classification is captured within the current regulatory system, and to determine what a soil classification model should address. It was questioned as to what the legislature would do with the study. A participant suggested that the study should provide specific recommendations to the legislature rather than general suggestions. Ultimately, legislative action would be required to implement any changes to the soil classification system.

Participants raised concerns about funding and resource allocation for updating soil data. Examples were given of New York using USDA funding to update their systems annually in partnership with Cornell University, and in California, one system was designed to automatically integrate annual updates from the USDA's Soil Survey Geographic database, reducing the need for ongoing daily maintenance. Hawaiʻi would need to coordinate ongoing management and funding in order to make updates more frequent and systematic.

Feedback on Regulatory Recommendations

The Regulatory recommendations are listed, followed by feedback provided from stakeholders.

Preserve the LSB Title while Applying the Land and Soil Capability (LSC) Model in Agricultural Governance Statewide:

The initial recommendation was to retain the LSB title while implementing the Land and Soil Capability (LSC) Model—an updated version of the LSB—in statewide agricultural governance. This strategy was intended to clearly distinguish between the existing LSB model and the new LSC model, and to allow for differentiation in discussion.

The discussion centered on whether to retain the LSB (Land Study Bureau) title while updating the soil classification system, with participants divided on the issue. Some favored retaining the title for continuity and to avoid the complexity of revising all related regulations, arguing that keeping the LSB title while updating the system's definition would ensure minimal disruption. Others, however, believed a new title would better reflect the updated system and prevent confusion, particularly since the original entity no longer exists. Concerns were raised that retaining the outdated title could lead to inconsistencies and misunderstandings, especially during the transition phase.

Participants stressed the importance of ensuring any changes align with existing regulatory frameworks and that the transition be gradual to allow stakeholders to adapt. A phased approach was recommended, where the LSB title would be maintained initially, with updates to the model happening in the background to minimize confusion and disruptions. It was also suggested that clear communication be prioritized to avoid regulatory inconsistencies during the transition period. A key recommendation was to grandfather ongoing projects to prevent complications arising from changes to the system.

The conversation also touched on the broader implications of integrating a dynamic soil classification system with existing regulations. Concerns were raised about the logistical and legal challenges of changing the system, particularly the need to balance technical mapping with prescriptive planning. Participants emphasized the importance of a coordinated approach between state and county regulations to address potential inconsistencies, suggesting that changes must be carefully mediated through a clear decision-making process.

Finally, it was agreed that any updates to the LSB model or title would require strong legislative support and funding. The group highlighted the need for policymakers to be fully informed and involved throughout the process, particularly to secure the necessary resources for implementing the changes. It was also recommended to gain additional public opinion before fully instituting the new system to avoid potential litigation and ensure a smoother transition.

Update Outdated Classifications in Regulations:

Participants agreed on the importance of updating outdated classifications to reflect modern agricultural practices and economic realities, advocating for a dynamic system that incorporates the latest data and technological advancements. However, concerns were raised about the potential legal implications of making changes without legislative approval, emphasizing the need for legislative backing to ensure regulatory consistency. Additionally, participants stressed the importance of integrating modern infrastructure improvements, such as updated irrigation data, into the updated classification system. Gradual implementation of changes was recommended to allow users time to familiarize themselves with the new LSC model.

Clarify Classification References in Regulations:

Participants emphasized the need for precise definitions of Land and Soil Capability (LSC) and other classification terms in regulations to prevent confusion, particularly as old and new systems may coexist. Ensuring consistent implementation across state and county jurisdictions was seen as crucial, with a coordinated approach recommended to avoid potential inconsistencies. The group leaned towards using the updated system as an informative tool for regulatory decisions rather than a prescriptive one. Participants were asked if they faced challenges with vague classifications. One regulator noted that applicants often include all relevant classifications in permit applications, and details are clarified through agency discussions to ensure accuracy. Continued engagement with agencies was seen as necessary to ensure that the correct productivity ratings are captured.

Address Classification Disparities at the Parcel Level:

Participants emphasized the need for a systematic and fair methodology and approach to address parcel-level classification disparities, ensuring accuracy and flexibility in land evaluations across diverse landscapes. Interest was expressed in having an updated system that accounted for local agricultural diversity, historical land use, and regional factors such as irrigation availability and natural disaster risks. Overall, participants provided valuable feedback emphasizing the need for careful consideration of both continuity and innovation in updating the soil classification system, with particular attention to legal, regulatory, and practical implications.

A concern was highlighted about the impact of allowing a parcel specific characterization leading to attempts to manipulate the system to allow impermissible uses. To prevent misuse or manipulation of the classification system, while also building community trust and collaboration, this recommendation was modified to focus on refining updated model outputs through a participatory map review process. Public input on draft land classification maps would help create a transparent process, ensuring that the maps are accurate and applied consistently across all areas. This approach would also help identify and correct any errors or inconsistencies before the maps are finalized.

Feedback on Model Update Recommendations

The general consensus of this group breakout is that there is a need for a more dynamic and comprehensive soil classification system in Hawaiʻi. A unified, regularly updated database that reflects local agricultural diversity and needs is crucial. Historical land use and local agricultural practices should be integrated into the soil classification framework. Any new system should align with regulatory frameworks to ensure practical application and acceptance.

Update LSB into a Land and Soil Capability (LSC) Model:

Participants in this breakout group broadly supported updating the LSB into the LSC model, emphasizing the need for a more adaptable system that better reflects current agricultural practices and land use. Some concerns were raised about the complexity of transitioning from the LSB to the LSC model, especially in terms of regulatory consistency and the potential confusion during the transition. The importance of aligning the new model with regulatory frameworks was highlighted to ensure its practical application.

Make LSC Model Updatable and Based on the Latest Data:

Participants strongly supported making the LSC model updatable and based on the most recent data, such as the USDA's SSURGO Annual Survey Refresh. Regular updates were seen as crucial to maintaining the model's accuracy and reliability, with many emphasizing partnerships with organizations like the USDA to integrate updated soil surveys. One stakeholder advocated for annual updates aligned with USDA releases, and some participants suggested merging various soil data systems into a unified database to create a comprehensive and dynamic soil profile. This would enhance the model's adaptability to evolving agricultural practices and land-use needs.

Concerns arose about the potential confusion from frequent updates if not systematically managed and communicated. Participants recommended a structured update process, potentially every five to ten years, with interim adjustments for significant changes. To ensure transparency and public trust, a systematic review process led by a public entity was proposed. This process would include public engagement to allow stakeholders to contribute and understand the impact of classification updates. The need for predictability and stability in updates was also emphasized, with some suggesting a model similar to building code revisions, updated periodically with safeguards against abrupt changes.

Cost considerations were highlighted, with participants agreeing that understanding the financial implications of maintaining and updating the model is essential when seeking legislative support. Discussions also centered on pushing for legislative actions to ensure sustained funding, particularly for the necessary computing infrastructure and data aggregation. Although the USDA's ongoing updates to Hawaiʻi's soil surveys—such as those accounting for the 2018 lava flows—are helpful, limited resources restrict the scale of these updates. Expanding federal support could be key if the new LSC model relies heavily on USDA data.

Participants stressed the importance of integrating diverse data sources, such as privately funded watershed projects, to ensure the model is both accurate and comprehensive. This would provide a more robust tool for informing land-use decisions and regulatory frameworks, helping to align agricultural practices with modern realities.

Ultimately, this recommendation was integrated with the recommendation to *Update LSB into a Land and Soil Capability (LSC) Model* and reframed as the recommendation to *Update the Land Study Bureau (LSB) Land Classification Model* in the final listing.

Integrate Historical and Current Land Use into LSC Model:

Participants supported integrating historical land use data into the LSC model, recognizing that past agricultural practices, such as intensive cultivation, have a lasting impact on current soil health and land suitability. This integration is crucial for creating a comprehensive evaluation of land capability, allowing the model to assess agricultural potential over time while minimizing environmental impacts. By incorporating this data, policymakers can make more informed land use decisions based on both historical and current factors influencing soil quality.

However, concerns were raised about the complexity of integrating such detailed historical information without overcomplicating the model. Participants emphasized the need for a balanced approach that considers historical influences without overwhelming the system. The use of tools like georeferenced aerial imagery was suggested as a way to assess historical agricultural activity efficiently, allowing for a more nuanced understanding of how past practices affect present soil conditions. Additional concern was raised about including how a history of intensive plantation use would be included as a factor, as h

The discussion also touched on the inclusion of cultural and indigenous land use practices. While traditional farming practices, such as taro cultivation, are acknowledged in certain systems like ALISH, others, such as LSB and LESA, do not fully account for these factors. Some participants suggested incorporating cultural practices and traditional ecological knowledge into the model, although they acknowledged the challenges of doing so. While current recommendations focus primarily on physical soil characteristics, future tools could gradually integrate cultural and qualitative factors to provide a more holistic view of land capability. The resurgence of traditional cropping systems, like loʻi, agroforestry, and loko iʻa, underscores the importance of considering cultural values in land use decisions moving forward.

Select Crops Strategically for Productivity Analysis:

Participants supported the strategic selection of crops for productivity analysis, emphasizing the importance of including culturally significant and economically valuable crops such as taro and coffee. The model should reflect both current and future agricultural needs, while accounting for diverse crop types and soil health. Participants highlighted the need for flexibility in the model to accommodate ongoing research into soil health and crop adaptability, ensuring that it can support various conditions and future agricultural practices.

The discussion also addressed geographic and geological differences across counties, where county-specific discussions were needed to understand local regulatory contexts. However, this study focuses on soil classification rather than prescribing specific crops, aiming to identify parcels capable of supporting diverse crops over time. The inclusion of unique local crops like taro was considered essential, particularly for small farmers, and there was a call to ensure the system remains relevant to local agricultural practices. The need for a more sophisticated crop rating system, expanding beyond the binary classification of crops to include detailed quality ratings akin to LSB's ABCDE system, was also discussed.

Participants stressed the importance of developing a soil capability model that accurately reflects local conditions and supports diverse agricultural uses. There was concern that oversimplifying complex soil data could lead to mismanagement, advocating for a more nuanced system that incorporates soil health and crop suitability data. Ongoing research into soil carbon and health data could eventually enhance the model, though this data is not fully available yet. The group agreed that unique crop ratings should be integrated into the model to improve land evaluation and support more precise decision-making in agricultural governance.

Feedback on Selected Model Parameters

The following records the feedback received with regard to updating LSB into a modern LSC Model using the following Suggested Model Parameters:

Purpose - Suggested: Capability (General Ag)

Participants generally agreed that the primary purpose of the model should be to assess agricultural capability and inform land use decisions. They emphasized the importance of the model providing accurate data to guide regulatory and planning efforts. However, there was concern about maintaining a clear distinction between scientific data and policy decisions, ensuring the model serves as a tool for informed decision-making without prescribing specific land uses. The model's scope should be well-defined to support effective decision-making while allowing flexibility in its application.

Land Uses Considered - Suggested: General Ag

There was broad support for concentrating on general agricultural land uses, but some participants highlighted the need to consider multifunctional land uses, such as integrating agriculture with renewable energy, including agrivoltaics. This approach would ensure the model remains relevant to modern agricultural practices and diverse land use demands. Additionally, participants called for the model to accommodate various agricultural practices, both traditional and innovative, such as hydroponics, to reflect the evolving landscape of agriculture. Similar to how LSB was originally structured, this could be accomplished through the aggregation of multiple suitability assessments for selected crops and agricultural land use types.

Geographic Coverage - Suggested: Statewide

Participants strongly supported statewide coverage for the model, emphasizing the importance of reflecting Hawaiʻi's diverse landscapes and varying agricultural conditions. Comprehensive geographic coverage was seen as essential to ensure the model's applicability across all regions, incorporating local agricultural practices and historical land use data to enhance its relevance to different areas of the state.

Land Evaluation Unit - Suggested: Soil Map Unit

The use of soil map units as the basis for land evaluation was generally accepted, with participants acknowledging the importance of precise and consistent units for accurate assessments. However, they suggested integrating additional data layers, such as historical land use and irrigation infrastructure, to improve accuracy. There was consensus on the need for flexible land evaluation units that can adapt to changing land uses and agricultural practices, allowing the model to account for varying land qualities within specific regions.

Spatial vs Non-Spatial Analysis - Suggested: Spatial

Participants emphasized the need for both spatial and non-spatial analysis in the model, with a preference for a system that integrates spatial data to accurately reflect land characteristics and suitability. The use of tools like GIS was suggested to enhance the model's spatial analysis capabilities. This approach would allow for more detailed and geographically specific evaluations, which are crucial for effective land use planning.

Land Characteristics vs Land Qualities - Suggested: Land Qualities

A holistic approach to land evaluation was supported, with emphasis on the importance of focusing on both land qualities (such as soil health, water availability, and climate resilience), in addition to physical characteristics like soil type and topography. This multifaceted assessment is considered essential for accurately determining land suitability, particularly in light of evolving agricultural practices and climate change.

Concerns were raised about how shifts from plantation agriculture to tourism, particularly in areas like Lahaina, and changes in irrigation systems affect soil classifications. The study aims to address these factors, acknowledging that updates to irrigation infrastructure and soil quality data may lead to recalibrating land ratings. As a result, unirrigated lands might receive lower classifications, influencing their potential uses. The updated model seeks to provide a robust tool for protecting valuable agricultural lands while adapting to current conditions.

Single-area vs Multi-area Suitability - Suggested: Single Area Suitability

The emphasis on single-area suitability was accepted, but some participants suggested the model also consider multi-area suitability for larger, coordinated agricultural projects or regional planning efforts. This would allow for a more flexible and thorough approach to land use evaluation. They emphasized the importance of assessing land suitability not only within individual areas but across multiple regions, particularly for large-scale agricultural initiatives or land use planning that spans broader geographic areas.

Static vs Dynamic Resource Base - Suggested: Dynamic Resource Base

There was strong support for a dynamic resource base that reflects changing soil, water availability, and other critical resources over time. Regular updates to the model were emphasized to ensure its relevance and accuracy amidst evolving conditions. Some questioned the focus on soil quality, given the rise of hydroponic and aquaponic farming, suggesting that future models might incorporate non-soil-based agricultural methods. Additionally, concerns were raised about the impact of natural disasters, such as wildfires, on soil quality, with suggestions to integrate disaster risk reduction into future landscape management and model developments.

Static vs Dynamic Land Suitability - Suggested: Dynamic Land Suitability

There was strong support for a dynamic land suitability model that adapts to evolving land use practices, environmental conditions, and technological advancements. This adaptability would ensure the model's long-term relevance and accuracy. The distinction between land capability (what land can support) and land use (how land is utilized) was emphasized, with the need for regular updates and recalibrations to reflect current conditions.

The discussion also highlighted the importance of considering factors beyond soil classification, such as water proximity, energy access, and local agricultural practices, which may not be fully captured by standardized systems. Additionally, addressing abandoned and degraded lands, particularly their fire susceptibility and potential for alternative uses like grazing, was seen as important. Clear criteria were needed to ensure accurate land use assessments across different land types.

Homogenous vs Compound Land Utilization Type - Suggested: Compound Land Utilization Type

Feedback favored a model that supports compound land utilization types, acknowledging that many lands in Hawaiʻi are used for multiple purposes. The model should be capable of assessing land suitability for a variety of uses simultaneously, ensuring it can address the complexity of land use in Hawaiʻi.

Suitability Measurement - Suggested: Physical Characteristics, Crop Yields, and Potentially Other Measures Like Economic Factors

There was agreement on the need for a comprehensive approach to land suitability measurement, combining physical characteristics, crop yields, and economic factors. This approach would provide more accurate evaluations, particularly in light of economic pressures and agricultural viability. Although the study scope was not to develop a new algorithm for this, it was seen as a valuable addition to be determined during future model development. Additionally, there was recognition of Hawaiʻi's unique classifications for rocky and lava lands, which can be productive despite being considered unsuitable elsewhere, and the role of crop selection in addressing this diversity. Overall, participants agreed that economic and development factors should be integrated into the model for a more accurate understanding of land suitability.

Results - Suggested: A-E Classification

Retaining the A-E classification system was generally supported for its simplicity and continuity, although some participants suggested enhancing it with additional layers or a more nuanced scale to better reflect modern agricultural considerations, such as current irrigation infrastructure. While there was interest in a more detailed rating system, like a 0-100 scale, it was agreed that retaining the existing A-E system would avoid the complexity of reclassifying lands and changing policies. Notably, calculations would likely result in numeric scale that

Participants emphasized that the model should produce clear, actionable, and transparent results that are useful for policymakers, farmers, and other stakeholders. Ensuring that the system supports informed decision-making in land use planning and agricultural governance was a priority. Additionally, there was a call for the model to align soil classification parameters with regulatory processes to ensure it supports sustainable agricultural practices and effective land use decisions.

KEY THEMES AND CONCERNS

Overall, stakeholder feedback highlighted the need for a modern, dynamic, comprehensive, and adaptable soil classification system. Participants emphasized the importance of incorporating a wide range of factors, such as cultural and indigenous aspects, economic pressures, irrigation, and crop suitability, to accurately determine land importance. They also supported regular updates, integrating modern agricultural practices with historical land use data to maintain the model's relevance and accuracy over time.

A central concern was ensuring the model could support multifunctional land uses, reflecting Hawaiʻi's diverse agricultural landscape. The need for systematic updates, led by a public entity for transparency, and the inclusion of updated soil surveys, particularly through partnerships like the USDA, was emphasized. There was also strong support for balancing traditional and innovative agricultural practices, while ensuring the model adapts to evolving environmental conditions and factors like natural disasters.

Additionally, participants raised concerns about the legal and regulatory implications of retaining the LSB title versus introducing a new classification system. They highlighted the importance of continuity and clarity during the transition, with a preference for maintaining the A-E productivity rating system to avoid disrupting existing policies. Securing legislative support and funding was deemed essential to effectively implement these updates, ensuring that changes are transparent and inclusive of stakeholder input before any significant reclassification or policy shifts occur.

Finally, while the study focuses primarily on regulatory use rather than direct farmer support, there was a call for clear decision-making processes and specific legislative recommendations to manage the complexities and ensure that land and soil capability guide informed land use planning and agricultural governance decisions.

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X. Final Recommendations

Overview

The core recommendations presented here have been developed through extensive analysis and consultation, drawing on insights gathered during Phase II outreach efforts. These recommendations focus on the modernization of Hawaiʻi's land use regulations, the transition from systems that rely on anachronous datasets, and an update of the Land Study Bureau (LSB) model. This shift is essential for enhancing the effectiveness and relevance of agricultural governance, ensuring that the regulatory framework is aligned with current agricultural land use and technological and theoretical advancements in land evaluation. Through the integration of updated data and a modern land evaluation methodology, the LSB model update aims to provide a more accurate, robust, and updatable classification system for agricultural governance.

The seven recommendations below focus on modernizing the Land Study Bureau (LSB) land classification model by developing a statewide assessment that integrates the latest soil data and land characteristics while retaining the familiar LSB title and classification system (Rec #1). The model would assess sustained land productivity by integrating historical and current land use data (Rec #2) and strategically evaluating major crops (Rec #3), ensuring it considers the long-term impacts of past agricultural activities while providing tools for assessing future agricultural suitability. A participatory approach to refining the updated LSB model outputs (Rec #4) would involve public input on crop selection and suitability, ensuring the process is transparent and comprehensive (Rec #3, Rec #4). Statutory mandates are recommended to ensure routine updates to LSB classification maps and periodic revisions of the model, to incorporate technological advancements and changing economic conditions (Rec #5). Regulatory use of systems relying on anachronous datasets, such as LESA and ALISH, would be replaced with the updated LSB model to improve regulatory decision-making (Rec #6), and regulations amended to clarify which soil classification system to use to ensure consistency in application (Rec #7).

The **seven core recommendations** in order are:

- Update the Land Study Bureau (LSB) Land Classification Model
- Assess Integrating Historical and Current Land Use into LSB Model Update
- Analyze Sustained Land Productivity with Strategic Crops and Public Tools
- Refine Updated LSB Model Outputs through Participatory Map Review
- Mandate Routine Map Updates and Model Revisions
- Update Outdated Classifications in Regulations
- Clarify Classification References in Regulations

Context and Rationale

Details, including context and rationale for each recommendation, are provided below. The context outlines the intent, process, and specific issues each recommendation addresses, while the rationale draws on research findings, stakeholder feedback, and best practices from other jurisdictions. Where applicable, references to relevant sections of the report link recommendations directly to detailed findings, guiding readers to pertinent sections and situating each recommendation within Hawaiʻi's unique agricultural and regulatory landscape. Together, these recommendations lay the foundation for an updated, adaptable soil classification system, with the goal of making it a valuable resource for sustainable agricultural planning and informed decision-making across the state.

1. Update the Land Study Bureau (LSB) Land Classification Model

The cornerstone recommendation is to update the Land Study Bureau (LSB) land classification model. This foundational step is crucial for creating a modern, accurate, and dynamic system for evaluating agricultural land in Hawaiʻi.

The current LSB model, last updated in the 1960s and 1970s, no longer accurately reflects the state's current agricultural landscape. Our research, detailed in Section III of the study, reveals that the existing system is based on outdated data and methodologies that do not account for significant changes in agricultural land use patterns, environmental conditions, soil science, or best practice in land evaluation over the past half-century. This outdated system compromises the state's ability to make informed decisions about land use and agricultural policy.

The LSB model should be updated to a dynamic, statewide system that retains the familiar LSB title and A to E output classes. This approach balances the need for modernization with the benefits of continuity, addressing concerns raised by stakeholders during outreach efforts (as detailed in Section VI). By maintaining the familiar LSB framework while updating its underlying data and methodologies, disruption to existing policies and statutes can be minimized while significantly improving the accuracy and relevance of the system.

The updated model would integrate the latest USDA Natural Resources Conservation Service (NRCS) soil data, current agricultural land use information, and other relevant factors. This integration would provide a more comprehensive and accurate assessment of land suitability for agriculture. Importantly, the update would expand the classification system to provide statewide coverage, addressing a significant limitation of the current system.

While this update represents a significant undertaking, our research into best practices from other jurisdictions (detailed in Section VII) suggests that such comprehensive updates are both feasible and highly beneficial. States like California and New York have successfully implemented similar updates to their soil classification systems, resulting in more effective land use planning and agricultural policy.

By updating the LSB model, Hawaiʻi will lay the groundwork for more informed, data-driven decision-making in agricultural land use. This updated system will serve as the foundation for the subsequent recommendations, each of which builds upon and extends the capabilities of this modernized LSB model.

2. Assess Integrating Historical and Current Land Use into LSB Model Update

The second recommendation emphasizes the need to thoroughly assess the potential effects of integrating historical and current land use data into the updated Land Study Bureau (LSB) model.

The current LSB model has significant limitations due to its lack of historical data and insufficient current use information, such as outdated irrigation extent as detailed in Section III. Without these details, the model may overlook valuable insights regarding soil conditions, crop suitability, and existing infrastructure that may not be evident from soil data alone.

Incorporating both historical and current land use information addresses these gaps by providing a more comprehensive understanding of land potential and value over time. This integration allows for a nuanced approach that may enable the system to effectively reflect the long-term value and impacts of land use without inadvertently limiting future use possibilities.

Research into best practices from other jurisdictions (detailed in Section VII) suggests that incorporating historical context, particularly use history impacts on soil quality, into land classification systems can lead to more informed and sustainable land use decisions. Additionally, research detailed in the review of existing systems (Section III) suggests that historical irrigation extent is outdated. This approach could balance the value of historical context with contemporary agricultural realities, addressing stakeholder concerns (detailed in Section VI).

Ultimately, integrating this broader dataset aims to enhance the LSB model's ability to provide a more comprehensive and contextually rich system for evaluating agricultural land. Revising the LSB model through this integration not only enriches its evaluation capabilities but also aligns Hawaiʻi's land management practices with both past and present realities, fostering more sustainable and informed agricultural development.

3. Analyze Sustained Land Productivity with Strategic Crops and Public Tools

The third recommendation advocates for a forward-looking approach to land classification by incorporating crop suitability modeling and developing accessible public tools. This enhancement is essential to refine the Land Study Bureau (LSB) model, making it more adaptive and responsive to Hawaiʻi's diverse agricultural landscape and evolving needs.

Currently, the LSB model relies on static assessments that may miss emerging opportunities or challenges in crop selection and land management, limiting its effectiveness in evaluating shifts in agricultural potential. Moreover, the lack of transparency in the existing framework restricts stakeholders' ability to understand, influence, and make informed decisions about agricultural land use. Without a robust, dynamic system for evaluating diverse crops and land-use potentials, Hawaiʻi's capacity to optimize agricultural productivity and respond to changing environmental and market conditions remains limited.

This recommendation proposes integrating a comprehensive crop suitability analysis within the LSB model, drawing on data such as soil quality, water resources, and climate projections to assess both current and future crop viability. This approach would generate detailed suitability maps that visualize potential productivity across varied land parcels, providing clear, accessible insights for producers, land managers, and the public. By making these maps publicly available and including decision-support tools, the updated model would empower stakeholders to evaluate land suitability for diverse crops and land uses, fostering a more data-informed approach to agricultural planning. These and similar data on other agricultural land use types could be aggregated, akin to the original LSB approach (Section III), into overall ratings.

Drawing from best practices, such as those observed in New York's crop-specific analysis model (Section VII), and informed by stakeholder outreach (Section VI), this dynamic approach will support proactive land use planning and policy-making. Integrating feedback from community stakeholders—emphasizing native and high-value crops suited to Hawaiʻi's ecosystems—ensures that the LSB model reflects both technical data and local knowledge.

In summary, this update will transform the LSB model into a transparent, user-friendly decision-support tool that merges scientific insights with community perspectives. It will offer Hawaiʻi's agricultural community a valuable resource for sustainable land management, aligning technical assessments with the diverse needs of local producers and supporting resilient agricultural planning across the state.

4. Refine Updated LSB Model Outputs through Participatory Map Review

The fourth recommendation emphasizes a stakeholder-driven review process for the updated Land Study Bureau (LSB) model outputs. This participatory approach will involve agricultural producers, land managers, and community members in reviewing draft classification maps, allowing local insights and expertise to guide the development of an accurate, practical, and locally relevant land classification system for Hawaiʻi.

As reflected in Section III (Evaluation of Existing Soil Classification Systems) and stakeholder concerns (Section VI), parcel-level classification disparities can create confusion and inaccuracies for users. Even within similar soil types, adjacent parcels might develop different ratings over time, over- or underestimating productive capacity due to changes in irrigation availability. This issue is exacerbated due to limited access to and understanding of the historical data used to generate these ratings.

Updated LSB model outputs should be refined through a Participatory Map Review. Along with highlighting the need for an updated, more accurate classification system that considers current conditions, refining model outputs through public review and input on draft output maps can enhance the accuracy and credibility of land classification systems. This approach balances the need for scientific rigor with the importance of local expertise, addressing concerns raised by stakeholders during outreach efforts (Section VI).

The need for a participatory map review process arose from stakeholder concerns about parcel-level classification disparities, which call for a systematic and equitable approach to land evaluations, while mitigating the risk of system manipulation that could lead to impermissible land uses. By allowing public input on draft maps, this approach aims to enhance transparency, ensure consistency, and identify errors before finalizing maps, thus strengthening the classification system's utility and integrity.

A participatory map review process can address these issues by integrating community and expert feedback into the updated model. This approach will enhance scientific rigor with local knowledge, ensuring that draft classification maps reflect current agricultural conditions and Hawaiʻi’s unique agricultural needs. Through facilitated workshops and feedback sessions, participants could provide input on crop and land-use suitability maps, helping to refine the model outputs based on practical, on-the-ground considerations.

By refining the LSB model outputs through a stakeholder-driven map review, Hawaiʻi will benefit from a classification system that is transparent, credible, and tailored by local knowledge. This improved model will serve as a valuable tool for policymakers, farmers, and land managers, enabling more informed and equitable land-use decisions that benefit from a reproducible model enhanced by local knowledge.

5. Mandate Routine Map Updates and Model Revisions

The fifth recommendation focuses on establishing a framework for routine updates and revisions of the Land Study Bureau (LSB) model. This step is crucial to ensure that the modernized land classification system remains relevant, accurate, and responsive to Hawaiʻi's evolving agricultural landscape over time.

While the LSB intended to conduct periodic updates to its land classifications, the agency was defunded in 1974, preventing these updates from being implemented (Section III), leading to obsolescence over the decades. As detailed in Section IX, stakeholders shared concerns that a static classification system could not effectively respond to the dynamic nature of agricultural practices, environmental changes, and technological advancements. This gap indicates a pressing need for a more flexible and contemporary approach.

The recommendation proposes a mandated schedule for routine updates and reviews, ideally supported by statutory measures. This framework would ensure that new data and methodologies are systematically integrated, and addresses stakeholder concerns about the necessity of balancing stability in land use planning with adaptability, as discussed during outreach efforts (Section VI and IX). By implementing a routine update process, the LSB model can remain a valuable decision-making tool amid changing climatic, economic, and agricultural conditions.

The update model could include automated data inputs such as the NRCS's Annual Soils Refresh of SSURGO. This would seamlessly integrate the latest soil and environmental data and allow for real-time adjustments to the model, maintaining its accuracy and relevance for land use and agricultural policy decisions.

While establishing a system for routine updates represents an ongoing commitment, our research into best practices from other jurisdictions (detailed in Section VII) suggests that such regular revisions are essential for maintaining an effective land classification system. States like California and New York have successfully implemented similar update frameworks, resulting in classification systems that remain responsive to changing environmental and agricultural conditions.

By mandating routine map updates and model revisions, Hawaiʻi will ensure that its land classification system remains a reliable and adaptable tool for agricultural planning and policy-making. This approach will safeguard the relevance of the LSB model, enabling it to continue serving as a valuable resource for farmers, policymakers, and planners in the face of evolving agricultural needs and environmental conditions.

6. Update Outdated Classifications in Regulations

The sixth recommendation emphasizes the need to replace outdated classifications in regulations with the modernized Land Study Bureau (LSB) model. This transition is crucial for ensuring consistency and accuracy in land use decision-making, thereby enhancing the effectiveness of the updated LSB model across jurisdictions.

Research on Soil Classification Systems References in State and County Codes and Regulations (Section V) reveals that current regulations include outdated references to soil classification systems. This can lead to unintended consequences, such as misallocated resources and policy mismatches, compromising the state's ability to make informed decisions about land use and agricultural policy.

To address this issue, the recommendation proposes transitioning to the updated LSB model across all levels of land use policy. Aligning regulations with the updated LSB classification can provide a cohesive framework that supports a unified statewide approach to agricultural land management with the benefits of using the most current and accurate data.

7. Clarify Classification References in Regulations

The seventh recommendation focuses on amending Hawaiʻi's land use regulations to ensure clear and consistent references to the updated Land Study Bureau (LSB) model. This critical step is essential for preventing confusion and inconsistency in the application of soil classifications across jurisdictions.

Some current regulations refer to soil classifications without specifying which system should be used, leading to potential disparities in policy interpretation (Section V). This lack of clarity can create regulatory conflicts and inefficiencies, inhibiting the state's ability to implement consistent land use policies.

To address this issue, the recommendation proposes to amend regulations to explicitly reference the updated LSB model where soil classifications are required. This approach balances the need for regulatory precision with the benefits of a unified classification system, addressing concerns raised by stakeholders during our outreach efforts. Providing clear classification references can enhance regulatory transparency and ensure uniformity in land classification applications across agencies and counties.

The amendment process would involve reviewing existing regulations to identify all instances where soil classifications are mentioned, then updating these references to specifically cite the LSB model. This effort simplifies the application of soil classifications for all stakeholders, including agricultural producers and county planners, by providing a standardized reference point.

RECOMMENDATIONS MATRIX

This Recommendations Matrix offers an overview of the core recommendations, including their origins, required tools, partnerships, or expertise for implementation, and practical steps or system changes that may be needed to enact each recommendation.

Title	Summary	Sources	Resources	Possible Operational Requirements
Update the Land Study Bureau (LSB) Land Classification Model	Update the Land Study Bureau (LSB) land classification model to a dynamic, statewide system that retains the LSB title and A to E output classes. Integrate the latest USDA NRCS soil data, agricultural land use and crop data, and other relevant factors, with clearly defined parameters for evaluating general agricultural land suitability. This approach ensures regulatory continuity and minimizes disruption to existing policies and statutes, balancing the need for modernization with the benefits of familiar language.	Project Team, Polis consensus, Stakeholder input, Best Practices Review	USDA NRCS partnership; Database management system; Collaboration with a university or similar institution and HDOA/ADC	Expand classification system to Statewide coverage; Revise LSB algorithm; Review legal implications; Modify the Modified Storie Rating Index (MSRI) linked to SSURGO and rainfall (Y factor) data; Enhance the system to automate the Y factor using irrigation extent data
Assess Integrating Historical and Current Land Use into LSB Model Update	Assess the benefits and challenges of integrating traditional, plantation, and current use patterns into the LSB model update. A thorough assessment is necessary to determine whether historical land use integration can reflect long-term value and impacts of use without narrowing the range of possibilities for future use. This could provide a foundation for assessing long-term land productivity and thus capacity for sustained agricultural use.	Project Team; Phase I Soil Systems Research; Systems Comparison	Hawaiʻi Open Data; GIS mapping tools; Historical Records	Aggregate and analyze plantation history and current use data

Title	Summary	Sources	Resources	Possible Operational Requirements
Analyze Sustained Land Productivity with Strategic Crops and Public Tools	Strategically select and evaluate a diverse range of crops and agricultural land use types for inclusion in the updated LSB model. Calculate the current and future suitability of each spatially, and provide these intermediary results as decision-support tools for public use. Engage stakeholders in reviewing crop selections and suitability map outputs. This approach ensures that the land productivity analysis is comprehensive, forward-looking, and transparent, empowering stakeholders and the public to make informed decisions based on reliable and accessible data.	Project Team; Polis consensus; Stakeholder input; Best Practices Review (New York)	Economic analysis tools; GIS software; Stakeholder engagement platforms	Identify and review representative crops for productivity analysis; Develop crop suitability models; Consider Potential Impacts; Establish a reliable Overall Productivity Rating for each Land Type; Design model to adapt to new crops or changes in agricultural practices over time
Refine Updated LSB Model Outputs through Participatory Map Review	Implement a transparent and participatory approach for addressing and resolving inconsistencies in land classification through public review and input on draft output maps. This ensures that the classification process is fair, accurate, and uniformly applied across different landscapes, preventing misuse or manipulation while fostering community trust and collaboration.	Project Team; Stakeholder input	GIS expertise; GIS software; Collaboration with County planning departments	Develop methods to resolve parcel-level rating inconsistencies; Develop review process; Create user-friendly mapping interfaces; Create system to manage public feedback; Review potential HAR amendments to address parcel-level disparities

Title	Summary	Sources	Resources	Possible Operational Requirements
Mandate Routine Map Updates and Model Revisions	Establish in statute that (a) LSB classification maps shall be routinely updated with the most current data, and (b) the LSB model shall be periodically reviewed and revised to incorporate technological advances, shifts in economic conditions, and evolving needs. These statutory requirements will ensure that the LSB classification maps and model remain accurate, relevant, and effective tools for guiding land use decisions.	Polis consensus; Best Practices Review (California); Phase I Soil Systems Research	USDA NRCS partnership; Research partnerships	Adoption of NRCS Annual Soils Refresh of SSURGO and/or similar, regularly updated data sources; Integration of regularly updated data source with existing classification systems; Develop a clear legislative framework to guide the update process
Update Outdated Classifications in Regulations	Replace outdated classification systems, such as LESA and ALISH, with the updated LSB model where relevant in regulations. This transition will strengthen the regulatory framework by providing more accurate and reliable data, thereby improving decision-making processes.	Regulations review	Policy updates	Identify affected regulations; Draft updates; Coordinate with relevant state and county agencies
Clarify Classification References in Regulations	Amend regulations that refer to soil classification but do not specify which soil classification system should be used. This will better define regulatory purpose and ensure consistency in regulatory application.	Regulations review	Policy updates	Identify vague regulations; Draft clarifications with precise use of classification system in regulation; Ensure consistency across policies; Continue engagement with necessary agencies

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XII. APPENDICES

APPENDIX A: COPY OF SIGNED ACT 189

Accessible at https://www.capitol.hawaii.gov/sessions/session2022/bills/GM1290_.PDF

GOV. MSG. NO. 1290

EXECUTIVE CHAMBERS
HONOLULU

DAVID Y. IGE
GOVERNOR

June 27, 2022

The Honorable Ronald D. Kouchi,
President
and Members of the Senate
Thirty-First State Legislature
State Capitol, Room 409
Honolulu, Hawai'i 96813

The Honorable Scott K. Saiki,
Speaker and Members of the
House of Representatives
Thirty-First State Legislature
State Capitol, Room 431
Honolulu, Hawai'i 96813

Dear President Kouchi, Speaker Saiki, and Members of the Legislature:

This is to inform you that on June 27, 2022, the following bill was signed into law:

SB2056 SD1 HD1 CD1 — RELATING TO SOIL CLASSIFICATIONS.
ACT 189

Sincerely,

DAVID Y. IGE
Governor, State of Hawai'i

Approved by the Governor
on JUN 27 2022

ACT 189

THE SENATE
THIRTY-FIRST LEGISLATURE, 2022
STATE OF HAWAII

S.B. NO. 2056 S.D. 1 H.D. 1 C.D. 1

A BILL FOR AN ACT

RELATING TO SOIL CLASSIFICATIONS.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF HAWAII:

SECTION 1. The legislature finds that the State has not completed a comprehensive soil study or completed sufficient agricultural soil mapping in over fifty years. The first and only statewide soil mapping, classification, and characterization study was conducted by the land study bureau of the university of Hawaii from 1965 through 1972. This classification system remains the master reference for the regulation of lands in the state agricultural land use district by the State and counties. The land study bureau classification system reflects the agricultural activities of plantation sugar cane and pineapple production that dominated Hawaii agriculture at the time of the study.

The legislature further finds that the United States Department of Agriculture maintains detailed information on Hawaii soils in its national soil classification system, which is regularly updated by the federal government. The United States Department of Agriculture's soils inventory and classification system is also the reference dataset for many of the United States Department of Agriculture's programs.

To meet the State's food sustainability goals and enhance local agricultural productivity, it is important to utilize effective standards for identifying productive agricultural lands and protect long-term agricultural use under state and county land use regulatory systems. Accurate soil data reflecting soil characteristics, soil properties, and identification of limits, risks, and soil suitability for various uses helps optimize public and private investments in agriculture to meet Hawaii's food and agricultural sustainability goals.

Accordingly, the purpose of this Act is to:

(1) Require the office of planning and sustainable development to conduct a study of the suitability of the land study bureau soil overall (master) productivity rating system and other soil classification systems in the regulation of agricultural lands in the State and make recommendations for the use of soil classification systems for agricultural land use regulation; and

(2) Appropriate funds to conduct the study.

SECTION 2. The office of planning and sustainable development shall conduct a study of the suitability of soil classification systems, including the soil overall (master) productivity rating system and detailed land classification of the land study bureau, for the regulation of agricultural lands by the State and counties.

SECTION 3. In conducting the study required by this Act, the office of planning and sustainable development shall request, as appropriate, the assistance of the department of agriculture, college of tropical agriculture and human resources of the University of Hawaii at Manoa, and the land use commission, which shall cooperate with and provide any necessary resources to the office of planning and sustainable development. The office of planning and sustainable development may further consult with the United States Department of Agriculture, if necessary.

SECTION 4. The office of planning and sustainable development shall submit a report of its findings and recommendations, including any proposed legislation, to the legislature no later than twenty days prior to the convening of the regular session of 2024.

SECTION 5. There is appropriated out of the general revenues of the State of Hawaii the sum of $325,000 or so much thereof as may be necessary for fiscal year 2022-2023 for the office of planning and sustainable development to conduct the study as required by this Act.

The sum appropriated shall be expended by the department of business, economic development, and tourism for the purposes of this Act.

SECTION 6. This Act shall take effect on July 1, 2022.

S.B. NO. 2056
S.D. 1
H.D. 1
C.D. 1

APPROVED this 27th day of June, 2022

GOVERNOR OF THE STATE OF HAWAII

S.B. No. 2056, S.D. 1, H.D. 1, C.D. 1

THE SENATE OF THE STATE OF HAWAIʻI

Date: May 3, 2022
Honolulu, Hawaii 96813

We hereby certify that the foregoing Bill this day passed Final Reading in the Senate of the Thirty-First Legislature of the State of Hawaiʻi, Regular Session of 2022.

President of the Senate

Clerk of the Senate

76-22

SB No. 2056, SD 1, HD 1, CD 1

THE HOUSE OF REPRESENTATIVES OF THE STATE OF HAWAII

Date: May 3, 2022
Honolulu, Hawaii

We hereby certify that the above-referenced Bill on this day passed Final Reading in the House of Representatives of the Thirty-First Legislature of the State of Hawaii, Regular Session of 2022.

Scott K. Saiki
Speaker
House of Representatives

Brian L. Takeshita
Chief Clerk
House of Representatives

APPENDIX B: COMPARISON CRITERIA AND RUBRIC TABLES

COMPARISON CRITERIA TABLE

Criteria	Description	Measurement	Measurement Difficulty	Source
Accuracy in identifying quality agricultural lands	How well the system classifies and delineates the most productive agricultural lands based on soil properties, soil health, topography, climate, etc.	Qualitative (High, Moderate, Low)	Moderate - Requires analysis of system methodology and comparison to actual agricultural productivity	Yamamoto, Chillingworth, RFP/Work Plan
Adaptability to changing conditions and crop production	The ease and feasibility of updating the system to account for new crops, technologies, soil data, etc.	Qualitative (High, Moderate, Low)	Easy - Can assess based on system methodology	Yamamoto, Chillingworth, RFP/Work Plan
Transparency, understandability, and documentation	How clear and accessible the methodology and rationale of the system are.	Qualitative (High, Moderate, Low)	Easy - Assess based on available documentation	Yamamoto, RFP/Work Plan, 10/3 Outreach Comments
Incorporation of non-soil factors	Extent to which non-soil factors (e.g., access to markets, land use plan alignment) are considered	Qualitative (High, Moderate, Low)	Easy - Review methodology for inclusion of non-soil factors	Yamamoto, Chillingworth
Geographic coverage	Completeness of geographic coverage across the State	Qualitative (High, Moderate, Low)	Moderate - Requires GIS analysis to quantify coverage	Yamamoto
Productivity & Agricultural Value	The extent to which the system accounts for the economic value of agricultural lands based on productivity.	Qualitative (High, Moderate, Low)	Moderate - Requires understanding methodology and data sources	10/3 Outreach Comments
Irrigation Infrastructure	The degree to which the system considers the presence, access, and need for irrigation infrastructure and water systems.	Qualitative (High, Moderate, Low)	Easy - Assess based on methodology	10/3 Outreach Comments
Cultural & Indigenous Considerations	The incorporation of Hawaiian indigenous knowledge, land classifications, and cultural factors into the methodology.	Qualitative (High, Moderate, Low)	Easy - Review methodology	10/3 Outreach Comments

Comparison Rubric Table

Criteria	LSB	ALISH	LESA	SSURGO
Accuracy in identifying quality agricultural lands	Moderate. LSB provides useful yield and soil information, but may not be as detailed as soil-specific systems.	High. ALISH provides comprehensive land use data, including soil properties.	High. LESA uses a variety of factors to evaluate agricultural land quality.	High. SSURGO provides detailed soil data, including properties and characteristics, which are crucial for identifying quality agricultural lands.
Adaptability to changing conditions and crop production	High. LSB is adaptable and can be updated with new data relatively easily.	Moderate. ALISH's adaptability may depend on the availability and integration of new data.	High. LESA is designed to be adaptable to changing conditions.	Moderate. While the database is comprehensive, updating it with new data can be a complex process.
Transparency, understandability, and documentation	High. LSB's methodology is clear and well-documented.	High. ALISH's methodology is clear and well-documented.	High. LESA's methodology is clear and well-documented.	High. The methodology and rationale behind SSURGO are well-documented and accessible.
Incorporation of non-soil factors	High. LSB considers a variety of factors beyond soil properties.	High. ALISH considers a variety of factors, including land use and accessibility.	High. LESA considers a variety of factors, including land use, accessibility, and proximity to markets.	Low. SSURGO primarily focuses on soil data.
Geographic coverage	Moderate. LSB excluded urban areas, Niʻihau, and Kahoʻolawe from analysis. Subsequent maps removed areas with urban districts boundaries.	Moderate. ALISH is criteria based and thus has limited geographic coverage.	Moderate. LESA is criteria based and limited by the spatial extents of multiple input layers.	High. SSURGO provides the most detailed level of soil geographic data available in the United States.
Productivity & Agricultural Value	Moderate. LSB used the most robust yield data, but these data are out of date.	Moderate. ALISH’s unique category considers special high yield or value crops.	High. LESA considers the economic value (via LSB and SPI) of agricultural lands.	Moderate. The database contains yield information on a few crops that can be used in agricultural management and land-use planning.

Criteria	LSB	ALISH	LESA	SSURGO
Irrigation Infrastructure	Moderate. LSB considered irrigation access, but this has not been updated since the system was created.	Moderate. ALISH considers soil moisture and irrigation need.	High. LESA considers the presence of irrigation infrastructure.	Low. SSURGO does not specifically consider irrigation infrastructure.
Cultural & Indigenous Considerations	Low. LSB does not specifically incorporate indigenous knowledge or cultural factors.	Moderate. ALISH incorporates some indigenous crops.	Low. LESA does not specifically incorporate indigenous knowledge or cultural factors.	Low. SSURGO does not specifically incorporate indigenous knowledge or cultural factors.

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APPENDIX C: POLIS REPORT

This report has been modified for better visual display.
The interactive report can be viewed online at https://pol.is/report/r4tfrhexm3dhawcfav6dy.

Report **https://pol.is/2xkaetybza**

Overview

Pol.is is a real-time survey system that helps identify the different ways a large group of people think about a divisive or complicated topic. Here's a basic breakdown of some terms you'll need to know in order to understand this report.

Participants: These are the people who participated in the conversation by voting and writing statements. Based on how they voted, each participant is sorted into an opinion group.

Statements: Participants may submit statements for other participants to vote on. Statements are assigned a number in the order they're submitted.

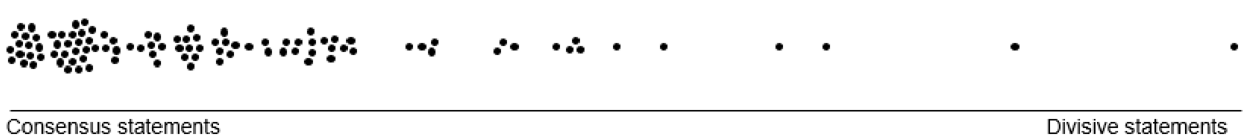
Opinion groups: Groups are made of participants who voted similarly to each other, and differently from the other groups.

This pol.is conversation was run by HH. The topic was 'Evaluating soil classification systems in Hawai'i'.

116	105	6,575	170	56.68	3.03
people voted	people grouped	votes were cast	statements were submitted	votes per voter on average	statements per author on average

How divisive was the conversation?

Statements (here as little circles) to the left were voted on the same way—either everyone agreed or everyone disagreed. Statements to the right were divisive—participants were split between agreement and disagreement.



Majority

Here's what most people agreed with.

60% or more of all participants voted one way or the other, regardless of whether large amounts of certain minority opinion groups voted the other way.

% Agreed | % Disagreed | % Passed | % Didn't vote

	STATEMENT	OVERALL 105	A 35	B 70
11	Protecting prime productive lands should remain a priority in agricultural land regulation..	84% 7% 7% (91)	79% 11% 8% (34)	87% 5% 7% (57)
28	Water infrastructure is needed to ensure IAL and similar lands are able to be utilized	81% 5% 13% (91)	77% 6% 16% (31)	83% 5% 11% (60)
30	Soil systems should be easy to use and understand	80% 5% 14% (91)	72% 12% 15% (33)	84% 1% 13% (58)
41	Protecting prime productive lands should remain a FACTOR in agricultural land regulation..	86% 2% 11% (87)	87% 3% 9% (32)	85% 1% 12% (55)
44	Any system incorporating soils for land use decisions should be updatable, dynamic, and easily incorporated into land use decisions	81% 4% 13% (86)	73% 10% 16% (30)	85% 1% 12% (56)
104	The LSB system is fine because soils don't change over time.	10% 69% 19% (56)	30% 55% 15% (20)	0% 77% 22% (36)

Areas of Uncertainty

Across all 105 participants, there was uncertainty about the following statements. Greater than 30% of participants who saw these statements 'passed'.

Areas of uncertainty can provide avenues to educate and open dialogue with your community.

	STATEMENT	OVERALL 105	A 35	B 70
68	SSURGO is useful for waterflow and erosion analysis for housing developments	29% 5% 64% (68)	36% 0% 64% (25)	25% 9% 65% (43)
46	Only LSB contains crop/animal yield estimates that are useful to farmers	15% 21% 63% (73)	22% 14% 62% (27)	10% 26% 63% (46)
55	SSURGO is useful for identify inputs to see if lands are economically feasible.	31% 10% 58% (70)	36% 4% 60% (25)	28% 13% 57% (45)
97	LSB is the primary system used in solar scoping due to use in land regulation	35% 5% 59% (54)	57% 0% 42% (19)	22% 8% 68% (35)
96	Site specific soil studies determine that the existing classifications are inaccurate	32% 9% 58% (53)	21% 15% 63% (19)	38% 5% 55% (34)

Opinion Groups

Across 105 total participants, opinion groups emerged. There are two factors that define an opinion group. First, each opinion group is made up of a number of participants who tended to vote similarly on multiple statements. Second, each group of participants who voted similarly will have also voted distinctly differently from other groups.

Group A: 35 participants

Statements which make this group unique, by their votes:

	STATEMENT	OVERALL 105	A 35	B 70
4	We should be cautious about major changes to systems that still work reasonably well.	51% 26% 22% (94)	78% 9% 12% (33)	36% 36% 27% (61)
74	Systems need updating, but we need to have a system that isn't constantly being updated too	47% 23% 28% (71)	64% 20% 16% (25)	39% 26% 34% (46)
90	climate change effects on endangered species movement needs to be also addressed	33% 33% 32% (59)	0% 65% 35% (20)	51% 17% 30% (39)
157	Important ag lands need good soil types, relatively flat, have gravity-flow non-potable water.	28% 42% 28% (14)	0% 71% 28% (7)	57% 14% 28% (7)
48	We need to release ag land for energy use.	26% 48% 25% (79)	11% 66% 22% (27)	34% 38% 26% (52)

Group B: 70 participants

Statements which make this group unique, by their votes:

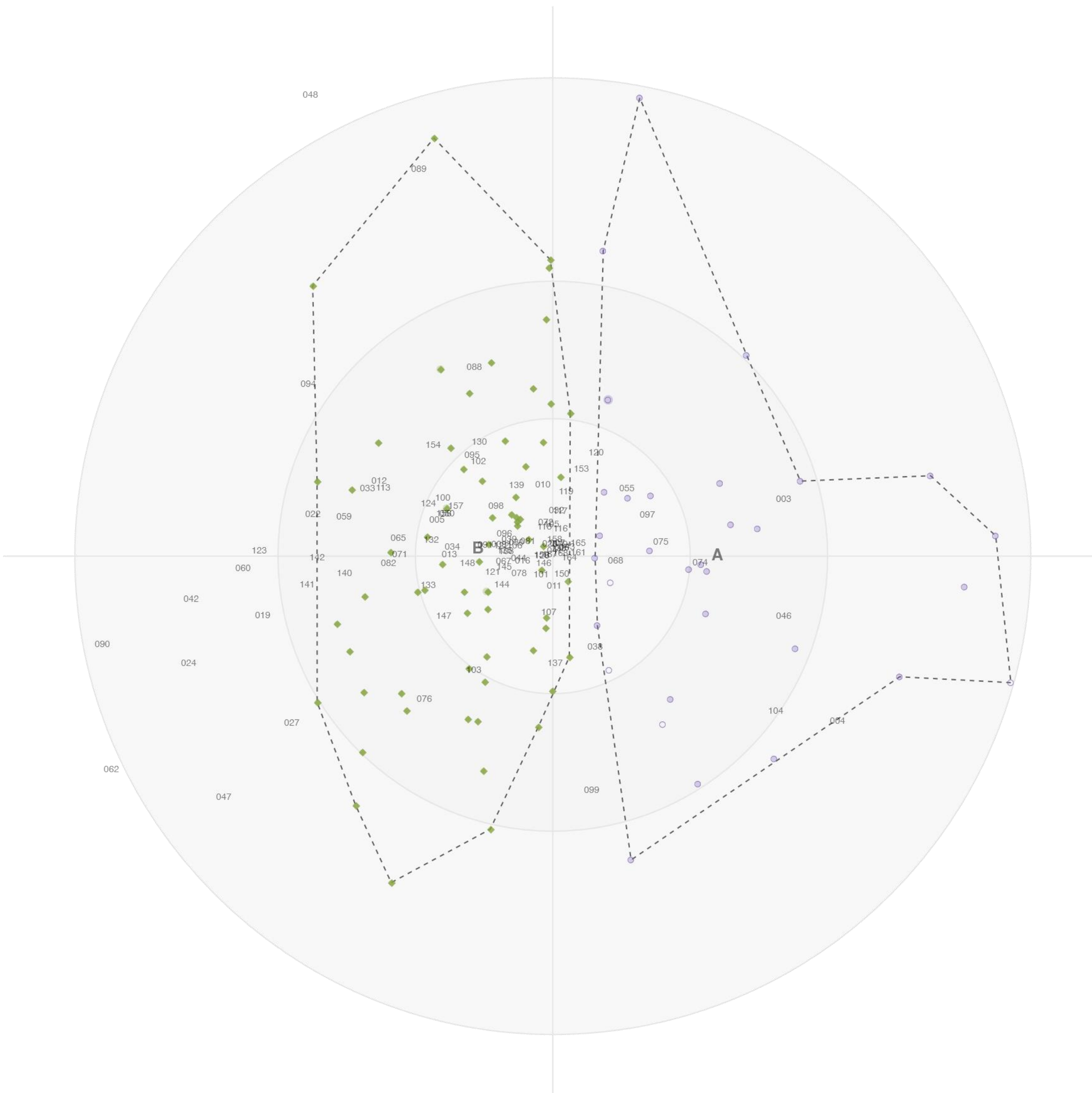
	STATEMENT	OVERALL105	A35	B70
24	Soil classifications should take into account ahupuaa and indigenous perspectives, justice, land access, and water access.	59% 22% 18% (93)	21% 48% 30% (33)	80% 8% 11% (60)
82	A land's potential for soil carbon sequestration should be considered in any new integrated framework	67% 11% 21% (70)	33% 29% 37% (24)	84% 2% 13% (46)
140	Systems should consider land cover change as a result of sea level rise.	63% 21% 14% (41)	25% 50% 25% (16)	88% 4% 8% (25)
65	Dynamic soil properties, like soil health, should be part of a new classification system	63% 8% 28% (73)	30% 23% 46% (26)	80% 0% 19% (47)
34	Data should be updated to reflect how lands are currently being used	78% 10% 11% (88)	56% 25% 18% (32)	91% 1% 7% (56)

Graph

Which statements were voted on similarly? How do participants relate to each other?

In this graph, statements are positioned more closely to statements which were voted on similarly. Participants, in turn, are positioned more closely to statements on which they agreed, and further from statements on which they disagreed. This means participants who voted similarly are closer together.

○ A ◆ B



All statements

Group votes across all statements, excluding those statements which were moderated out.

Sort by: Statement ID

	STATEMENT	OVERALL 105	A 35	B 70
3	We regularly consult LSB ratings when assessing agricultural potential for land. It provides a useful baseline..	41% 15% 43% (90)	53% 9% 37% (32)	34% 18% 46% (58)
4	We should be cautious about major changes to systems that still work reasonably well..	51% 26% 22% (94)	78% 9% 12% (33)	36% 36% 27% (61)
5	A major limitation of current systems is the lack of regular updates to reflect changing conditions..	73% 11% 14% (95)	52% 29% 17% (34)	85% 1% 13% (61)
6	The LSB system undervalues land quality in some regions..	57% 3% 39% (82)	56% 6% 36% (30)	57% 1% 40% (52)
7	Digital soil maps like SSURGO offer more detailed insights, but can be difficult to interpret without adequate training..	67% 3% 29% (85)	70% 3% 26% (30)	65% 3% 30% (55)
9	Periodic re-evaluation and stakeholder input would help keep existing systems relevant..	79% 6% 13% (94)	61% 17% 20% (34)	90% 0% 10% (60)
10	It's challenging to reconcile differences between multiple classification systems on the same land..	68% 11% 20% (88)	64% 16% 19% (31)	70% 8% 21% (57)
11	Protecting prime productive lands should remain a priority in agricultural land regulation..	84% 7% 7% (91)	79% 11% 8% (34)	87% 5% 7% (57)
12	Existing classifications overly focus on productivity, which shouldn't be the only consideration..	57% 18% 23% (92)	48% 33% 18% (33)	62% 10% 27% (59)
13	Existing systems don't account for climate change or traditional Hawaiian land management..	70% 6% 22% (89)	45% 16% 38% (31)	84% 1% 13% (58)
16	Systems were designed to protect sugar and pine do not reflect current use, diversified use, agriculture on marginal lands or taro farming	76% 4% 19% (89)	63% 9% 27% (33)	83% 1% 14% (56)
19	Enclosed agriculture (vertical, shade, green houses etc) needs to be considered in any system update	55% 19% 25% (92)	36% 42% 21% (33)	66% 6% 27% (59)
22	Distance to services and history of use are important considerations	65% 20% 13% (97)	45% 42% 11% (35)	77% 8% 14% (62)
24	Soil classifications should take into account ahupuaa and indigenous perspectives, justice, land access, and water access.	59% 22% 18% (93)	21% 48% 30% (33)	80% 8% 11% (60)
27	Soil types are important to identify traditional/cultural resources and vegetation.	55% 20% 24% (95)	33% 39% 27% (33)	67% 9% 22% (62)
28	Water infrastructure is needed to ensure IAL and similar lands are able to be utilized	81% 5% 13% (91)	77% 6% 16% (31)	83% 5% 11% (60)
30	Soil systems should be easy to use and understand	80% 5% 14% (91)	72% 12% 15% (33)	84% 1% 13% (58)
32	Need for a robust modern system that supports agricultural PRODUCTIVITY	68% 7% 24% (91)	71% 6% 21% (32)	66% 8% 25% (59)
33	The LSB soil classification system feels outdated	57% 9% 32% (92)	41% 29% 29% (31)	65% 0% 34% (61)
34	Data should be updated to reflect how lands are currently being used	78% 10% 11% (88)	56% 25% 18% (32)	91% 1% 7% (56)
38	Vertical farming should not be used as a diversion to authorize development of Agricultural lands.	38% 22% 38% (85)	45% 25% 29% (31)	35% 20% 44% (54)
39	Soil remediation is not considered in the current assessment of soil quality.	46% 7% 45% (81)	43% 6% 50% (30)	49% 7% 43% (51)
41	Protecting prime productive lands should remain a FACTOR in agricultural land regulation..	86% 2% 11% (87)	87% 3% 9% (32)	85% 1% 12% (55)
42	Different classification system each for crops, grazing/livestock, vertical farming, ornamentals, hydroponics.	48% 30% 21% (90)	28% 53% 18% (32)	60% 17% 22% (58)
44	Any system incorporating soils for land use decisions should be updatable, dynamic, and easily incorporated into land use decisions	81% 4% 13% (86)	73% 10% 16% (30)	85% 1% 12% (56)

46	Only LSB contains crop/animal yield estimates that are useful to farmers	15% 21% 63% (73)	22% 14% 62% (27)	10% 26% 63% (46)
47	The State should hold managers and owners accountable for fallow ag lands or crops that have little use in our lives (i.e., pineapple).	37% 32% 30% (81)	13% 48% 37% (29)	50% 23% 26% (52)
48	We need to release ag land for energy use.	26% 48% 25% (79)	11% 66% 22% (27)	34% 38% 26% (52)
50	Systems like SSURGO should release original data to allow users to do their own interpolation	38% 15% 46% (73)	24% 24% 52% (25)	45% 10% 43% (48)
55	SSURGO is useful for identify inputs to see if lands are economically feasible.	31% 10% 58% (70)	36% 4% 60% (25)	28% 13% 57% (45)
59	Classification maps and indexes must be modernized to optimize for those factors of value in Hawaii today, i.e., not just productivity	65% 16% 18% (75)	40% 29% 29% (27)	79% 8% 12% (48)
60	Collective indices of "resilience" should be developed as a system to underlie a new classification system	42% 20% 37% (69)	11% 38% 50% (26)	60% 9% 30% (43)
62	Indigenous values and water rights should be centered in the development of a classification system that may be used for land use regulation	47% 28% 24% (78)	13% 55% 31% (29)	67% 12% 20% (49)
65	Dynamic soil properties, like soil health, should be part of a new classification system	63% 8% 28% (73)	30% 23% 46% (26)	80% 0% 19% (47)
67	SSURGO needs to be updated to include relevant, local data and methodologies for collecting data about Hawaii's soils	50% 2% 46% (69)	42% 3% 53% (26)	55% 2% 41% (43)
68	SSURGO is useful for waterflow and erosion analysis for housing developments	29% 5% 64% (68)	36% 0% 64% (25)	25% 9% 65% (43)
71	Soils could be classified based on potential for improvement in soil quality and health or as a factors in climate mitigation	67% 13% 19% (73)	44% 22% 33% (27)	80% 8% 10% (46)
72	Soil classifications are one tool in the toolbox, but may not be the best way to determine land use priorities	75% 8% 16% (73)	73% 7% 19% (26)	76% 8% 14% (47)
74	Systems need updating, but we need to have a system that isn't constantly being updated too	47% 23% 28% (71)	64% 20% 16% (25)	39% 26% 34% (46)
75	LSB's soil productivity approach should be foundation for any update, additional considerations and uses could be add-ons but not the focus.	44% 19% 36% (72)	59% 18% 22% (27)	35% 20% 44% (45)
76	Pastureland should be separated from agricultural lands. Not less important, just separate, based on the quantity of food produced alone.	33% 37% 28% (69)	25% 55% 18% (27)	38% 26% 35% (42)
78	Any new system should not be so oversimplified that bad actors manipulate/take advantage of it	76% 5% 18% (76)	64% 10% 25% (28)	83% 2% 14% (48)
79	The State should come up with a cohesive classification of what use proper use of prime lands and isn't.	58% 11% 29% (68)	56% 12% 32% (25)	60% 11% 27% (43)
81	LSB classes C and lowers are used to discount land quality and upzone, despite agricultural potential	60% 5% 34% (70)	61% 7% 30% (26)	59% 4% 36% (44)
82	A land's potential for soil carbon sequestration should be considered in any new integrated framework	67% 11% 21% (70)	33% 29% 37% (24)	84% 2% 13% (46)
88	Agrivoltaics can help stimulate agriculture in areas that have not recently been used for agriculture.	46% 15% 38% (65)	31% 22% 45% (22)	53% 11% 34% (43)
89	Class A land should also be allowed for renewable energy use if there is an appropriate and approved agriculture plan for the land.	47% 37% 14% (67)	34% 52% 13% (23)	54% 29% 15% (44)
90	climate change effects on endangered species movement needs to be also addressed	33% 33% 32% (59)	0% 65% 35% (20)	51% 17% 30% (39)
91	identify AG lands that could be rehabilitated and not just classified as A and B classifications	73% 5% 21% (60)	47% 14% 38% (21)	87% 0% 12% (39)

94	LSB soil classifications appear to be arbitrary compared to current use of parcels	29% 26% 44% (61)	19% 47% 33% (21)	35% 15% 50% (40)
95	The classification system needs to recognize that there is a need for both agricultural productivity as well as energy production	65% 19% 14% (61)	59% 27% 13% (22)	69% 15% 15% (39)
96	Site specific soil studies determine that the existing classifications are inaccurate	32% 9% 58% (53)	21% 15% 63% (19)	38% 5% 55% (34)
97	LSB is the primary system used in solar scoping due to use in land regulation	35% 5% 59% (54)	57% 0% 42% (19)	22% 8% 68% (35)
98	Outdated LSB layers don't reflect possible use	58% 12% 28% (56)	42% 21% 36% (19)	67% 8% 24% (37)
99	Food sustainability is more important than energy production.	50% 25% 23% (59)	52% 19% 28% (21)	50% 28% 21% (38)
100	The system should consider a classification for land that can be used for dual purposes like agrivoltaics (plants/crops or animals)	52% 14% 32% (55)	35% 15% 50% (20)	62% 14% 22% (35)
101	The priority of any classification should be identifying the ground truth rather than agreeing with current classifications	70% 3% 25% (54)	57% 5% 36% (19)	77% 2% 20% (35)
102	Energy versus food production is a false dichotomy.	55% 16% 28% (60)	38% 28% 33% (21)	64% 10% 25% (39)
103	Soils that are being used for food security should receive a higher soil classification rating	50% 22% 27% (58)	45% 27% 27% (22)	52% 19% 27% (36)
104	The LSB system is fine because soils don't change over time.	10% 69% 19% (56)	30% 55% 15% (20)	0% 77% 22% (36)
105	The soil classification system needs an appeal process	52% 15% 31% (51)	47% 21% 31% (19)	56% 12% 31% (32)
106	An updated soils survey should be completed since soils have eroded and composition has changed due to topsoil loss	74% 7% 17% (51)	60% 15% 25% (20)	83% 3% 12% (31)
107	The opportunity to analyze soil classification should focus on protecting ag lands and not an opportunity to lose more land to non-ag uses	76% 11% 11% (52)	68% 15% 15% (19)	81% 9% 9% (33)
108	In Hawaii, there is a need for soil monitoring with changes in land management and ongoing erosion	76% 4% 20% (50)	57% 10% 31% (19)	87% 0% 12% (31)
113	Regarding food sustainability and energy production these issues should be approached simultaneously if possible	63% 20% 16% (49)	38% 50% 11% (18)	77% 3% 19% (31)
116	There should be a clear distinction between technical land classification schema and land use policy/designation schema	68% 2% 29% (47)	66% 5% 27% (18)	68% 0% 31% (29)
117	Modern Geotech datasets should be integrated into current soil classifications	55% 2% 42% (49)	57% 0% 42% (19)	53% 3% 43% (30)
118	Input layers should be provided along with any final classifications	55% 6% 38% (47)	50% 11% 38% (18)	58% 3% 37% (29)
119	Complex boundary lines that incorporate multiple layers aren't well tailored for regulatory functions	60% 5% 33% (51)	63% 5% 31% (19)	59% 6% 34% (32)
120	It is challenging to hold landowners accountable for land conditions when market determines use	62% 22% 16% (50)	63% 15% 21% (19)	61% 25% 12% (31)
121	Soil sampling should occur regularly in order to know what the composition is and the determines the success of the crop.	70% 12% 18% (50)	52% 23% 23% (17)	78% 6% 15% (33)
122	Soil classifications should consider highly erodible land during updates	78% 6% 16% (50)	47% 17% 35% (17)	93% 0% 6% (33)
123	Soil class. should consider comprehensive economic considerations. For ex, is it ag vs energy, ag + energy, food vs fiber, or food + fiber?	34% 27% 38% (44)	0% 50% 50% (16)	53% 14% 32% (28)

124	Regulation incorporating soil classifications would happen more quickly at the county level vs the legislature	32% 32% 34% (43)	23% 52% 23% (17)	38% 19% 42% (26)
126	It would be good if conservation plans coming through the soil and water districts included reference to local soil classification systems.	69% 0% 30% (43)	62% 0% 37% (16)	74% 0% 25% (27)
130	Hard to strike the balance between long-term preservation of ag land and updates to that system that reflect changing land use dynamics	47% 23% 28% (42)	31% 31% 37% (16)	57% 19% 23% (26)
132	Agroforestry was a widespread traditional practice and important today. Traditional agroforestry areas are usually classified as marginal	44% 13% 42% (38)	21% 21% 57% (14)	58% 8% 33% (24)
133	the system should consider forestry potential when classifying soil. Sustainable native timber forestry is an emerging industry in Hawaii	67% 16% 16% (37)	42% 35% 21% (14)	82% 4% 13% (23)
135	remote sensing technologies can be used to regularly inform us on soil conditions and changes	61% 5% 33% (39)	35% 14% 50% (14)	76% 0% 24% (25)
137	Options for solar production within urban areas should be exhausted before use of prime agricultural lands for photovoltaics.	68% 24% 7% (41)	71% 21% 7% (14)	66% 25% 7% (27)
138	The State and County should agree on one type of soil classification.	80% 2% 17% (40)	78% 0% 21% (14)	80% 3% 15% (26)
139	It isn't a loss for agriculture to have photovoltaic if it's agrivoltaic. It's been seen to be a benefit in some cases.	54% 16% 29% (37)	50% 21% 28% (14)	56% 13% 30% (23)
140	Systems should consider land cover change as a result of sea level rise.	63% 21% 14% (41)	25% 50% 25% (16)	88% 4% 8% (25)
141	Intensity of water use by the land user should be a factor in a rating.	45% 29% 24% (37)	26% 53% 20% (15)	59% 13% 27% (22)
142	Systems should consider the impact of invasive species (eg weeds, deer), on land degradation and its subsequent suitability for agriculture	61% 25% 12% (39)	31% 56% 12% (16)	82% 4% 13% (23)
143	Minimize administrative costs for managing soil classifications by streamlining processes with digital systems.	64% 2% 32% (37)	71% 0% 28% (14)	60% 4% 34% (23)
144	Pasturelands should be a distinct category within the classification system	44% 24% 31% (29)	46% 30% 23% (13)	43% 18% 37% (16)
145	In order to provide a systematic approach to soils, wetlands/hydric soils should be added to the soil classification systems.	71% 12% 15% (32)	53% 23% 23% (13)	84% 5% 10% (19)
146	Loopholes that allow for Gentlemen Estates must be addressed to ensure proper use of agricultural lands.	82% 7% 10% (28)	76% 15% 7% (13)	86% 0% 13% (15)
147	There should be a mandatory quota for production on agricultrual lands to ensure agricultural lands remain productive.	39% 39% 21% (28)	30% 61% 7% (13)	46% 20% 33% (15)
148	Agricultural activities that benefit the surrounding ecology and improve ecosystem services need to be prioritized and incentivized.	72% 17% 10% (29)	46% 38% 15% (13)	93% 0% 6% (16)
150	This process should focus on soil classification, what is the soil composition, porosity, etc at a specific point of time.	64% 21% 14% (14)	62% 37% 0% (8)	66% 0% 33% (6)
153	The LSB soil classifications should not be used as a system of regulatory land-use zoning.	40% 33% 26% (15)	50% 37% 12% (8)	28% 28% 42% (7)
154	Combining renewable energy with agriculture on Class-A land could make farming and ranching more successful.	33% 40% 26% (15)	22% 66% 11% (9)	50% 0% 50% (6)
156	Land classification should include fuel load growth potential, fire susceptibility of lands and fire management options.	43% 37% 18% (16)	25% 50% 25% (8)	62% 25% 12% (8)
157	Important ag lands need good soil types, relatively flat, have gravity-flow non-potable water.	28% 42% 28% (14)	0% 71% 28% (7)	57% 14% 28% (7)

158	Soil classification should be just one factor in many to determine the best use of land	73% 13% 13% (15)	75% 12% 12% (8)	71% 14% 14% (7)
159	"best use" should not be limited to economics	81% 6% 12% (16)	62% 12% 25% (8)	100% 0% 0% (8)
161	Statements only refer to LSB. The ALISH and LESA systems have qualities that should be included in any agriculture and soil discussion.	25% 25% 50% (4)	50% 0% 50% (2)	0% 50% 50% (2)
164	ALISH and LESA systems should be considered when discussing land use, agriculture and soil qualities.	75% 0% 25% (4)	100% 0% 0% (2)	50% 0% 50% (2)
165	Real-time updated systems are very costly and may not be a reasonable use for policymaking.	40% 20% 40% (5)	33% 0% 66% (3)	50% 50% 0% (2)
167	County of Hawaii has determined Ag Tax exemptions based on soil rating and not on how the land is used. This is a problem for ranchers.	40% 0% 60% (5)	33% 0% 66% (3)	50% 0% 50% (2)
168	Classifications and updates should be based on new scientific learning about soil, not just creating a new numbering system.	100% 0% 0% (6)	100% 0% 0% (4)	100% 0% 0% (2)

APPENDIX D: ALL ACCEPTED POLIS STATEMENTS

Accepted statements are statements that have been moderated into the Polis conversation based on their reflection of original, meaningful, and relevant statements expressing opinions of or thoughts about soil classification systems and their use in land use planning and agricultural land regulation in Hawaiʻi. Statements were moderated into the conversation in real time by a member of the team. Statements with superscript ([1]) reflect seed comments, which were used in the initial focus group meeting to seed thinking and conversation on soil classification systems. Statements with superscript ([2]) reflect statements added after the Focus and County meetings were concluded. Punctuation and spelling reflect user input; the Polis system does not allow for editing of statements on the backend.

Statement No.	Statement	Content	Category
3[1]	We regularly consult LSB ratings when assessing agricultural potential for land. It provides a useful baseline.	LSB	Current use
4[1]	We should be cautious about major changes to systems that still work reasonably well.	Systems	Recommendations for improvement
5[1]	A major limitation of current systems is the lack of regular updates to reflect changing conditions..	Systems	Weakness
6[1]	The LSB system undervalues land quality in some regions.	LSB	Weakness
7[1]	Digital soil maps like SSURGO offer more detailed insights, but can be difficult to interpret without adequate training.	SSURGO	Weakness
9[1]	Periodic re-evaluation and stakeholder input would help keep existing systems relevant.	Systems	Recommendations for improvement
10[1]	It's challenging to reconcile differences between multiple classification systems on the same land.	Systems	Weakness
11[1]	Protecting prime productive lands should remain a priority in agricultural land regulation..	Regulation	21st Century system
12[1]	Existing classifications overly focus on productivity, which shouldn't be the only consideration..	Systems	Weakness
13[1]	Existing systems don't account for climate change or traditional Hawaiian land management..	native Hawaiian perspectives	Weakness
16	Systems were designed to protect sugar and pine do not reflect current use, diversified use, agriculture on marginal lands or taro farming	Systems	Weakness
19	Enclosed agriculture (vertical, shade, green houses etc) needs to be considered in any system update	Other factors	21st Century system
22	Distance to services and history of use are important considerations	Other factors	21st Century system
24	Soil classifications should take into account ahupuaa and indigenous perspectives, justice, land access, and water access.	native Hawaiian perspectives	21st Century system

Statement No.	Statement	Content	Category
27	Soil types are important to identify traditional/cultural resources and vegetation.	native Hawaiian perspectives	Current use
28	Water infrastructure is needed to ensure IAL and similar lands are able to be utilized	Other factors	21st Century system
30	Soil systems should be easy to use and understand	Systems	Recommendations for improvement
32	Need for a robust modern system that supports agricultural PRODUCTIVITY	Systems	21st Century system
33	The LSB soil classification system feels outdated	LSB	Weakness
34	Data should be updated to reflect how lands are currently being used	Data	Recommendations for improvement
38	Vertical farming should not be used as a diversion to authorize development of Agricultural lands.	Regulation	21st Century system
39	Soil remediation is not considered in the current assessment of soil quality.	Other factors	Weakness
41	Protecting prime productive lands should remain a FACTOR in agricultural land regulation.	Regulation	21st Century system
42	Different classification system each for crops, grazing/livestock, vertical farming, ornamentals, hydroponics.	Systems	21st Century system
44	Any system incorporating soils for land use decisions should be updatable, dynamic, and easily incorporated into land use decisions	Systems	Recommendations for improvement
46	Only LSB contains crop/animal yield estimates that are useful to farmers	LSB	Current use
47	The State should hold managers and owners accountable for fallow ag lands or crops that have little use in our lives (i.e., pineapple).	Regulation	Recommendations for improvement
48	We need to release ag land for energy use.	Energy	21st Century system
50	Systems like SSURGO should release original data to allow users to do their own interpolation	SSURGO	Recommendations for improvement
55	SSURGO is useful for identify inputs to see if lands are economically feasible.	SSURGO	Strength
59	Classification maps and indexes must be modernized to optimize for those factors of value in Hawaii today, i.e., not just productivity	Other factors	Recommendations for improvement

Statement No.	Statement	Content	Category
60	Collective indices of "resilience" should be developed as a system to underlie a new classification system	Other factors	21st Century system
62	Indigenous values and water rights should be centered in the development of a classification system that may be used for land use regulation	native Hawaiian perspectives	21st Century system
65	Dynamic soil properties, like soil health, should be part of a new classification system	Other factors	21st Century system
67	SSURGO needs to be updated to include relevant, local data and methodologies for collecting data about Hawaii's soils	SSURGO	Recommendations for improvement
68	SSURGO is useful for waterflow and erosion analysis for housing developments	SSURGO	Current use
71	Soils could be classified based on potential for improvement in soil quality and health or as a factors in climate mitigation	Other factors	Recommendations for improvement
72	Soil classifications are one tool in the toolbox, but may not be the best way to determine land use priorities	Systems	Current use
74	Systems need updating, but we need to have a system that isn’t constantly being updated too	Systems	Recommendations for improvement
75	LSB’s soil productivity approach should be foundation for any update, additional considerations and uses could be add-ons but not the focus.	LSB	Recommendations for improvement
76	Pastureland should be separated from agricultural lands. Not less important, just separate, based on the quantity of food produced alone.	Regulation	21st Century system
78	Any new system should not be so oversimplified that bad actors manipulate/take advantage of it	Systems	21st Century system
79	The State should come up with a cohesive classification of what use proper use of prime lands and isn't.	Regulation	Recommendations for improvement
81	LSB classes C and lowers are used to discount land quality and upzone, despite agricultural potential	LSB	Current use
82	A land's potential for soil carbon sequestration should be considered in any new integrated framework	Other factors	21st Century system
88	Agrivoltaics can help stimulate agriculture in areas that have not recently been used for agriculture.	Energy	21st Century system
89	Class A land should also be allowed for renewable energy use if there is an appropriate and approved agriculture plan for the land.	Energy	Recommendations for improvement
90	climate change effects on endangered species movement needs to be also addressed	Other factors	Recommendations for improvement

Statement No.	Statement	Content	Category
91	identify AG lands that could be rehabilitated and not just classified as A and B classifications	LSB	Recommendations for improvement
94	LSB soil classifications appear to be arbitrary compared to current use of parcels	LSB	Weakness
95	The classification system needs to recognize that there is a need for both agricultural productivity as well as energy production	Systems	Recommendations for improvement
96	Site specific soil studies determine that the existing classifications are inaccurate	Systems	Weakness
97	LSB is the primary system used in solar scoping due to use in land regulation	LSB	Current use
98	Outdated LSB layers don’t reflect possible use	LSB	Weakness
99	Food sustainability is more important than energy production.	Other factors	Current use
100	The system should consider a classification for land that can be used for dual purposes like agrivoltaics (plants/crops or animals)	Energy	21st Century system
101	The priority of any classification should be identifying the ground truth rather than agreeing with current classifications	Systems	Recommendations for improvement
102	Energy versus food production is a false dichotomy.	Energy	Current use
103	Soils that are being used for food security should receive a higher soil classification rating	Systems	Recommendations for improvement
104	The LSB system is fine because soils don't change over time.	LSB	Strength
105	The soil classification system needs an appeal process	Systems	Recommendations for improvement
106	An updated soils survey should be completed since soils have eroded and composition has changed due to topsoil loss	Data	Recommendations for improvement
107	The opportunity to analyze soil classification should focus on protecting ag lands and not an opportunity to lose more land to non-ag uses	Regulation	Recommendations for improvement
108	In Hawaii, there is a need for soil monitoring with changes in land management and ongoing erosion	Data	Recommendations for improvement
113	Regarding food sustainability and energy production these issues should be approached simultaneously if possible	Energy	Recommendations for improvement

Statement No.	Statement	Content	Category
116	There should be a clear distinction between technical land classification schema and land use policy/designation schema	Systems	Recommendations for improvement
117	Modern Geotech datasets should be integrated into current soil classifications	Data	Recommendations for improvement
118	Input layers should be provided along with any final classifications	Data	Recommendations for improvement
119	Complex boundary lines that incorporate multiple layers aren't well tailored for regulatory functions	Regulation	Weakness
120	It is challenging to hold landowners accountable for land conditions when market determines use	Regulation	Weakness
121	Soil sampling should occur regularly in order to know what the composition is and the determines the success of the crop.	Data	Recommendations for improvement
122	Soil classifications should consider highly erodible land during updates	Other factors	Recommendations for improvement
123	Soil class. should consider comprehensive economic considerations. For ex, is it ag vs energy, ag + energy, food vs fiber, or food + fiber?	Other factors	Recommendations for improvement
124	Regulation incorporating soil classifications would happen more quickly at the county level vs the legislature	Regulation	Recommendations for improvement
126	It would be good if conservation plans coming through the soil and water districts included reference to local soil classification systems.	Regulation	Recommendations for improvement
130	Hard to strike the balance between long-term preservation of ag land and updates to that system that reflect changing land use dynamics	Regulation	Current use
132	Agroforestry was a widespread traditional practice and important today. Traditional agroforestry areas are usually classified as marginal	native Hawaiian perspectives	Current use
133	the system should consider forestry potential when classifying soil. Sustainable native timber forestry is an emerging industry in Hawaii	Other factors	Recommendations for improvement
135	remote sensing technologies can be used to regularly inform us on soil conditions and changes	Data	Recommendations for improvement
137	Options for solar production within urban areas should be exhausted before use of prime agricultural lands for photovoltaics.	Energy	Recommendations for improvement
138	The State and County should agree on one type of soil classification.	Regulation	Recommendations for improvement

Statement No.	Statement	Content	Category
139	It isn't a loss for agriculture to have photovoltaic if it's agrivoltaic. It's been seen to be a benefit in some cases.	Energy	Recommendations for improvement
140	Systems should consider land cover change as a result of sea level rise.	Other factors	Recommendations for improvement
141	Intensity of water use by the land user should be a factor in a rating.	Other factors	Recommendations for improvement
142	Systems should consider the impact of invasive species (eg weeds, deer), on land degradation and its subsequent suitability for agriculture	Other factors	Recommendations for improvement
143	Minimize administrative costs for managing soil classifications by streamlining processes with digital systems.	Systems	Recommendations for improvement
144	Pasturelands should be a distinct category within the classification system	Systems	Recommendations for improvement
145	In order to provide a systematic approach to soils, wetlands/hydric soils should be added to the soil classification systems.	Systems	Recommendations for improvement
146	Loopholes that allow for Gentlemen Estates must be addressed to ensure proper use of agricultural lands.	Regulation	Recommendations for improvement
147	There should be a mandatory quota for production on agricultrual lands to ensure agricultural lands remain productive.	Regulation	Recommendations for improvement
148	Agricultural activities that benefit the surrounding ecology and improve ecosystem services need to be prioritized and incentivized.	Other factors	Recommendations for improvement
150[2]	This process should focus on soil classification, what is the soil composition, porosity, etc at a specific point of time.	Systems	Recommendations for improvement
153[2]	The LSB soil classifications should not be used as a system of regulatory land-use zoning.	Regulation	Recommendations for improvement
154[2]	Combining renewable energy with agriculture on Class-A land could make farming and ranching more successful.	Energy	Recommendations for improvement
156[2]	Land classification should include fuel load growth potential, fire susceptibility of lands and fire management options.	Other factors	Recommendations for improvement
157[2]	Important ag lands need good soil types, relatively flat, have gravity-flow non-potable water.	Systems	Recommendations for improvement

Statement No.	Statement	Content	Category
158[2]	Soil classification should be just one factor in many to determine the best use of land	Regulation	Recommendations for improvement
159[2]	"best use" should not be limited to economics	Other factors	Recommendations for improvement
161[2]	Statements only refer to LSB. The ALISH and LESA systems have qualities that should be included in any agriculture and soil discussion.	Systems	Recommendations for improvement
164[2]	ALISH and LESA systems should be considered when discussing land use, agriculture and soil qualities.	Systems	Recommendations for improvement
165[2]	Real-time updated systems are very costly and may not be a reasonable use for policymaking	Data	21st Century system
167[2]	County of Hawaii has determined Ag Tax exemptions based on soil rating and not on how the land is used. This is a problem for ranchers.	Regulation	Current use
168[2]	Classifications and updates should be based on new scientific learning about soil, not just creating a new numbering system.	Systems	Recommendations for improvement

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APPENDIX E: ALL REJECTED POLIS STATEMENTS

As described above, "Rejected" statements are statements that are moderated out of the Polis conversation in order to facilitate the most productive conversation about the topic. Statements that were moderated out included spam or nonsensical comments; non-specific or irrelevant statements; questions; statements that contained more than one idea; and duplicative statements. For examples of each of these, please see Summary of Outreach Activities, which includes a description of the Polis system.

Rejected statements are being included in this report to provide transparency on the comments that were moderated out of the conversation.

Rejected Statements
Thanks for the follow-up survey
I am concerned about how the superficial nature of this input consolidation system will affect the outcome of this important project.
That would depend by on users financial abilities
ALISH and LESA systems should be used when considering land use, agriculture and soil qualities.
Should ALISH and LESA systems be considered in land use, agriculture and soil discussions?
The statements only referred to LSB. Why aren't ALISH and LESA systems being discussed?
Thanks
To protect important ag lands need good soil types, relatively flat, have gravity-flow non-potable water. Stop interbasin transfer of water.
Soil classification should be just one factor in many to determine the best use of land, and "best use" should not be limited to economics
Mahalo
Agree that crop land should be distinct from pasture land but not based, but disagree that food quantity should be a consideration.
what "productive" ag lands means is different to a soil scientist, a farmer, a land owner, an investor...
A project at UH to consider is the Benchmark Soils Project, which proved that ag technologies can be transferred based on Soil Series.
Does crosscutting issues, like agrivoltaics, demonstrate some limitations to thinking behind more static classification systems?
Existing systems don't account for climate change or traditional Hawaiian land management. Separate into two questions.
How might a classification system help incentivize soil remediation and GHG sequestration on working lands?
Consider the old with the new.
There are extensive data sets compiled from modern geotechnical literature that should be used in developing the current study
What capacity are we considering for renewable energy development? Power the specific plot of land for ag prodution?

Rejected Statements
Land , and vegetative condition could be a fact of use for land conversion
“Highest and best” land use is to increase our collective resilience. Soil classification is one factor in determining potential.
Soil type/classification needs to inform the design of individual wastewater systems, especially in proximity to the coast/water.
Regulation based on agricultural land classification system - land for variety of crops/uses, existing specialty crops, and Hawaiian crops.
Some of the comments are more technical than I am familiar with, but I do understand the need for a new large update and consistent updates.
how will the data be updated - per legislative session, etc?
Soils that have undergone or continue to be at high risk of massive erosion.
Soils with high potential for sustained food production with minimal nutrient export (for ecosystem health)
Soils that have high potential for carbon sequestration management
Be clearer about what soil classification is classifying. If it is more than soil quality, be clearer about all factors in the index.
Utilizing hydroponic or aquaponic farming renders preservation of agricultural lands solely based on soil classification obsolete
Important to ID how differences in historical vs. current use will be incorporated (ex. loi ~100 yrs ago, now developed or filled, etc.)
Uncertainty should be explicitly stated and included, even if large
xxx
Underlying geology and land use and land position (mauka/makai) should be considered
Underlying geology and land use and land position (mauka/makai)
OPSD uses OSPD and ALISH when reviewing land use district boundary amendments that go before the LUC
A statewide update to SSURGO would be useful
Resilience should be a factor: water availability, natural and cultural resources, future climate, crop suitability, regenerative capacity.
There are too many systems. They need to be congruent.
Land and soil classifications must base their designations on a systems-based understanding of land use
Soil class systems don't consider the remediation many soils now require before anything can be grown safely (must be bioremediation).
utilizing land for more than one state priority should be considered since some land has multiple potential priorities
Outdated data underlying the SSURGO soil classifications limits usefulness in climate mitigation and adaptation forecasting
This statement is 2 issues. As for climate change there are many adaptable crops.

Rejected Statements
submitting separately
Soil carbon data is highly spatially interpolated and can be unreliable
As technologies develop there may be land available that just needs water once or occasionally. Agua culture! What else is developing??
A modern classification system should prioritize land for local consumption, not pure productivity
Vertical Farming is the future, like EVs. Cannot disregard it.
Permaculture is a popular system in Hawaii County. It does not need flat lands, but it can still be productive.
New criteria should be included in agricultural land regulation
Education about soil classifications is important to inform project design.
The current land classification system is embedded in the racist dispossession of kanaka maoli
Having a soil classification system is helpful for providing a policy framework
Water availability should be considered. Even if there are great soils, if water is not available, extensive ag may not be possible.
Need to look at how soil and labor will shape the future of ag
Rural classification was created to be a buffer between ag and urban use
IAL is based on ag productivity and protecting those lands
Productivity is part of the issue, need to consider previous and potential uses (hydroponics, etc)
SWCD planners need to consider soil qualities (ie erosion) in their conservation planning
Consideration of economic value of agricultural output, beyond just soil quality, could improve classification
Updating soil systems could assist LUC to create new SLUD category to allow for other (non-urban/non-ag) uses
Need for a robust modern system that supports agricultural productivity and regulation (via protection).
Special Use Permit process focuses on LSB, but others are considered as well.
Technology and public input could enable more precise, frequently-updated models..
LSB is out of date because irrigation infrastructure has changed
Soils can be manipulated. Why regulate uses based on soils?
How can the current system be appealed or questioned?

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APPENDIX F: SOIL SYSTEM REFERENCES IN STATE AND COUNTY CODES AND REGULATIONS TABLE

The table below is a significantly truncated version of the full dataset which is available on the project website at https://arcg.is/1T99X0.

The online version includes additional columns with full language of the policy, a link to the reference document, the section placement within reference document structure, and other columns to enable filtering. The entire database is also full text searchable.

The columns in the table below are:

- Rule or Regulation Reference & Name
- Soil Classification System: The system(s) referenced (e.g. LSB, ALISH, etc.) or other note
- Focus: A categorization to aid readability and where possible lump similar types.
- Source: Original reference document
- Notes: Provided for policies that were either a) did not clearly define the system(s) to be used or b) mention general soil type or class along with the soil classifications of interest in this report. Direct quotes from statute or rules in these notes are italicized.

Rows are sorted by State, County, then by regulation number and lastly by rule number.

Rule or Regulation Reference & Name	Soil Classification System	Focus	Source	Notes
Hawaiʻi Revised Statutes § 46-4. County zoning	Soil class/type, Unclear	District/zoning definition	Hawaiʻi Revised Statutes	Does not explicitly list soil classification data to consider but states that "In establishing or regulating the districts, full consideration shall be given to all available data as to soil classification and physical use capabilities of the land to allow and encourage the most beneficial use of the land consonant with good zoning practices."
Hawaiʻi Revised Statutes § 141D-4. Transfer and management of agricultural enterprise lands and agricultural enterprises; agricultural enterprise program	LSB	Land transfer	Hawaiʻi Revised Statutes	
Hawaiʻi Revised Statutes § 166E-3. Transfer and management of non-agricultural park lands and related facilities to the department of agriculture	LSB	Agricultural and Non-agricultural parks	Hawaiʻi Revised Statutes	
Hawaiʻi Revised Statutes § 171-34. Planning; intensive agricultural and pasture uses	LSB	Agricultural planning	Hawaiʻi Revised Statutes	
Land Use Commission § 205-2. Districting and classification of lands	LSB	District/zoning definition	Hawaiʻi Revised Statutes	

Rule or Regulation Reference & Name	Soil Classification System	Focus	Source	Notes
Land Use Commission § 205-4.5. Permissible uses within the agricultural districts	LSB	Land use control	Hawaiʻi Revised Statutes	
Land Use Commission § 205-6. Special permit	LSB, IAL	Land use control	Hawaiʻi Revised Statutes	
Land Use Commission § 205-44. Standards and criteria for the identification of important agricultural lands	ALISH, IAL	Agricultural dedication	Hawaiʻi Revised Statutes	
Hawaiʻi State Planning Act § 226-104. Population growth and land resources priority guidelines	ALISH, IAL	Economic priorities	Hawaiʻi Revised Statutes	Notes agricultural land of importance. doesn't clarify if this is ALISH, IAL, or otherwise.

Rule or Regulation Reference & Name	Soil Classification System	Focus	Source	Notes
HDOA § 4-153-8. Planning.	Unclear	Agricultural and Non-agricultural parks	Hawaii Administrative Rules	Regarding Agricultural Park development, section (b) lists multiple items that could involve use of classification systems: *(1) Site selection analysis, including preliminary site inspection and boundary mapping, sufficient to establish the suitability of the land for its intended uses;* *(3) Agricultural feasibility analysis, including agronomic suitability and production capability of the project area, identification of potential markets, costs and economic returns to farm production at the site, and recommended lot sizes;* *(7) Design of project improvements (such as roads and irrigation facilities), including construction drawings and specifications, cost estimates, soils and drainage reports, quantity takeoffs, approval signatures from permitting agencies, and arrangements for utilities installations; and*
HDOA § 4-158-13. Planning.	Unclear	Agricultural and Non-agricultural parks	Hawaii Administrative Rules	Regarding Non-Agricultural Park Lands, section (b) lists multiple items that could involve use of classification systems: *(1) Site selection analysis, including preliminary site inspection and boundary mapping, sufficient to establish the suitability of the land for its intended uses;* *(3) Agricultural feasibility analysis, including agronomic suitability and production capability of the project area, identification of potential markets, costs and economic returns to farm production at the site, and recommended lot sizes;* *(7) Design of project improvements (such as roads and irrigation facilities), including construction drawings and specifications, cost estimates, soils and drainage reports, quantity takeoffs, approval signatures from permitting agencies, and arrangements for utilities installations; and*

Rule or Regulation Reference & Name	Soil Classification System	Focus	Source	Notes
DLNR § 13-5-16. Designation of subzones.	ALISH, LESA	District/zoning definition	Hawaii Administrative Rules	
DLNR § 13-106-5. Management plan format.	Soil class/type, Unclear	Tree farm planning	Hawaii Administrative Rules	Tree farm management plans should address soil types and classes, however classes are not defined. *(4) General Property Description - Covers the description of the property. The description shall include: Tax Map Key description, acres designated as tree farm property, location to nearest town, general aspect, slope, elevation, annual rainfall, access roads, forest composition, size and crown class, soil classes, threatened and endangered species information and conservation district use classification.* *(8) Soils classification and suitability - Each soil type shall be identified along with the acres involved. Information can be obtained from the United States Department of Agriculture, Soil Conservation Service's Soil Survey handbook.*
DBEDT § 15-15-25. Permissible uses within the "A" agricultural district.	LSB	Land use control	Hawaii Administrative Rules	
DBEDT § 15-15-50. Form and contents of petition.	ALISH, LSB, Unclear	District/zoning definition	Hawaii Administrative Rules	Boundary amendment petitions require the "soil classification" as well as specific classifications: *(10) Description of the subject property and surrounding areas including the use of the property over the past two years, the present use, the soil classification, the agricultural lands of importance to the State of Hawai'i classification (ALISH), the Land Study Bureau productivity rating, the flood and drainage conditions, and the topography of the subject property;*

Rule or Regulation Reference & Name	Soil Classification System	Focus	Source	Notes
DBEDT § 15-15-90. Imposition of conditions; generally.	Unclear	Land use control	Hawaii Administrative Rules	Part (17) references prime agricultural land, but doesn't specify the classification. Presumably USDA NRCS farmland classification, derived from SSURGO data, or ALISH is to be used.
DBEDT § 15-15-120. Criteria and procedure for the identification of important agricultural lands.	ALISH, IAL	Agricultural dedication	Hawaii Administrative Rules	
DBEDT, HHFDC § 15-307-26. Project proposal; minimum requirements.	LESA, Soil class/type, Unclear	House development	Hawaii Administrative Rules	Development of housing projects proposals are to include soil classification and LESA data, however soil classification is not defined: *(8) Description of the land for the proposed project as to present use, soil classification, agricultural importance as determined by the Land Evaluation and Site Assessment Commission, flood, and drainage conditions;*
Kauai County § 8-2.4(q)(20) Uses in districts.	LSB	Land use control	Kauai County Code	
Kauai County Department of Finance § RP-2-6 Findings of fact	Unclear	Agricultural dedication	Kauai County Admin Rules	Notes that the productivity rating should be considered but does not define the rating system to be used. "RP" means the Rules of the Director of Finance Relating to Dedication of Lands to Agricultural Use under Section 5A-9.1 of the Kauai County Code
Kauai County Department of Finance § RP-2-9 Special tax assessment of dedicated lands.	Unclear	Agricultural dedication	Kauai County Admin Rules	Notes that quality of soil should be a consideration in determining land value, but does not specify how it should be determined. "RP" means the Rules of the Director of Finance Relating to Dedication of Lands to Agricultural Use under Section 5A-9.1 of the Kauai County Code

Rule or Regulation Reference & Name	Soil Classification System	Focus	Source	Notes
Honolulu County § 21-3.50 Agricultural districts—Purpose and intent.	ALISH	District/zoning definition	Revised Ordinances of Honolulu	
Honolulu County § 21-3.60 Country district—Purpose and intent.	ALISH	District/zoning definition	Revised Ordinances of Honolulu	
Honolulu County § 24-1.14 Golf course development.	LSB	Land use control	Revised Ordinances of Honolulu	
Honolulu County Department of Budget and Fiscal Services Real Property Assessment Division § 4-11-5 Findings of Fact.	Unclear	Agricultural dedication	Honolulu County Department of Budget and Fiscal Services Real Property Assessment Division Rules	Notes that the productivity rating should be considered but does not define the rating system to be used.
Maui County § 3.48.320 - Land classified as agriculture or commercialized residential and used for agriculture.	Unclear	Agricultural dedication	Maui County Code	Notes that soil quality should be used in determining land use value for agriculture, but does not specify how this should be determined.
Maui County § 3.48.350 - Dedicated lands.	Unclear	Agricultural dedication	Maui County Code	Notes that the productivity rating should be considered but does not define the rating system to be used.
Maui County § 19.04.040 - Definitions.	ALISH	Definitions	Maui County Code	

Rule or Regulation Reference & Name	Soil Classification System	Focus	Source	Notes
Maui County § 19.30A.020 - District criteria.	ALISH	District/zoning definition	Maui County Code	
Maui County § 19.30A.050 - Permitted uses.	LSB	District/zoning definition	Maui County Code	
Maui County § 5. Findings of Fact.	Unclear			Notes that the productivity rating should be considered but does not define the rating system to be used.
Hawaii County § 19-60. Long-term commercial agricultural use dedication	Unclear	Agricultural dedication	Hawaii County Code	References productivity rating but doesn't specify which.
Hawaii County § 19-61. Short-term commercial agricultural use dedication.	Unclear	Agricultural dedication	Hawaii County Code	References productivity rating but doesn't specify which.
Hawaii County § 25-5-60. Purpose and applicability	ALISH, LSB	District/zoning definition	Hawaii County Code	
Hawaii County § 25-5-80. Purpose and applicability.	Unclear	District/zoning definition	Hawaii County Code	References important agricultural lands but does not define them. May be referring to IAL, LESA, or another output.

Rule or Regulation Reference & Name	Soil Classification System	Focus	Source	Notes
Hawaii County § 25-6-44. Application for project district; requirements.	LSB, ALISH, Soil class/type	District/zoning definition	Hawaii County Code	Requires a County Environmental Report based on a form prepared by the Planning Director. A Project District Application was not found online. However the AGRICULTURAL PROJECT DISTRICT APPLICATION, which is also covered by RULE 14. COUNTY ENVIRONMENTAL REPORTS, in the COUNTY OF HAWAI'I PLANNING DEPARTMENT RULES OF PRACTICE AND PROCEDURE, includes a Background and County Environmental Report form. In section C. PHYSICAL CHARACTERISTICS AND ENVIRONMENTAL SETTING OF THE PROPERTY AND SURROUNDING AREA, subsection Physical Characteristics/Environmental Setting lists, among other items, the following classification systems as required information to be included: *12. Agricultural Lands of importance in the State of Hawai'i (ALISH) designation:* *13. U.S.D.A. Natural Resources Conservation Services Soil Service Report soil type :* *14. Land Study Bureau soil rating :"*
Hawaii County § 25-6-50. Purpose and applicability.	Unclear	District/zoning definition	Hawaii County Code	The Agricultural Project District purpose references important agricultural lands but does not define them. May be referring to IAL, LESA, another output, or be a general statement.

Rule or Regulation Reference & Name	Soil Classification System	Focus	Source	Notes
Hawaii County § 25-6-54. Application for agricultural project district; requirements.	LSB, ALISH, Soil class/type	District/zoning definition	Hawaii County Code	Requires a County Environmental Report based on a form prepared by the Planning Director. The AGRICULTURAL PROJECT DISTRICT APPLICATION includes a Background and County Environmental Report form. In section C. PHYSICAL CHARACTERISTICS AND ENVIRONMENTAL SETTING OF THE PROPERTY AND SURROUNDING AREA, subsection Physical Characteristics/Environmental Setting lists, among other items, the following classification systems as required information to be included: *12. Agricultural Lands of importance in the State of Hawaiʻi (ALISH) designation* *13. U.S.D.A. Natural Resources Conservation Services Soil Service Report soil type* *14. Land Study Bureau soil rating*
Hawaii County § 14-5 County Environmental Report - Content and Requirements	LSB, ALISH, Soil class/type	Environmental reporting	County Of Hawaii Planning Department Rules Of Practice And Procedure Hawaii County	Outlines what a County Environmental Report shall contain in form prepared by the Planning Director. The AGRICULTURAL PROJECT DISTRICT APPLICATION includes a Background and County Environmental Report form. In section C. PHYSICAL CHARACTERISTICS AND ENVIRONMENTAL SETTING OF THE PROPERTY AND SURROUNDING AREA, subsection Physical Characteristics/Environmental Setting lists, among other items, the following classification systems as required information to be included: *12. Agricultural Lands of importance in the State of Hawaiʻi (ALISH) designation* *13. U.S.D.A. Natural Resources Conservation Services Soil Service Report soil type* *14. Land Study Bureau soil rating*

Rule or Regulation Reference & Name	Soil Classification System	Focus	Source	Notes
Hawaii County § 25-2-42. Amendments initiated by property owners and other persons.	LSB, ALISH, Soil class/type	Environmental reporting	County Of Hawaii Planning Department Rules Of Practice And Procedure Hawaii County	Requires a County Environmental Report based on a form prepared by the Planning Director. The CHANGE OF ZONE APPLICATION includes a Background and County Environmental Report form. In section C. PHYSICAL CHARACTERISTICS AND ENVIRONMENTAL SETTING OF THE PROPERTY AND SURROUNDING AREA, subsection Physical Characteristics/Environmental Setting lists, among other items, the following classification systems as required information to be included: *12. Agricultural Lands of importance in the State of Hawai'i (ALISH) designation* *13. U.S.D.A. Natural Resources Conservation Services Soil Service Report soil type* *14. Land Study Bureau soil rating*

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APPENDIX G: LIST OF CONSIDERED JURISDICTIONS

Jurisdiction	Reason for Consideration	Short List Rationale	Notes
Alaska	Alaska has unique land use, conservation, forestry, and agriculture practices due to its vast size and diverse ecosystems.		
California	California uses the Land Capability Classification (LCC) system to identify and protect prime agricultural land through the California Land Conservation Act (Williamson Act). They also use the LCC for environmental impact assessments. CA's Sustainable Agricultural Lands Conservation Program (SALC) program takes a multifunctional approach (although more planning than technical criteria focused).	Multiple state programs assess and protect agricultural lands, some update annually.	https://anrcatalog.ucanr.edu/pdf/8335.pdf https://www.conservation.ca.gov/dlrp/fmmp https://www.conservation.ca.gov/dlrp/fmmp/Pages/Important-Farmland-Categories.aspx
Colorado	Colorado uses the Colorado Conservation Easement Tax Credit Program to incentivize landowners to conserve their land by providing them with a state income tax credit.		
Florida	Florida uses the Florida Forever program, one of the largest public land acquisition program of its kind in the United States, to conserve environmentally significant land. The Florida Forever Program Plan is updated annually.		
Illinois	Illinois uses the Farmland Assessment Act to provide property tax relief to landowners who use their land for agricultural purposes.		
Maine	Similar average farm size and count of farms		
Maryland	Maryland uses the LCC to prioritize land for its farmland protection programs through the Maryland Agricultural Land Preservation Foundation (MALPF).	Former plantation landscape with similar farm size and amount.	https://mda.maryland.gov/malpf/pages/default.aspx https://msa.maryland.gov/megafile/msa/speccol/sc5300/sc5339/000113/017000/017643/unrestricted/20131655e.pdf

Jurisdiction	Reason for Consideration	Short List Rationale	Notes
Montana	Montana values agricultural land every two years using the Montana Agricultural Land Classification and Valuation Manual.		
New Jersey	New Jersey uses the Farmland Assessment Act to provide property tax relief to landowners who use their land for agricultural purposes.		
New York	New York has a strong agricultural sector and uses the Agricultural Districts Program to protect and promote the availability of land for farming purposes.	An Agricultural Land Classification System for New York State was developed in 1981 to determine the agricultural value per acre of land for assessment purposes. NY has also been exploring soil health and carbon assessments.	https://agriculture.ny.gov/system/files/documents/2023/01/agriculturallandclassificationsystemfornewyork_0.pdf https://www.newyorksoilhealth.org/resources/soil-health-characterization/ https://cpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/6/7573/files/2018/04/Characterization-of-Soil-Health-in-New-York-State-Technical-Report.pdf
Oregon	Oregon uses the LCC to guide its agricultural land use planning efforts through the Oregon Department of Land Conservation and Development (DLCD).		
Pennsylvania	Pennsylvania has a strong agricultural sector and uses the Pennsylvania Farmland Preservation Program to protect viable agricultural lands by acquiring agricultural conservation easements.		
Puerto Rico	Puerto Rico has unique land use, conservation, forestry, and agriculture practices		
Rhode Island	Rhode Island has the highest farm real estate values per acre of any state in the country and uses a current use assessment categories system established by a Farm, Forest and Open Space Land Value Subcommittee.		

Jurisdiction	Reason for Consideration	Short List Rationale	Notes
Texas	Texas has a large amount of agricultural land and uses the Open-Space Land Act to provide property tax relief to landowners who manage their land in ways that conserve and protect natural resources.		
Washington	Washington has a strong agricultural sector and uses the Washington State Conservation Commission to provide technical and financial assistance to landowners who wish to implement conservation practices on their land.		
Vermont	The national definition of Prime Farmland was modified to include information that applies to soils in Vermont.		
Australia	Queensland, New South Wales, and Tasmania have land and soil capability assessment and evaluation systems		

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APPENDIX H: MODEL PARAMETER SELECTION & COMPARISONS

LAND EVALUATION PARAMETER SOURCES

Parameter	Description	Source
Purpose	Capability systems evaluate land for broad, general uses like agriculture, while suitability systems assess land for specific purposes, like a given crop.	Riveira & Maseda
Land Uses Considered	Whether general agricultural land utilization types such as agriculture or grazing, or specific uses such as crops are being evaluated	Riveira & Maseda
Geographic Coverage	Completeness of geographic coverage across the state	Project Team
Land Evaluation Unit (LEU)	The smallest unit for land suitability decisions, determines the granularity of land evaluation results and can be a grid cell, single map delineation (polygon), or set of delineations with common characteristics like a thematic map legend category, and may range from a field to a landscape unit.	Rossiter; Adapted from axis #8 minimum decision area
Spatial Analysis	Whether the model considers the geographic location and spatial relationships of the land areas being evaluated.	Rossiter
Land Characteristics vs. Qualities	Whether the model uses directly measurable attributes (land characteristics) or complex attributes (land qualities) derived from those characteristics	Rossiter; Adapted from axis #4 Evaluation based on Land Qualities or not
Single- vs. Multi-Area Suitability	Whether the model evaluates each area independently (single-area) or considers multiple areas together with interactions and constraints (multi-area).	Rossiter
Static vs. Dynamic Resource Base	Whether the land characteristics are considered constant over time (static) or changing over time (dynamic).	Rossiter
Static vs. Dynamic Land Suitability	Whether the land suitability is considered constant over time (static) or changing over time (dynamic).	Rossiter
Homogeneous vs. Compound Land Utilization Type	Whether the model considers a single type of land use (homogeneous) or multiple, interacting land uses (compound).	Rossiter
Suitability Measurement	How land suitability is expressed. E.g., whether through physical constraints, crop yields, or economic value	Rossiter axis #5; Riveira & Maseda's "information required"
Results	How the output of the land evaluation model is classified and presented (e.g., discrete classes vs continuous scale).	Riveira & Maseda

LAND EVALUATION PARAMETERS TYPOLOGY

Model Parameters

Parameter	Description	LSB	LCC	ALISH	LESA	LSC Draft
Purpose	Which structured approach is used to evaluate land for various uses, ensuring sustainable and optimal utilization: Capability Systems (i.e., general ag) or Suitability Systems (specific uses)?	Capability	Capability	Capability Prime class somewhat assesses suitability for mechanized intensive production. Unique and Other	Capability	Capability
Land uses considered	Which specific land utilization types (LUTs) are used (ag, forestry, urban development, conservation, and/or recreation)?	General Ag Productivity Ratings for pineapple, sugarcane, vegetables, orchard fruits, forage, grazing, and forestry	General Ag	Productivity Ratings for pineapple, sugarcane, vegetables, orchard fruits, forage, grazing, and forestry	General Ag	General Ag Productivity Ratings for vegetables, orchard fruits, forage, grazing, and forestry

Model Parameters

Parameter	Description	LSB	LCC	ALISH	LESA	LSC Draft
Geographic Coverage	Completeness of geographic coverage across the state?	Partial - excludes Urban areas.	Full - Statewide for the major Hawaiian islands	Partial - Excluded urban areas >10 ac, water bodies >10 ac, public use lands, developed military installations, and lands with slope >35%.	Full - Statewide for the major Hawaiian islands Note: Not all factors had statewide mapping	Full - Statewide for the major Hawaiian islands
Land Evaluation Unit (LEU)	What is the smallest unit used for land suitability decisions?	Soil map unit	Soil map unit	Soil map unit	Soil map unit	Soil map unit
Spatial vs. Non-Spatial Analysis	Are geographic location and spatial relationships of the land areas being evaluated?	Non-spatial	Non-spatial	Spatial	Spatial	Spatial

Model Parameters

Parameter	Description	LSB	LCC	ALISH	LESA	LSC Draft
Evaluation Based on Land Characteristics vs. Land Qualities	Does the model use complex attributes (land qualities) derived from simpler, directly measurable attributes (land characteristics)?	Land Qualities	Land Characteristics	Diagnostic Land Characteristics (particularly soil properties)	Both Diagnostic Land Characteristics and Land Qualities (including socio-economic and policy factors)	Land Qualities
Single-Area vs. Multi-Area Suitability	Does the model evaluate each area independently (single-area) or consider multiple areas with interactions and constraints (multi-area)?	Single	Single	Single	Single	Single

Model Parameters

Parameter	Description	LSB	LCC	ALISH	LESA	LSC Draft
Static vs. Dynamic Resource Base	Are land characteristics considered constant (static) or changing (dynamic) over time?	Static	Static	Static	Static	Dynamic
Static vs. Dynamic Land Suitability	Is land suitability considered constant (static) or changing (dynamic) over time?	Static	Static	Static	Static	Dynamic
Homogeneous vs. Compound Land Utilization Type	Does the model consider a single type of land use (Homogeneous) or multiple, interacting land uses (Compound)?	Compound	Homogeneous	Both, leaning Compound	Compound	Compound

Model Parameters

Parameter	Description	LSB	LCC	ALISH	LESA	LSC Draft
Suitability Measurement	How is land suitability expressed: Physical Constraints, Crop Yields, or Economic Factors?	Physical Constraints (MSRI), Crop Yields	Physical Constraints	Physical Constraints, Crop Yields	Physical Constraints, Economic Factors and Development Pressures	Physical Constraints, Crop Yields, and Economic Factors?
Results	What were the discrete groups of land evaluation model classifications?	5 capability classes: A-E	8 capability classes: Class I-Class VIII	3 capability classes: Prime, Unique, Other, with implicit fourth category of excluded or unclassified lands	Continuous capability classification	5 capability classes: A-E

APPENDIX I: SELECTED INITIAL RECOMMENDATIONS

As mentioned in Section VIII, Development of Initial Recommendations, the consultant team developed approximately forty preliminary recommendations informed by Phase I research findings and feedback gathered through outreach. These recommendations addressed a range of improvements in soil classification, agricultural land management, data and technology integration, policy updates, stakeholder collaboration, and tax structures. Following a review by OPSD and the Steering Committee, the recommendations were refined to focus on a core set of foundational recommendations that aligned closely with the primary objective—enhancing soil classification systems and their application in agricultural land regulation. Topics such as tax policy, climate change, and renewable energy, though recognized as significant, were considered beyond the study's immediate scope.

This appendix contains select preliminary recommendations that OPSD deemed valuable for future considerations even though they extend beyond the core recommendations.

RECOMMENDATIONS FOR FUTURE CONSIDERATION

Category	Title	Summary	Sources	Resources	Possible Operational Requirements
General Framework	Adopt Demand-Driven Land Evaluation	Adopt a demand-driven approach for land evaluations by focusing on the specific needs of stakeholders and decision-makers to guide land use planning. Engage with these decision-makers to understand their requirements and tailor evaluation techniques and outputs, ensuring the provided information is relevant and actionable for more effective land use decisions and regulation.	Project Team	Policy review; Stakeholder workshops	
General Framework	Develop Purpose-Specific Land Classification Systems	Establish land classification systems tailored to discrete stakeholders and regulations. Different classification systems should address specific issues such as farm support, multifunctional land use, and renewable energy. Ensure each system has a well defined decision-making purpose with regulatory integration and explicit assumptions to prevent misuse.	Project Team, Polis consensus	Stakeholder engagement; Web development; Interagency collaboration	Development of tailored classification systems or user interfaces for different stakeholder needs. Potential amendments to enable creation of differentiated systems.

Category	Title	Summary	Sources	Resources	Possible Operational Requirements
Multifunctional Suitability	Integrate Non-Soil Factors in Decision-Making Tools	Develop a suite of tools that complement the baseline Soil Capability system, enhancing land use planning and decision-making. These tools can assess agricultural land suitability for various purposes including renewable energy development, conservation prioritization, agricultural productivity, and climate change adaptation, thus supporting targeted land use strategies.	California best practice, Regulations review, Stakeholder comments, Polis	Interagency collaboration; GIS expertise; Research partnerships	Development of integrated tool suite for targeted land use planning and decision-making. Potential amendments to support the application of land use planning tools for targeted land uses.
Multifunctional Suitability	Consider AFT's PVR index	Consider integrating the American Farmland Trust's Productivity, Versatility, and Resiliency (PVR) index to identify highly productive and resilient agricultural land, supporting effective land use planning and conservation.	Project Team	AFT's PVR index and mapping assistance	Incorporate PVR into planning and zoning.
Multifunctional Suitability	Update Economic, Social, and Policy Factors in LESA System	Re-evaluate and revise the Site Assessment factors in Hawai'i's Land Evaluation and Site Assessment (LESA) system to more accurately reflect current and future economic, social, and policy considerations in agriculture. Involve stakeholders in the revision process to ensure the updated factors are relevant and accurately address projected agricultural needs.	Project Team	Stakeholder engagement; Economic analysis; Interagency collaboration	Revision of LESA Site Assessment factors and scoring.

Category	Title	Summary	Sources	Resources	Possible Operational Requirements
Multifunctional Suitability	Integrate Soil Health Measures into Classification and Regulation Systems	Develop and integrate standardized soil health metrics into soil classification systems to improve land quality evaluations. Link these metrics to requirements in conservation programs and agricultural incentives, mandating soil conservation plans and the adoption of healthy soil practices for lands participating in easement programs or receiving incentives.	Maryland best practice, New York best practice, Project Team, Stakeholder Comments	Interagency collaboration; Technical assistance; Financial incentives; Research partnerships; GIS expertise	Development and integration of soil health and remediation metrics into classification system; Incorporation of conservation plan and healthy soils requirements into easement programs.
Smart Solar	Strategically Plan for Agriculture and Renewable Energy Dual Use	Lead initiatives to strategically site solar farm installations to reduce productive land loss, incentivizing development in preferred locations through updated zoning and land use laws to balance energy production with agricultural preservation.	Polis, AFT Smart Solar Recs	Government funding and participation	Establish regional planning processes. Develop policies and programs to incentivize solar on preferred areas. Update plans, zoning, land use laws. Potential building code updates, permitting changes. Zoning and land use law changes.
Smart Solar	Classify Lands for Renewable Energy Development	Develop a classification system to assess agricultural lands for renewable energy development suitability, using tools like the Cropland Index Model to identify areas requiring mitigation or impact fees, directing funds to conservation efforts.	California best practice, New York best practice	Interagency collaboration; GIS expertise; Stakeholder engagement	Establishment of mitigation requirements or impact fees for renewable energy projects on high-value agricultural lands.

Category	Title	Summary	Sources	Resources	Possible Operational Requirements
Smart Solar	Implement Conversion Caps for Agricultural Land	Implement conversion caps to restrict the amount of agricultural land classes used for development or renewable energy projects. Policies should set a specific cap, define eligible farmland, outline geographic limits, specify whether the conversion is temporary or permanent, and establish conditions for exceptions.	Polis, AFT Smart Solar Recs	Government policy development	Develop conversion cap policies. Likely requires legislative action.
Smart Solar	Set Per-Acre Conversion Fees to Protect Agricultural Land	Impose meaningful per-acre conversion fees for energy development on agricultural land to fund preservation and deter conversion. Set fees according to land quality and apply them to specific types of development and conversions. Adjust fees based on factors like permanence and adoption of agrivoltaics. Reinvest the funds in local farmland protection and farm viability.	New York best practices, AFT Smart Solar Recs	Government policy development	Develop conversion fee policies. May require legislative action.
Smart Solar	Require Best Management Practices for Solar Developments	Mandate best management practices as minimum standards for solar developments on agricultural lands to protect soil and water resources, ensuring sustainable use and maintenance of land productivity throughout project phases.	AFT Smart Solar Recs	Government permitting processes	Update permitting requirements. May require changes to permitting rules.

Category	Title	Summary	Sources	Resources	Possible Operational Requirements
Smart Solar	Collect and Share Soil Data During Solar Project Permitting	Collect and publicly share land classification data during solar project permitting to assess aggregate impact, inform policy making, and ensure transparent and informed decisions regarding land use and agricultural production integration.	AFT Smart Solar Recs	Government data collection	Establish data collection and sharing processes. May require changes to permitting/application rules.
Smart Solar	Define and Incentivize Solar Development on Marginal Lands	Define "marginal farmland" suitable for solar development, considering factors like soil quality and classification, parcel size, agricultural infrastructure, water access, and history of use. Incentivize solar energy development in these areas. Streamline permitting and/or providing financial support for siting in preferred areas.	Policy review, Stakeholder comments, AFT Smart Solar Recs	Stakeholder input, data analysis, GIS analysis, policy development	Develop criteria for marginal lands suitable for solar. Create mapping and analysis tools. Develop policies and programs to incentivize solar on preferred areas. Possible amendments to state district and county zoning codes to define and identify marginal lands.
Smart Solar	Define and Incentivize Agrivoltaics on Agricultural Land	Establish clear guidelines and incentives for agrivoltaics on preferred agricultural lands. Develop incentives such as tax credits and expedited permitting to promote dual-use practices integrating solar energy production with crop cultivation. Complement these incentives with disincentives for installing solar infrastructure on high-quality agricultural land.	Polis, Stakeholder comment, AFT Smart Solar Recs	State agriculture agency expertise	Develop definition and standards for agrivoltaics, and incentive programs with verification. May require legislative action for program authority.

Category	Title	Summary	Sources	Resources	Possible Operational Requirements
Ancillary	Integrate Classification into State Land Protection Programs	Integrate a classification System into the criteria for existing state land protection funding programs like the Legacy Land Conservation Program (LLCP) to provide a standardized, science-based approach for evaluating and prioritizing agricultural lands for conservation.	Maryland best practice, Project Team	Interagency collaboration; Criteria development	Incorporation of soil classification criteria into LLCP selection process. Amendments to HRS on Legacy Lands to include soil classification considerations.
Ancillary	Apply Classifications in Agricultural Land Tax Assessments	Use a classification system to establish differential and property tax assessments for agricultural lands, ensuring these assessments reflect the actual agricultural value and capacity of the land for fair taxation and efficient land use.	New York best practice	Legislative action; Economic analysis; Collaboration with county tax departments	Integration of land classifications into agricultural tax assessment process. Amendments to county codes related to agricultural tax assessments.
Ancillary	Establish a State Agricultural Conservation Easement Program	Create a state program for purchasing agricultural conservation easements, involving local governments and farmers to protect agricultural lands effectively, modeled after established best practices.	Maryland best practice, Project Team	Legislative action; Dedicated funding; Interagency collaboration; Stakeholder engagement	Creation of dedicated agricultural conservation easement program, mechanisms for local government and farmer involvement. New statutory language may be required to establish program and define roles.

Category	Title	Summary	Sources	Resources	Possible Operational Requirements
Ancillary	Implement an Agricultural Transfer Tax for Land Preservation	Establish an agricultural transfer tax when agricultural lands upzoned to fund farmland preservation and deter conversion to non-agricultural uses. Align the tax with county differential assessments and other agricultural preservation programs.	Maryland best practice	Legislative action; Interagency collaboration; Stakeholder engagement	Incorporation of climate change projections and multifunctional land use assessments into classification system. Potential amendments for application of targeted land use planning tools.
Ancillary	Protect Prime and Rehabilitate Underutilized Agricultural Lands	Prioritize the protection of prime agricultural lands in land use planning and decision-making, while also identifying and promoting opportunities for the rehabilitation and productive use of underutilized or misclassified lands. Develop and implement incentive programs that encourage the revitalization of degraded or underutilized agricultural lands. Link incentives to local production renewable energy goals, and ecosystem service outcomes.	Polis consensus, Project Team, Stakeholder comments	Interagency collaboration; GIS expertise; Financial incentives	Update relevant statutes and regulations to prioritize land protection and rehabilitation in land use planning and decision-making. Develop incentive programs that encourage sustainable land management practices and support resilience factors.

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