



Research Notes

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A Visual-Spatial Inventory of Agritourism Assets in Central Puerto Rico to Leverage Sustainable Regional Development after the Hurricane Disaster



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ABSTRACT: Puerto Rico's struggled to respond in the aftermath of Hurricane María in 2017. In particular, the rural municipalities of Puerto Rico were severely impacted due to high levels of vulnerability and government failure to reach remote communities. Due to this struggle, the municipalities of Utuado, Ciales, Florida and Jayuya identified a need for a systems-level approach to develop resilience to future disasters. The development of agritourism is an opportunity to increase social-ecological resilience through income diversification, increased savings, and food security. However, it is first essential to identify the region's capacities, limitations, and opportunities through mapping existing tourism infrastructure. Spatially explicit documentation supports the development of sustainable agritourism through providing access to existing resources, geographically displaying the current state of agritourism and highlighting opportunities for enhancing sustainability and resilience. This paper spatially represents the current state of tourism offerings related to gastronomy, accommodations, farms, and attractions that build the foundation of agritourism in Utuado, Ciales, Florida and Jayuya municipalities in Puerto Rico. Three steps led to the spatial representation: inventorying tourism assets, visualizing these assets through Google Maps, and exploring their contribution to a region-wide, systematic sustainable agritourism development strategy, using the functionalities of ArcGIS Storymap. The inventory, catalogs the number and variety of tourism resources available, the Google Maps visually displays those resources, and the ArcGIS Storymap synthesizes findings to be utilized by stakeholders, leveraging agritourism development to increase social-ecological resilience. This paper outlines the spatial maps of tourism resources and provides tools for decision makers, farmers, and tourists.

KEYWORDS: Puerto Rico; COSSAO; agritourism; sustainability; resilience; disaster; spatial

Introduction

As climate change increases the frequency and severity of natural hazards, Puerto Rico has experienced an increased need for socio-ecological resilience (Zimmerman, Willis &

Hernandez-Delgado, 2020). In the context of this project, resilience is the ability of a system to absorb disturbance and still retain its basic function, structure and feedbacks (Walker & Salt, 2012), albeit with adjustments that reflect the learnings from the shock (Cutter, 2015). Islands states and territories in the Caribbean are susceptible to a range of environmental hazards, such as hurricanes, landslides, and earthquakes (Julien, 2018). Furthermore, residents of the Caribbean are experiencing significant climate impacts through the increased frequency and severity of hurricanes in the region (Méndez-Lázaro Bernhardt, Calo, Pacheco Díaz, García-Camacho, Rivera-Lugo, Acosta-Pérez, Pérez., & Ortiz-Martínez, 2021). These hazards translate into cascading disasters as they intersect with socio-ecological and technological systems; social determinants and conditions that exacerbate island's vulnerabilities: unprotected buildings and infrastructure, limited access to disaster preparation resources, at-risk livelihoods, and a reliance on imported food (Rudner, 2019).

Hurricane Maria struck Puerto Rico on the 20th of September, 2017, leaving a wake of destruction and catastrophic loss of life and livelihoods (Garcia-Lopez, 2018). Importing the majority of goods from the mainland USA, including 85% of its food, Puerto Rico was experiencing a technological lag, a financial crisis, an exodus of intellectual and financial resources, and a state of bankruptcy filed to receive federal protection (Straub, 2020). This state of financial and social distress left Puerto Rico especially vulnerable to disaster. As the strongest hurricane to hit the country in 80 years, Hurricane Maria caused Puerto Rico to suffer immense economic losses, increased poverty rates, mass migration from the island, and loss of life (Garcia-Lopez, 2018). Months after the hurricane struck, a significant percentage of the population was still lacking access to electricity, water, and food (Garcia-Lopez, 2018). Puerto Rico was especially vulnerable to disaster in part because many national policies focused on short-term economic gains and not long-term resilience (Randhir, 2016).

In particular, federal and local aid struggled to reach rural areas of Puerto Rico. The rural mountainous region of Utuado, Puerto Rico suffered hurricane impacts, such as landslides, power outages and water shortages, as well as destruction of farms, homes, and roads (Schmidt & Hernandez, 2017). Puerto Rico suffered the longest energy blackout registered in the United States in recent history (Román, Stokes, Shrestha, Wang, Schultz, Carlo, Sun, Bell, Molthan, & Kalb, 2019). In rural areas of Puerto Rico, power outages lasted for almost eight months (Straub, 2020).

Federal agency assistance took more than 42 days and the local government took more than 10 days to respond (Holladay, Mendez-Lazaro, & Brundiars, 2020). Fundamentally, Utuado and the surrounding rural regions did not have the social and economic characteristics to cope with, resist, and recover from Hurricane Maria, leaving them vulnerable to traumatic losses and slow recovery. This lack of support from the government agencies caused a fundamental shift in the way that the region now approaches disaster risk mitigation (Holladay et al., 2021).

Without government aid, Utuado and surrounding communities self-organized and launched recovery efforts (Holladay et al., 2021). First among these organizations was the Corporation of Primary Health Services and Socioeconomic Development of Utuado (COSSAO), which had been working since 2013 on sustainable development in the region. COSSAO's fundamental goal became to transform Utuado into a self-reliant community (Holladay Mendez-Lazaro, & Brundiars, 2021).

COSSAO was quick in building alliances with other local organizations, universities, and private companies and in engaging the community. Through strategic planning and unified efforts, the community utilized their own financial and human capital to respond to the impacts of Hurricane Maria. In just four months, they cleared debris, constructed a community primary health center, and stabilized infrastructure; followed by forging plans to pursue socio-economic development and future planning opportunities (Board, 2018; Holladay, Mendez-Lazaro, Centeno, Rivera-Gutierrez, Adams, & Brundiars, 2019). This ability to respond to and recover from Hurricane Maria was possible because of important developments that were launched since 2013 and thus could be quickly activated and expanded in the aftermath of the hurricane (Brundiars & Eakin, 2018; Brundiars 2020).

Founded four years before Hurricane Maria, COSSAO had identified the need for resilience. In partnership with the Graduate School of Public Health, University of Puerto Rico Medical Sciences Campus, they developed health programs and acquired several properties to provide community health resources. These properties were converted into a solar-powered clinic and outdoor exercise space to serve the community of 7,000 residents in and around one of its barrios (neighborhoods within a municipality), the barrio of Tetuán. Only one year before the hurricane struck, COSSAO purchased an abandoned coffee hacienda in the barrio of Tetuán, now known as Hacienda Rullan, which aims to produce and sell coffee, host tourist activities, a heritage museum, a café, and agrotherapy programs. In addition to their focus on building resilience of people and ecosystems, COSSAO also embraced a sustainable development agenda, particularly focusing on four of the Sustainable Development Goals (SDG): SDG #3 (Ensure healthy lives and promote well-being for all and at all ages); SDG #8 (Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all), SDG #12 (Ensure sustainable consumption and production patterns) and SDG #15 (Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss).

Post-hurricane Maria, COSSAO honed in its resilience efforts to focus on the development of agritourism as a source for socio-economic development through economic diversification in Utuado and the surrounding municipalities of Ciales, Florida, and Jayuya. Agritourism in the region aspires to be sustainable and to improve the resiliency of farming to extreme weather events by providing a higher quality of life and agricultural sustainability. In this context, sustainable agritourism is defined by the Puerto Rico Tourism Company as agricultural initiatives that include the integration of the local community, education, the conservation of natural resources, and the development of the local economy. To support sustainable agritourism, COSSAO, state partners (Puerto Rico Tourism Company), pioneering agritourism farmers, and the local community partnered with a group of universities (University of Puerto Rico, Troy University, and Arizona State University) to secure a grant through the U.S. Department of Agriculture's Southern Sustainable Agriculture Research Education (SSARE) program to achieve an increased level of resilience through agritourism development. This three-year grant (2020-2023) aims to study the potential of developing agricultural tourism in Utuado and surrounding rural municipalities. In order to do so effectively, there needs to be a holistic understanding of the current tourism infrastructure, an analysis of what areas need to be developed, and a high-level of community involvement and participation in order to successfully leverage agritourism as a strategy for economic diversification and increased disaster resilience (Randhir, 2016). The results of this research

will inform the development of the Agritourism Initiative, which was launched at the beginning of the grant period.

In order to address the remaining gaps, this paper outlines the steps taken to create an inventory of existing agritourism assets, create a spatial visualization and synthesis of existing resources in the rural communities of Utuado, Jayuya, Ciales, and Florida and link these to considerations for social-ecological resilience. These informational resources serve as a foundation for a systems-level understanding of what assets exist in the region to enable project partners (including farmers, COSSAO, and the Puerto Rico Tourism Company) to leverage opportunities for future sustainable agritourism development. An accessible inventory and visualization of resources provides knowledge and maps the current agritourism system in a way that lays the foundation for further sustainable development in the region.

Literature Review

Agritourism, sustainability and resilience

Agritourism serves as a means to enhance farmers' quality of life and increase public education efforts around agriculture, improving overall economic and social benefits (Ammirato, Felicetti, Raso, Pansera, & Violi, 2020). Thus, agritourism is more than an economic diversification strategy as it allows farmers to pursue a complex set of entrepreneurial economic and non-economic goals (Barbieri, Sotomayor & Aguilar, 2019). These goals often consist of diversifying farmer income, encouraging local food production, and minimizing harmful environmental impacts of both agriculture and tourism (Valdivia & Barbieri, 2014). To reach such goals, agritourism engages in actions like direct-to-consumer sales, outdoor recreation, education, entertainment, and events. Depending on the level of development of a particular farm, agritourism can incorporate aspects such as farm stays, self-guided walks, harvest events, classes, workshops, production tours, or engagement with farm animals (Baipai, Chikuta, Gandiwa, & Mutanga, 2021). These activities allow farmers to diversify their income without increasing their acres under production, to develop a network with other actors interested in promoting the agritourism sector, and to engage visitors in meaningful discussion around agriculture and its contributions to the environment as well as the local culture and history.

Sustainability, within a tourism context, is the intersection of social, economic, ecological, and institutional variables and goals, wherein it is then broadly defined as the capacity of a community to create systems designed around intra and intergenerational justice, socio-ecological integrity and natural resource maintenance, as well as satisfying livelihoods and viable economies (Gibson, 2006). Sustainability, therefore, is a set of normative goals that stretches into infinity. Importantly, sustainability and resilience should not be conflated. Resilience is a component of sustainability. Resilience—as examined within tourism systems—is the system capacities for absorbing, learning and adapting to internal stressors and external pressures to grow and become more dynamic, within the social, economic, institutional, and ecological domains and goals of system sustainability (Weis, Chambers, & Holladay, 2021). In alignment with sustainability and resilience, responsible tourism is defined as the actions taken to achieve sustainability within a tourism setting (Goodwin, 2022).

Agritourism strategies, when responsibly oriented towards sustainability and resilience, foster the stewardship of the environment as well as the local cultural and economic context while also increasing the resilience of the farmers and their land (Holladay, et al., 2019, Goodwin, 2022). Agritourism contributes to environmental sustainability by producing and selling food locally, reducing the shipping of produce to destinations and therefore minimizing the carbon footprint, and by focusing tourism on environmentally-based touristic activities (Pillay & Rogerson, 2013). Agritourism contributes to social sustainability and resilience by fostering relationships among agritourism providers (Holladay, et al., 2021), as well as by reinvigorating traditional foods, heritage farming and cultural preservation while opening new opportunities for learning from one another, sharing knowledge, and developing social networks (Holladay & Powell, 2016).

Agritourism contributes to economic sustainability by providing a higher level of food security and generally supporting consumption of agricultural products. Additionally, agritourism diversifies local production and multi-sourcing of income for farmers, in particular through value-added products and services (Van Sandt, Low, Jablonski, & Weiler, 2021). Additionally, regionally-oriented agritourism aims to foster the creation of connections among agritourism offerings (e.g., through packages and tours), which fosters relationships among providers and thus further helps to keep profits within the local economy, strengthening resilience (Lamie, Chase, Chiodo, Dickes, Flanigan, Schmidt, & Streifeneder, 2021).

Lastly, agritourism can also support risk reduction and build social-ecological resilience through economic diversification as well as through sustainable agriculture practices such as water harvesting, building healthy soils, creating greater ability to capture and store moisture, regulating water flows, and reducing erosion by sloping the land while planting permanent and diverse land-cover (Altieri & Nicholls, 2017). Combined with disaster management for farms and businesses, these nature-based disaster risk reduction strategies promote resilience to natural hazards prevalent in the region (e.g., hurricanes, landslides) and speed up enterprises' "up-time" after disturbance (Toader & Mocuta, 2020).

Developing agritourism initiatives

To develop a regional agritourism initiative and ensure the long-term success of a sustainable and resilient agritourism system, literature presents a conceptual framework of a five steps process (Wiek, 2015). We adapted this conceptual framework to guide our overall research to allow us to examine the resilience and sustainability of agritourism for our study (fig.1). Step 1 includes creating a systems-based understanding of the current state of agritourism in Utuado. Step 2 draws on these insights and the sustainability goals, which COSSAO proposed for regional development and focuses on crafting a vision of sustainable and resilient agritourism. In step 3, a strategy to work towards the vision will be developed and implemented (step 4). Evaluation and making adjustments, while visualized as the 5th step in figure 1 below, is part of the preceding steps, as this process collaborates with community partners to incorporate their perspectives and expertise along the whole process (Schmidta, Chase, Barbieri, Rilla, Knights, Thilmany, Thomas, Dickes, Cornlisse, Lamie, Callahan, George, & Leff, 2022) and to specify sustainability and resilience goals within the local context (Randhir, 2016).

development of activities and facilities, accommodations, and natural resource management (Faridah & Pramukanto, 2020).

Additionally, a visual spatial inventory assists with the development of agritourism by informing stakeholders of existing tourism assets and providing the necessary information for future community-based regional planning. This gains in importance, as it is becoming increasingly common for tourists to self-direct their travel through independent research. However, when travel information is scattered or unconfirmed, tourists are less likely to engage with a destination (Wu et al., 2013). Google Maps and other self-navigable tourism asset inventories allow for tourism information to be presented in an accurate and accessible manner for tourists (Wu, Liang, & Liu, 2013). Furthermore, tourists are more likely to travel to a destination if there are several agritourism stops to visit (Shah, Gibson, Shah, & Pratt, 2020). Similarly, such a systems view allows local agritourism entrepreneurs to carve out their niche while adding to the overall offerings. Thus, regional planning promotes a greater diversity of attractions to visitors.

Lastly, in the case of Utuado, a spatially explicit inventory and map would allow promoters of regional agritourism, such as COSSAO and Puerto Rico Tourism Company, to identify recreational opportunities and capitalize on them through various strategies. Building strategies represent the next step of sustainable regional agritourism development (Kuehn et al., 1998), involving designing packages for visitors, farm festivals, farm markets, or the creation of promotional, marketing, and evaluation strategies for agritourism programs (Khanal, Honey, Omobitan, 2020). These strategies help identify and combine financial resources and other assets while avoiding duplication of efforts in the region. Overall, in order to enhance sustainability and resilience in Utuado and the surrounding municipalities through the development of agritourism, there needs to be a foundational understanding of existing tourism assets to inform development.

To operationalize and apply the good practices described in the literature to our research project, this project asked:

What are the spatial networks of gastronomy, accommodations, farms, and attractions that support the development of sustainable agritourism in Utuado, Jayuya, Ciales and Florida municipalities in Puerto Rico?

Methods

To answer the research question, this research project adopts a participatory research approach (Randhir, 2016; Tuzon, Hilao, Marana, Villalobos, Garcia, & Medallon, 2014). The researchers (and authors of this paper) collaborated with their project partners, in particular with COSSAO, the Puerto Rico Tourism Company, and participating farmers. Six farmers participated in this study; they joined as they are either in the process of kick-starting or fostering initial agritourism activities on their farm. Their farms and agritourism offerings are complementary and thus could offer a starting point for building a destination. Puerto Rico Tourism Company is the state agency in charge of fostering sustainable tourism on the Island and aims to connect local efforts to state resources; two leading agency representatives collaborated in the project. COSSAO is the trusted community organization and visionary leader in the region and networked these partners and the universities into this project.

COSSAO's president and the community coordinator participated in the project. The collaborative research process extended over one year and entailed three 'all-hands-meetings' involving all project partners to ensure critical decisions are taken through a deliberative approach.

The first meeting was conducted at the beginning of this project to ensure the information gathered for the inventory would entail the relevant and salient information. All participating project partners (fellow University representatives, COSSAO, members of the Puerto Rico Tourism Company, and local farmers) participated in a collaborative discussion surrounding the inventory structure and essential data to be included. Following this discussion, and through reference to foundational literature on agritourism development, data collection for the inventory began. The inventory focused on spatial information for gastronomy (restaurants), natural attractions, accommodations (lodgings, hotels, rentals by owners), historical sites, and excursion enterprises. Then, during the first meeting our team, including researchers and project partners, selected a customized Google Map as the platform to display the inventory. Three reasons informed this choice: 1) everyone who has the link can access it worldwide via the internet; 2) no add-on tools or software are needed in order to install the platform; and 3) Google Maps provides basemap information to better understand the surrounding environment and inventory information. Google Maps has the capacity to incorporate georeferenced thematic layers and overlay graphics, data, descriptions, and images in real time via the web and through mobile devices (Martínez-Graña, Goy & Cimarra, 2013).

Following the meeting, data points were searched and geo-coded by location, through Google Maps using approximate coordinates. Key words such as 'restaurants,' 'food,' 'hotels,' 'accommodations,' and 'tours' were input into Google, Trip Advisor, AirBnB, VRBO, and Expedia. Then, in order to create the inventory, relevant data (including names, addresses, contact information, and descriptions) was gathered, organized, and formatted via Microsoft Excel into five separate datasheets: 1. Gastronomy/Restaurants, 2. Lodgings and Rooms, 3. Excursion Enterprises, 4. Cultural, Historic, Natural and Archeological Sites, and 5. Farms. Each datasheet included coordinates, street addresses (where applicable), names, and descriptions. The inventory was then translated onto the customized Google Map using coordinates, images, and descriptions gathered during the inventory research process.

The second meeting was conducted midway through the project. This virtual meeting discussed the final stages of the inventory and presented the first draft of the spatial visualization of the inventory through Google Maps. The visualized inventory was presented to participating project partners and all project partners were asked to share their feedback in a collaborative discussion. Following the meeting, information was supplemented with descriptions sourced from farm and business websites of the locations of the farms and agritourism activities, detailing current agricultural tourism offerings and services, and providing associated contact information where possible. Additional information was collected through phone interviews with municipal and private sector representatives working on agritourism projects to clarify questions and add missing information. After this point, the researchers began to construct the ArcGIS Storymap to synthesize the core information collected and present the final resources (the Google Maps, larger SSARE grant information, and local partner information) in a singular location. The ArcGIS Storymap platform was selected due to its capacity to integrate digital information into an accessible format for interactive public use and engagement (Howland et al., 2020). Additionally, local partners

had already utilized the platform with great success and the platform has an easy-to-use builder to weave content together (videos, photos, and more) into a compelling and interactive narrative that is easy to publish and share. Furthermore, the technical benefits include public availability and worldwide access as well as better cross-platform capability (e.g., Microsoft Windows, Linux, and Apple Mac OS).

The third and final meeting was conducted nearly 11 months after the project's inception. Collaboration was maintained through email conversations and exchanges. Two weeks before the meeting was scheduled, a Google Form survey was sent to representatives of COSSAO, the Puerto Rico Tourism Company, and collaborating farmers asking for feedback on the Google Maps and ArcGIS Storymap. During the meeting, the feedback was discussed. After the meeting, final changes were made based on feedback to finalize the Google Map and Storymap.

Results

The results comprise a total of 151 agritourism-relevant assets spread across five categories. The results are detailed in Table 1, below

Table 1: Data Points Sorted by Categories

Category	Number of Data Points
Cultural, Historic, Natural and Archeological Sites	37
Gastronomy/Restaurants	53
Farms	13
Lodgings and Rooms	32
Excursion Enterprises*	15
Community Based Tourism Enterprise	1
Total Agritourism Relevant Assets	151

The results were visualized in two forms. First, a geospatial and interactive Google Map visually displayed the inventory information (*excluding Excursion Enterprises, which was not spatially explicit). Second, a GIS Storymap was created to convey the agritourism assets through telling stories of project partners in more detail. The interactive Google Map visualization is directed to tourists as the primary audience. The GIS Storymap envisions the target audience as both tourists and project partners; namely COSSAO, the local leader of the agritourism initiative, and Puerto Rico Tourism Company, a country-wide amplifier, representing various stakeholder groups of the local, regional and wider community.

To display data points from the interactive Google Map to the static map presented in this paper, the customized Google Maps was exported to the KML format file. This KML file was imported into ESRI ArcGIS Pro (2.9.3 version) via its built-in conversion tool. After that, the static map (see Figure 2) was designed and generated using the World Navigation Map as the basemap in ESRI ArcGIS Pro.

Google Maps

To create the interactive Google Map (Figure 2), the inventory information on current agricultural tourism offerings on Gastronomy, Lodgings and Rooms, Excursion Enterprises, and Cultural, Historic, Natural, and Archaeological Sites and associated contact information, was represented geospatially. Data points and their descriptions were offered in English and Spanish versions.

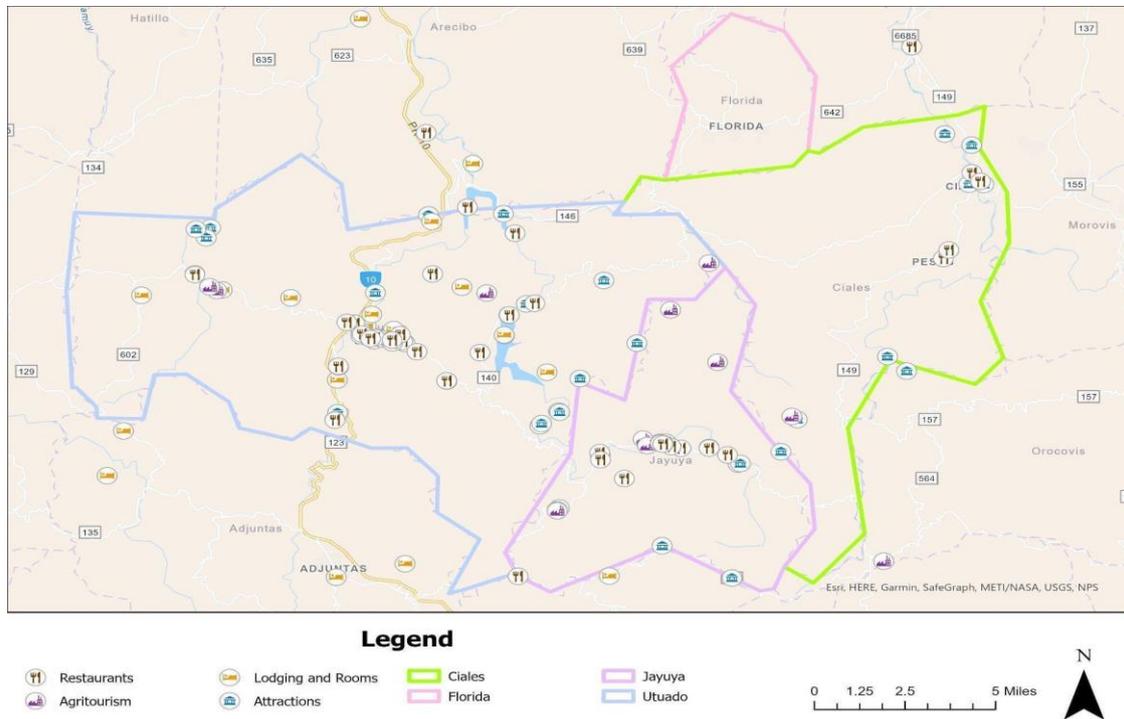


Figure 2. Google Maps Overview: Agritourism Offerings in the municipalities of Utuado (west), Florida (north), Jayuya (south) and Ciales (east)

Figure 3, below, shows the community-based tourism location, as part of the map. This community-based tourism offering was uniquely created for the region of Utuado and surrounding municipalities.

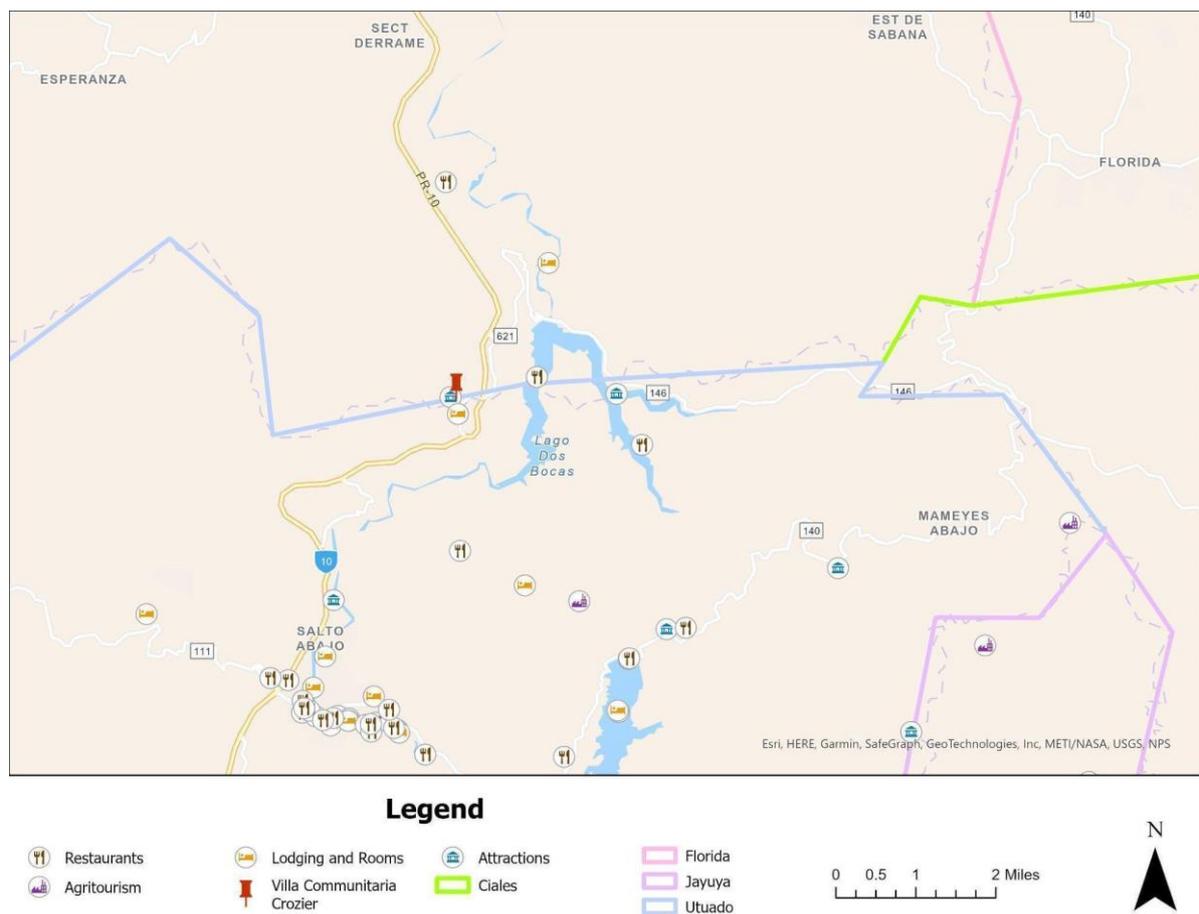


Figure 3. Example of a Community-Based Tourism location (Villa Comunitaria Crozier) on the Google Map

ArcGIS Story Maps

The visualization through an ArcGIS Storymap builds the foundation to involve project partners to tell the evolving story of this collaborative agritourism initiative project called Agroturismo de la Montaña as well as the stories of other participating project partners in detail and over time. The ArcGIS Storymap combines spatially explicit representation to localize the information in geo-coded ways and the participatory approach allows for collaborative and culturally-sensitive storytelling where users can create their own path through the data and generate their own interpretations (Howland et al., 2020). Building the foundation for this vision, this project created the initial structure of the ArcGIS Storymap made up of 3 sections.

Section 1 serves as the introduction to the ArcGIS Storymap, introducing the concept of agritourism, establishing a set definition and parameters for the project context and detailing the background of the agritourism initiative project “Agroturismo en la Montaña.” Section 1, thus, offers the framework for future additions to the site from project team members with the intention that all findings and resources emerging from this initiative can be gathered by project team members and displayed in a centralized and useful way. This helps to ensure that future sections and additions are built out in a logical and cohesive flow.

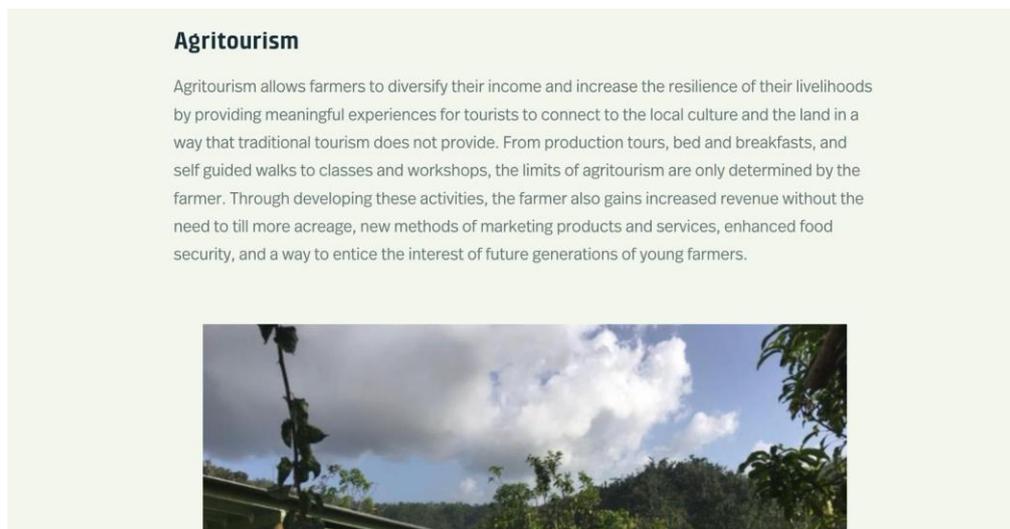


Figure 4. Introduction of the ArcGIS Storymap introducing the concept of agritourism.

Section 2 displays the interactive Google Map created for the region of Utuado and its neighboring municipalities and connects the viewer through a button to navigate to the Google Map website. The goal of this was to gather all project resources centrally in one place, taking advantage of the functionalities provided by the ArcGIS Storymap. The Google Map is intended to serve as a resource for project partners including Puerto Rico Tourism Company, COSSAO, participating farmers as well as other local farmers, and tourists. By connecting the Google Map to the ArcGIS Storymap, the Google Map is more accessible and framed in the context of the project rather than as a separate tool. By displaying all project resources in one place, tourists, local farmers, and project partners have easier access to the Google Map (and other resources), rather than only being shared individually.

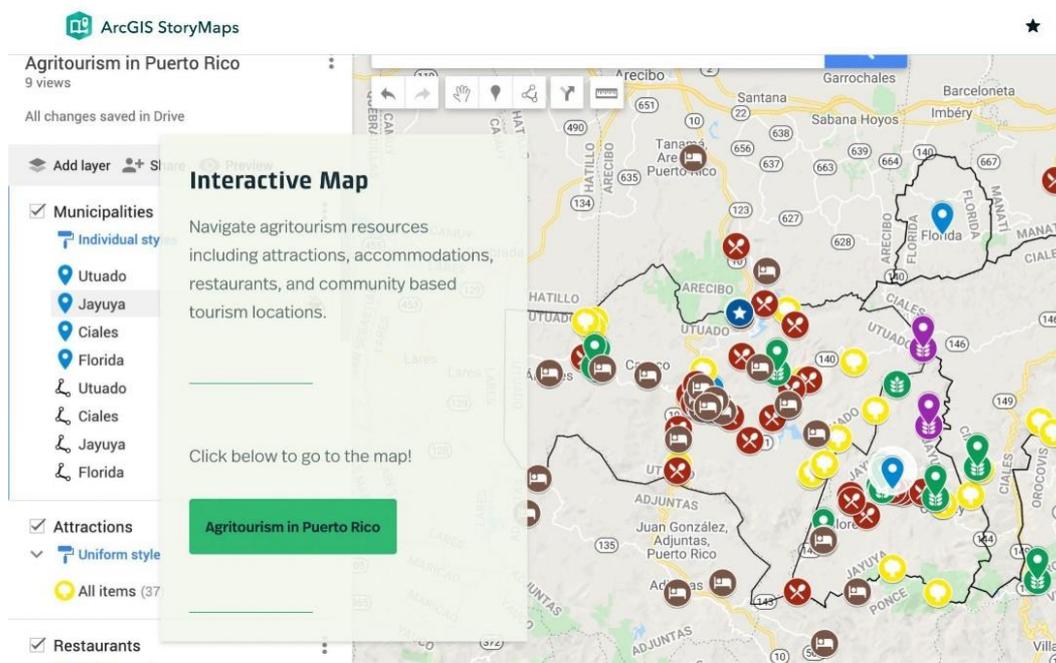


Figure 5. Storymap links to the interactive Google Map.

Section 3 focuses on the stories of the partnered farms and uses a “tour” style to allow viewers to move from one farm to the next. The tours tell the story of how the agritourism enterprise has been developed, inform about the offerings in words and photos, and specify the goals that motivated and drove the development of agritourism on each farm.



Figure 6. Section 3 displays partnered farms.

In summary, the purpose of the ArcGIS Storymap is to provide a starting point that captures the existing data and invites ongoing collaboration among project partners to evolve the ArcGIS Storymap according to the needs of the partners and the emerging research results

Feedback

To ensure collaboration, the Google Map and the ArcGIS Storymap feedback was collected from three of the six collaborating local farmers as well as from all representatives from the Puerto Rico Tourism Company and COSSAO, and local university students involved in the project. In order to foster a collaborative discussion, a virtual Zoom meeting was held to walk project partners, including professors, students, and farmers through the Google Map and Storymap. After the two resources were presented, the three collaborating farmers shared their feedback. Major feedback focused on clarifying the physical accessibility of the tourism assets via the automatic route guidance that Google defaulted to. In response, customized route accessibility was added as an option for farmers (or other representatives of assets displayed on the map). Farmers are now able to customize routes on the map from major starting locations, like the City of Utuado or San Juan, Puerto Rico, to the farm (Figure 4). Additionally, the project received positive feedback surrounding the Spanish translations of all the points on the Google Map, the photos displayed with each point, and the potential of the Storymap to connect all the different aspects of the “Agroturismo en la Montaña” initiative

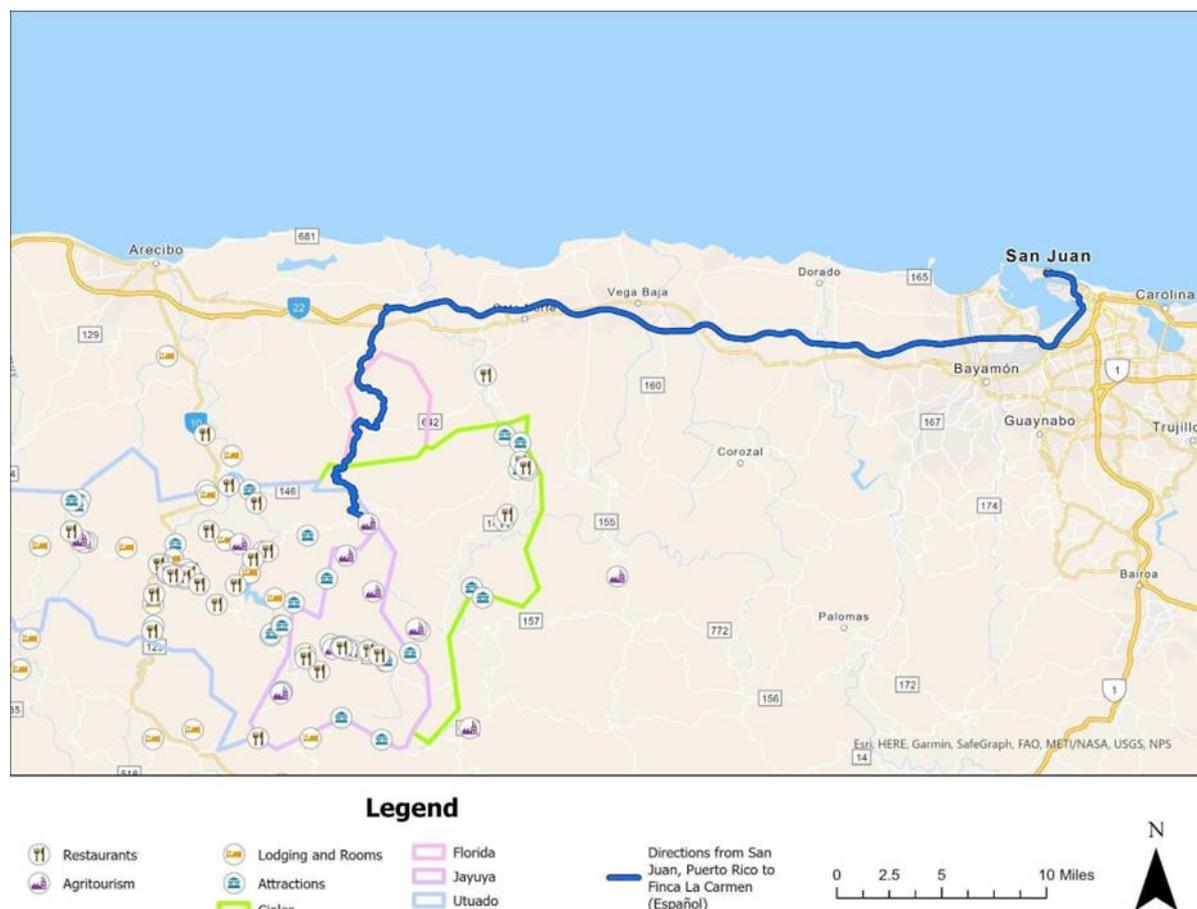


Figure 7. Example of customized route from San Juan to Finca La Carmen. Owners of the farm can ensure the route to the farm is accurate, safe, and accessible.

Discussions

The goal of this study was to map a spatially explicit inventory of agritourism resources in Central Puerto Rico to better understand the current agritourism assets as a system. Through the inventory and spatial visualization this research will help to assist stakeholders, agencies and decision-makers better understand what assets are available and what assets are needed for sustainable regional agritourism development in order to increase social-ecological resilience across social, economic, ecological and institutional domains (e.g. Powell, Green, Holladay, Krafe, Duda, Nguyen, Spencer, & Das, 2018; Holland, et al., 2022). Indeed, the tourism industry (in this case agritourism) has strong potential for building community and regional resilience (Yang, Kim, Pennington-Gray, Ash, 2022) through self-organization and local governance (Espeso-Molinero & Pastor-Alfonso, 2020), community economic development (Lee & Jayakumar, 2021) and considerations for environmental stewardship (Jamaliah & Powell, 2019).

The Inventory

Within the context of this study, 151 existing tourism assets were identified to establish tourism asset baselines to inform future agritourism development and interventions. Although the inventory assists agritourism development by gathering resources in a defined study area

(Gavilanes Montoya, Esparza Parra, Chávez Velásquez, Tito Guanuche, Parra Vintimilla, Mestanza-Ramón, & Vizuete, 2021), the results of this study do not reveal interconnections between asset points. The inventory, however, establishes that there is an existing foundation of tourism assets in the region, which has been correlated with higher rates of tourist satisfaction (Gavilanes Montoya et al., 2021). This higher likelihood of success can serve as a motivator for agritourism stakeholders to engage in the maintenance and further development of agritourism assets to increase opportunities for bolstering social capital (e.g. social networks, learning, sharing), economic diversity, local decision making and environmental stewardship, which are all hallmarks of social-ecological resilience (Holladay & Powell, 2013). Further, the disconnected nature of tourism assets in the region can be addressed to create a more well-connected regional tourism offering through cooperative and reciprocal interventions that support benefits to all stakeholders (Li, Dong & Zu, 2020).

Google Map

Importing geographical documentation of data points into a visual platform like Google Maps facilitates use of that information for stakeholders (Martínez-Graña, Goy & Cimarra, 2013). The Google Map in this study was created to geographically display the existing assets in a tangible way that is likely to be used by both providers to position themselves, and by users (tourists). Through the incorporation of the inventory onto Google Maps, it was revealed that there are currently attractions, restaurants, and lodgings that could support the further development of agritourism. There are also 13 farms that offer, or potentially could offer, agritourism-related activities to further the development of the region's agritourism offerings. The current Google Map is also lacking in four critical areas, which we discuss briefly: 1) Implementation of Custom Routes; 2) Display of Excursion Enterprises; 3) Display and Inventory of Community Based Tourism Initiatives; and 4) Display and Inventory of Disaster Preparedness Resources.

(1) **Implementation of Custom Routes:** Feedback from local stakeholders indicated that the auto-populated routes in Google Navigation were either incomplete, unsafe, or inaccurate. This issue is also discussed in literature. Google Maps users have been found to experience inaccurate location sensors when in rural or off-road areas, as well as problems with the routing algorithm being inaccurate or inconsistent (Eiband et al., 2019). Additionally, the success of tourist sites is directly related to the quality of the tourism experience, including proper route guidance and accessibility (Gavilanes Montoya et al., 2021). To address this, the Google Map created in this project is equipped with the ability to add customized, safe routes. Individual farmers, business owners, or local representatives would have to add a customized route as a layer on the map during a future stakeholder meeting and account for this in their visitor-facing communications.

(2) **Display of Excursion Enterprises:** Although present in the Inventory, "Excursion Enterprises" are not represented on the Google Map due to the lack of geo-specific coordinates for the businesses. Many of the companies that offer excursion experiences in the region list their address in cities such as San Juan, but operate locally in Utuado, with excursions to various historical sites and national attractions. Relationship building is necessary to engage these excursion enterprises in supporting the regional development of agritourism offerings.

(3) **Display and Inventory of Community Based Tourism Initiatives:** In a late revision of the Google Maps, it was brought to the research team's attention that another layer of "Community Based Tourism Initiatives" could be added to the Google Map and the Inventory. For the purposes of this study, the team added a placeholder datapoint to serve as an example of a Community Based Tourism layer. The current Google Map is lacking in a thorough display or understanding of the Community Based Tourism Initiatives in the region. Addressing this gap can serve as an incentive for COSSAO to engage in dialogue with community members interested in supporting the agritourism initiative.

(4) **Display and Inventory of Disaster Preparedness Resources:** The Google Map does not yet present government resources or disaster risk reduction resources. These are essential for the security and resilience of farmers in the region. In the future, a secondary Google Map or another layer detailing these resources should be added.

ArcGIS Storymap

Part of the development of these regional agritourism offerings is the use of the ArcGIS Storymap, which creates an avenue for storytelling. Storytelling has the potential to influence traveler decision making through creating narratives around tourism destinations (Youssef et al., 2019). Additionally, storytelling helps articulate and establish a regional identity around agritourism through branding, showcasing the region as a destination, and communicating the benefits of agritourism to both farmers and tourists (Youssef et al., 2019).

The ArcGIS Storymap integrates hard data (i.e. coordinates, names, other information listed in the inventory) and qualitative data into an accessible framework for interactive public engagement and as a framework for storytelling (Howland et al., 2020). The ArcGIS Storymap platform has the capability to incorporate links, images, databases, maps, descriptions in a manner that can be utilized by non-GIS users to popularize the results of scientific data (Oubennaceur, Chokmani, El Alem, & Gauthier, 2021). Therefore, the current version of the ArcGIS Storymap is only utilizing some of its potential. Although the development of agritourism enhances resilience through economic diversification and increased food security, other vulnerabilities still need to be addressed in order to increase resilience. A major factor for this region's ability to develop are its vulnerabilities and its lack of resilience to disasters like Hurricane Maria (Randhir, 2016). Moving forward, in order to address other areas of vulnerabilities (including disaster preparedness, risk evaluations, and communication) the ArcGIS Storymap should incorporate disaster preparedness resources. This tool is able to represent a good option in hazard and risk communication in areas that have a high level of vulnerability to natural hazards (Oubennaceur et al., 2021). The ArcGIS Storymap also has the capability of integrating future findings of the SSARE grant project—combining resources, results, and telling a story of the project and region as a whole

Implications

Decision makers

Decision makers, including the Puerto Rico Tourism Company and the Department of Agriculture as state-wide stakeholders, and municipal and local stakeholders like COSSAO, can use these maps as a key resource to market agritourism to explore the development of

resilient and sustainable agritourism using a systems lens. Moreover, related to future planning, this group of stakeholders can use the information entailed in the geospatial inventory and the ArcGIS Storymap to inform their decisions on regional planning, specifically on how to proceed with community visioning, subsequent agritourism development interventions, and providing localized disaster risk management resources. In the Caribbean, agritourism has the potential to have an immense impact on people's livelihoods through creating resilience to climate change, managing food prices through local self-production, and fostering positive health impacts (Addinsall, Scherrer, Weiler, & Glencross, 2016). Over half of Caribbean countries import more than 80 percent of the food they consume, leaving them vulnerable to food insecurity during times of natural disasters (FAO, 2015 as cited in Thomas, 2018). By stimulating domestic food production and creating income diversification for farmers, sustainable agritourism has the ability to reduce the vulnerability of farms to natural hazards (Thomas et al., 2018).

During the collaborative feedback process of creating the Google Map and the Storymap, one area of feedback was the need to identify more community based tourism (CBT) programs. Currently, the inventory and the Google Map identify one successful community-based tourism enterprise, "Villa Comunitaria Crozier." This CBT initiative offers educational, cultural, and nature-based encounters for tourists to promote the development of communities near Utuado and Arecibo. This initiative was identified as a "placeholder" in the inventory and Google Map until further research is conducted to identify other CBT programs operating in the region. It is important to note that COSSAO is developing its own agritourism project Hacienda Rullan in the barrio of Tetuán. Thus, future research should identify and learn from the Villa Comunitaria Crozier and other community-based initiatives to inspire and inform the incubation and implementation of additional community-based initiatives in the region. Research on CBT in the Caribbean suggests that related efforts should be based in participatory planning and capacity building, strategic partnerships facilitating links to market, local management and ownership, goals based in community and environmental values, assistance from enablers (government, funding institutions, and private sector), and focus on generating supplemental income for long term community stability (Dodds, Ali & Galaski, 2018). Through these efforts, CBT has the potential to enable strong ties between members of the community and link the community to its environment (Cáceres-Feria, Hernández-Ramírez, & Ruiz-Ballesteros, 2021). Through the mobilization of community resources and connections, CBT has the ability to develop a region's resilience by increasing its capacity to respond to and mitigate the consequences of disturbances (Cáceres-Feria et al., 2021).

Farmers

Farmers will be able to use this information in several ways. For one, farmers can use the Google Map to understand the resources that surround their location and to identify and connect with other farmers that are implementing agritourism practices, generating synergistic benefits and working towards a regional economy and branding. The generation of synergistic benefits increases resilience through the building of social capital through learning, sharing, and creating networks (Holladay & Powell, 2013). Second, they can use it as an instrument for outreach and attracting tourists, inspiring them to further explore and engage in sustainability practices. Attracting tourists increases economic resilience through the development of new revenue streams (Holladay et al., 2021).

Tourists

Tourists can use the Google Map and the ArcGIS Storymap to explore agritourism locations and networks when visiting Puerto Rico. By having access to geo-spatially referenced resources to inform their travel, such as the ArcGIS Storymap, and therefore the Google Map, tourists can build their travel itinerary and choose to participate as clientele, thus contributing to the development of agritourism. Tourists are a source of diversified income for farmers and tourism revenue has the potential to support new revenue streams, job creation and alternative livelihoods (Holladay & Powell, 2013). Therefore, having resources such as the Google Map and ArcGIS Storymap to make agritourism more accessible for tourists is essential for the authentic and locally informed development of targeted regions as agritourism destinations. Locally informed development is centered in self-organization, power sharing and local control, all hallmarks of social-ecological resilience (Ostrom, 1995).

Conclusion

The work presented in this paper explored the spatial networks of gastronomy, accommodations, farms, and attractions that support the development of agritourism in the central municipalities in Puerto Rico, including Utuado, Jayuya, Ciales and Florida. The study identified existing assets that can support the development of agritourism and inventoried and geo-spatially displayed these through user-friendly Google Maps and an ArcGIS Storymap. Additionally, there are 13+ potential farms that could implement further agritourism practices. Through the development of sustainable agritourism, the municipalities will have the potential to benefit financially and socially from strong, reliable, and resilient institutions. Through the increased opportunities for income and the development of social and environmental awareness, the resources that were developed through this project will serve as a stepping stone for the overall success of the “Agroturismo en la Montaña” project.

However, to seize these opportunities, more work is needed. The work presented in this paper represents the beginning of a longer process of regional agritourism development. As indicated in the framework for the overarching project (fig 1.), the presentation of an inventory and spatial visualization is the important first step to inform the next stages of development. The current map is lacking in some key information that could be valuable for stakeholders. First, although the map depicts the existing assets in the system, it does not display an understanding of how those resources are interconnected. Next steps include conducting a social network analysis to determine a systems-based structure that interconnects these assets with farmers and project development stakeholders on the various levels of implementation (i.e. farmers, local project managers, the Puerto Rico Tourism Company, and government resources/officials). Next, if the Google Map can be improved in its display of 1) customized safe routes; 2) excursion enterprises; 3) community based tourism initiatives; and 4) disaster preparedness resources, it has the potential to also serve as a resource for increased socio- ecological resilience and disaster recovery. As studied in a Puerto Rico Case Study in 2020, mapped agricultural assets can act as sources of food and community spaces when disasters strike (Qin, 2020). Therefore, not only does the Google Map serve as a foundation for agritourism development, but by revealing the gaps in the inventory and how to address them, it also has the potential to benefit overall resilience to disasters through increasing awareness of community resources.

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