



Scanning Models of Food Systems Resilience in the Indo-Pacific Region

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The Indo-Pacific is a region of the world experiencing rapid growth in population and development. However, it is also exposed to a number of social, economic, geopolitical, and biophysical stressors, which may undermine the region's ability to support its population, ensure food security, and sustain livelihoods. In response to the complex suite of stressors, a number of development initiatives and research programs have been established to build resilience in the region's food systems. These initiatives vary in scope and scale, but also in what they mean by the term resilience and the components of the food system they address. This variation has implications for the outcomes of these efforts and how well they match a theoretical ideal of resilience. This review examines how resilience and food systems are defined, conceptualized, and applied within research studies and projects or initiatives on food systems resilience funded or supported by national, regional, or multilateral government, and non-governmental institutions in the Indo-Pacific region. It also compares how the concepts are treated from an academic or theoretical perspective vs. in practical applications. We take a two-pronged approach: first, identifying organizations engaged in the Indo-Pacific region and developing an inventory of initiatives and projects that have bearing on food systems resilience; and second, carrying out literature searches to record research studies in the region that examine resilience within food systems. We then identify any formalized frameworks or definitions of resilience and/or food systems guiding these projects and studies. The results indicate there is a heavy focus on climate change and natural disasters, and to a lesser extent health-related shocks, in food systems resilience research and practice. Definitions, however, are inconsistently reported, and are often more simplistic than resilience theory depicts, favoring resilience conceptualizations around adaptation and a production-oriented food systems framing. While the specific definitions vary between research and applied projects, the fragmented and ambiguous use of terms presents a challenge for policy applications and coordination. Overall, establishing some clear guiding resilience principles, modified according to contextual factors, could enable more streamlined resilience work in Indo-Pacific food systems.

Keywords: climate change, adaptation, sustainable development, food systems, Pacific Islands, Southeast Asia, resilience

INTRODUCTION

East Asia and the Pacific face a unique combination of challenges and opportunities, which shape the region's food production and consumption. In the last decade, the region has seen major infrastructure and economic development leaps (Rathbone and Redrup, 2014), conspicuously shifting consumption patterns (Hodgson, 2013), and substantial donor aid supporting poverty alleviation and economic developments through investments in transportation, infrastructure, and agriculture (Dornan and Pryke, 2017; Ingram, 2020). Yet at the same time, the region continues to be plagued by persistent poverty, social and economic inequalities, and environmental vulnerabilities (Palanivel et al., 2016; UNDP, 2020). Food systems play a critical role in the maintenance and growth of society, supporting food security, livelihoods, and wellbeing, particularly under these conditions.

Food systems are crucial because they not only provide sustenance to ensure food security, but also form the backbones of people's livelihoods from production all along the broader value chain of processing, transporting, and selling food products (Ericksen et al., 2009). Shocks and stresses, most recently the COVID-19 pandemic, have highlighted certain underlying vulnerabilities and current levels of resilience in food systems in the region, particularly when these systems are faced with compounding risks arising from coincidence of extreme events, trade disruptions, and interruptions in supply (Béné, 2020; Farrell et al., 2020; Naidoo and Fisher, 2020). Yet there are still major gaps in our understanding of what constitutes resilient food systems, and how those concepts are applied in practice. This paper discusses the state of resilient food systems research and practice in the Indo-Pacific sub-region (here inclusive of countries in Southeast Asia [SEA] and Pacific Island Countries and Territories [PICTs]), focusing primarily on work carried out by international, intergovernmental, donors, and academic institutions, taking stock of the strengths and shortcomings of the current conceptualizations of "resilience" and "food systems" in the regions.

The Indo-Pacific includes regions experiencing rapid growth in population and development (Palanivel et al., 2016), which has implications both in terms of exposure and sensitivity to shocks and stressors, and capacity to respond to them. Both regions have integrated regional bodies, such as the Association of Southeast Asian Nations (ASEAN), and the food system-related CROP agencies (Council of Regional Organizations in the Pacific) of the Pacific Islands. Countries in SEA and PICTs face a number of risk factors relevant to food systems, including dependence on food imports, pre-existing gender, health, and economic inequities, fragmented value chains and food governance systems, poor biosecurity infrastructure, growing informal and marginalized labor markets, and climate change impacts (Robins et al., 2020). That said, these two regions also differ in terms of their interactions or physical connection with mainland Asia, their levels of urbanization and population densities, and modes of governance and regional cooperation, as examples. In turn, this suggests that even prior to carrying out the scan, we expected to find different

opportunities and hurdles for the two regions, relating to food systems resilience.

In Southeast Asia (SEA), which houses over 600 million people, levels of development range from "medium-low" (for Human Development Index, HDI) in countries like Myanmar, Lao People's Democratic Republic, and the Philippines, to "high" in Singapore, Brunei, and Malaysia (Sadeka et al., 2018). Half the population lives in urban centers, although this ranges from less than one-quarter in Cambodia to 100-percent in Singapore (UNESCAP, 2019). Regional disparities like these exist due to both geographic characteristics, such as areas that are drought-prone in Indonesia or exposed coast in the Philippines, and socioeconomic context, for example densely-populated urban centers like Singapore or Kuala Lumpur (Hijioka et al., 2014). Climate shocks include rising sea levels and risks of flooding, extreme monsoonal rainfall, and increased landfall of cyclones (Hijioka et al., 2014).

Pacific Island countries and territories (PICTs) are composed of 22 Pacific Islands – of which only two-percent is landmass and 98% is ocean – and approximately 12.5 million people reside in the region (UNESCAP, 2017; SPC, 2020). Levels of human development vary across the PICTs – ranging from high-very high HDI in countries like Palau, Fiji, Tonga, Samoa, to medium in Papua New Guinea and Kiribati (UNDP, 2020). A reliance on tourism, remittances, and international trade for income-generation is common across the PICTs. With an increasing reliance on calorie-dense and nutrient-poor imported foods, the Pacific has one of the highest Non-Communicable Disease death rates in the world (Bell et al., 2016). The Pacific region is also a high risk natural disaster area, experiencing an increasing number and intensity of extreme weather events such as tropical cyclones and flooding, and the highest rates of sea-level rise globally (UNESCAP, 2017).

Food and livelihood insecurity and persistent poverty in the Indo-Pacific regions have prompted the establishment of a number of research studies and project-based initiatives to build resilience in food systems. Here we have focused on those led by national or regional government bodies, international organizations or NGOs, research institutes, and donors, rather than community or local grass-roots initiatives. Because these institutions have a diversity of objectives and outcomes, efforts related to food systems resilience vary in scope and scale, but also in what they mean by the term "resilience" and the components of the "food system" under consideration. This variation has implications for the outcomes of these efforts and how well they match a theoretical ideal of resilient food systems. As such, it is important to understand how resilience in food systems is being conceptualized in different contexts, so as to better tailor such initiatives to meet local needs, establish common expectations of scope and scale, and achieve desired outcomes.

Resilience and Food Systems Frameworks

Both the terms "resilience" and "food systems" are difficult to put boundaries around; however, there are frameworks that provide a starting point from which to build context-specific conceptualizations (Ericksen, 2008; Evans, 2011; CARE International, 2016; USAID, 2018; HLPE, 2020). We drew on

several frameworks and conceptual pieces to help define the scope of this study, as well as develop the coding framework used in this analysis.

Food systems have been broadly defined as comprising the different drivers (e.g. urbanization, technology development, economic growth), components (e.g. environment, people, processes, infrastructure, institutions), and activities (e.g. production, processing, distribution, preparation, and consumption) that contribute to food security outcomes (Ericksen, 2008; Brouwer et al., 2020; HLPE, 2020). As one primary objective of a food system, achieving food security is considered the circumstances when “all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for a healthy and active life” (Pinstrip-Andersen, 2009). Our working definition of food systems also includes the achievement of other goals, such as improved conservation outcomes, gender equity, livelihoods, and local capacities, which align with the Sustainable Development Goals that have been implicated in high-level food security and nutrition discourses (HLPE, 2020). Despite this inherent complexity in food systems, they are often approached piecemeal; studies often examine food systems from the supply/production, mid-stream processes, or demand perspectives, rather than at a systemic level (Brouwer et al., 2020).

A food system risks failing to deliver on its primary objectives when confronting current or future disturbances or stresses, such as economic shocks, institutional failures, actors in conflict, and environmental changes (Ericksen, 2008; Evans, 2011; Hoddinott, 2014). Resilience in the face of such stresses may be context-specific, but also often requires consideration for an approach that encompasses complexity and systemic interactions. In addition to environmental constraints from soil degradation, biodiversity loss, land conversion, and pollution, structural risk factors – from trade agreements and governance structures, corporate consolidation and existing value chains, and persistent injustices and food sovereignty struggles - have been suggested as critical for food system resilience (Mooney et al., 2021).

While scholarship on resilience spans multiple disciplines, and varies accordingly, the concept as applied to the food and agricultural development contexts shares many similar terms and fundamental principles. At its heart, a resilient food system is conceptualized as supporting food security and related objectives over time and in spite of various and possibly unforeseen disturbances, by ensuring sufficient, accessible, and stable supplies of food (Tendall et al., 2015; Béné, 2020). Resilience can be understood through a common set of capacities of the system: to *avoid* or prevent exposure to disturbances, *absorb* the effects of disturbances, *recover* and restore after disturbance, *adapt* and learn moving forward from a disturbance, and *transform* a system in the long-term (Folke et al., 2010; Tendall et al., 2015; Doherty et al., 2019). Common phrasing in the literature conveys the sentiment of “bouncing back better”, denoting that resilience is a subjective concept that is not merely about maintaining the existing function of a system, but learning from and improving upon it (Béné, 2020; Walker, 2020).

We acknowledge that “what a resilient food system is” depends on the context. As such, we take an inductive approach for this study to determine how these terms have been defined or conceptualized within the research studies and on-the-ground projects that are reviewed, pointing to the terminology employed in existing definitions whenever possible.

OBJECTIVES AND METHODS

This review aims to identify the ways in which research studies and projects conceptualized and applied the notions of “resilience” in “food systems”, focusing on two sub-regions in the Indo-Pacific (Southeast Asia and the Pacific Islands). We focus the review on work undertaken by academic, national, regional, or multilateral government, and non-governmental institutions, as the monitoring and evaluation of these projects is often better documented; projects tend to be undertaken across a range of different case studies, allowing scalable outcomes to be determined; and resources from these organizations are growing in the resilient food systems space. Specifically, the review seeks to understand:

1. How resilience and food systems are defined or conceptualized by the reviewed projects and research studies in the Indo-Pacific;
2. How these concepts compare in research studies vs. applied in projects; and
3. What differences or similarities arise between the definitions and applications of these concepts within the reviewed projects and research studies in Southeast Asia and the Pacific Islands.

Structured Search

We took a two-pronged approach to identifying projects/initiatives and research studies (see **Table 1** for terms). During stage 1, we identified organizations in the regions implementing projects that addressed issues of relevance to food systems resilience. In stage 2, we looked at the landscape of applied and exploratory research on resilience in Indo-Pacific agri-food systems.

Web searches were carried out between December 2020 and April 2021. For stage 1, we initially identified regional organizations/bodies through keyword searches, and the websites of regional coordinating bodies, such as the Association of Southeast Asian Nations (ASEAN) and the Council of Regional Organizations in the Pacific (CROP). This was followed by snowball sampling to identify additional projects and research studies not originally included in the inventory. We consulted organizational websites to identify projects or broader initiatives that related to some aspect of the food system and dealt with resilience, and then extracted information from the websites, reports, project documents, and other media. For stage 2, we carried out a series of keyword searches on Google Scholar (see **Supplementary Table 1**) and looked through the first 100 results of each search, to identify research studies to be examined as representative of the research in the region.

Search results were only included if they covered at least one country in Southeast Asia (SEA) or a Pacific Island Country or

TABLE 1 | Descriptions of main terms used in the methods for the structured search, data extraction, and analysis.

Term	Description
Project	A time-bounded activity carried out <i>in-situ</i> with the objective of building resilience in a food system. A project may have a research component or apply the results of previous research.
Initiative	Compendium of related projects, funded under the same banner, led by the same organization, and all contributing to the same overarching objective. Projects may focus on different aspects.
Research study	Individual output from a desk-based, synthetic, or empirical research activity. This can be in the form of a peer-reviewed journal article or a report, brief, or working paper published as gray literature by an organization.
Organization	Body leading the project, initiative, or study. Organizations include multilateral, governmental, and non-governmental organizations, universities, non-academic research institutions, and donor agencies or funders with a presence in SEA and/or PICTS.
Theme types	This term is used to describe the three broad areas of data extracted: “main topic” captures the shock/hazard and/or driver/motivation of the project or study; “food system” includes the aspects of the food system under consideration; “resilience” covers the way(s) in which resilience is conceptualized.
Coded themes	Specific terms identified under each theme type to capture what the project or study was about.

Territory (PICT). SEA includes Brunei; Cambodia; Christmas Island (Australia); Cocos (Keeling) Islands (Australia); Indonesia (and West Papua¹); Lao People’s Democratic Republic; Malaysia; Myanmar; Philippines; Singapore; Thailand; Timor-Leste; and Vietnam. PICTs comprise the 22 Pacific island member countries and territories (American Samoa, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Nauru, New Caledonia, Niue, Northern Marianas, Palau, Papua New Guinea, Pitcairn Islands, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu and Wallis & Futuna).

Results of the search were only included in this analysis if they met the following criteria:

- At least one country in the region of interest was present;
- Either a project on-the-ground (or the umbrella initiative), or a research study in the form of a peer-review article, white paper, report, or similar;
- Project completed or study published after 2009, or current/ongoing initiative;
- Explicitly addressed some aspect of resilience within some component of the food system;
- Not at a global level or focused solely on international trade;
- Existing syntheses of projects in the region and empirical research were included, but not solely conceptual or theoretical publications.

¹ Considered a politically contested space, although technically under sovereignty of Indonesia.

A total of 61 projects and 53 research studies in SEA and 58 projects and 37 research studies for PICTs were included in the analysis. Of these, ten of the projects and nine of the research studies had countries from both regions represented. See **Supplementary Material** for a breakdown by country, and the data table with more details of each data point.

Analysis and Comparison

Data generation and analysis were based on the project descriptions and supporting documents, or the study publication. For both the projects and the studies, we documented:

- The lead organization, and project or research partners;
- The stressor(s) (e.g. climate change) and/or motivation or desired outcomes (e.g. sustainable development) being addressed;
- Which aspects of the food system were involved; and
- How resilience was conceptualized, assessed, and/or measured.

For “food system” and “resilience”, we noted an exact definition when provided.

We applied mixed methods to the analysis of projects and research studies, combining qualitative content analysis and the use of thematic coding, with social network analysis. From the compiled documents and materials (including publications and project reports), we inductively coded themes, which fell under one of three main theme types: *main topic* was the focus (a stressor and/or motivation), and *resilience* and the *food system* were how these terms were being conceptualized or defined. Coding was done iteratively, with related topics aggregated under common codes after initial coding, and codes for “resilience” and “food systems” refined to employ terms used in the definitions presented in Section Resilience and Food Systems Frameworks whenever possible, for the purpose of comparability. The final codebook can be found as **Supplementary Table 3**.

For each project or research study, the theme codes were entered as a tie, and the type of theme was delineated as a tie attribute. This allowed for the generation of different networks showing the relative importance of specific topics under the different theme types (i.e. main topic, resilience, food system), for the two regions, and comparing projects to research studies. Networks were created and degree and betweenness measures of centrality for the different topics calculated using the “igraph” package (Csárdi and Nepusz, 2006) in R Studio (R Core Team, 2021). These were then visualized using the “GGally” package (Schloerke et al., 2021). All centrality measures are included in the **Supplementary Materials**, as only degree centrality scores are presented in the results section. Results were similar using either degree or betweenness centrality scores.

In comparing Southeast Asia and the Pacific Islands, and projects vs. research studies, we considered commonalities and whether there were consistently themes or terms over- or underrepresented, particularly in relation to the frameworks described earlier.

RESULTS

Main Topics

On the whole, climate change was the overwhelming focus of most projects reviewed, and still dominant for research studies (see **Figure 1**). Our results in both regions show themes of economic or geopolitical shocks and nutrition have been under-examined. In Southeast Asia, sustainable development was a major objective, and gender equity was a topic of greater prevalence than in PICTs. While the results show a few efforts in Southeast Asia addressing the COVID-19 pandemic as a stressor, in this region none of the resilient food systems projects or research studies we reviewed were motivated by general health-related outcomes. In the PICTs results, food security and health were comparative contrasts to their meager appearances in Southeast Asia's results (**Table 2**). Global change was also a more prominent theme in the results from PICTs, perhaps due to the connections between globalization, shifting diets, non-communicable disease patterns, and climate change.

Some areas of divergence between the main topics of the reviewed projects vs. research studies in both regions included: a greater emphasis placed on i) gender equity, sustainable development and livelihoods, and ii) natural disasters for projects. Conversely, global change (or globalization), nutrition, and health were more frequently topics explored in research studies.

Agriculture and Food Systems

Generally, the reviewed projects and research studies conceptualized food systems predominantly in terms of food production (see **Figure 2**). The results for Southeast Asia featured primarily land-based production and smallholder systems, whereas those from PICTs demonstrated a more balanced approach with fisheries and aquaculture, as well (**Table 3**). Value chains, markets, and infrastructure were more frequently included in the conceptualizations of food systems for the SEA results, while in the PICTs results, food supply and food storage were marginally more prevalent components. This may relate to small island nations' challenges around imports and food self-sufficiency. Few of the reviewed projects and studies in either region included urban settings in their food systems framings, although there were hints of Southeast Asia's growing attention to urbanization. Other components, particularly food processing, infrastructure, transportation, and loss and waste were also only included in a small number of the reviewed projects and studies. While this could point to critical gaps in research and practice on food systems, it could also indicate that these food system components may play only a minor role in the regions.

Social-ecological systems were almost only included in the food systems framings of research studies, highlighting the lack of social components targeted by projects. In Southeast Asia, the reviewed projects dealt more with food processing, supply, infrastructure, and value chains than research studies. In PICTs, the research adopted a more holistic view of food systems than the projects by including food processing, storage, supply, consumption, and trade.

Resilience

Conceptualizations of resilience outlined here are based on standard terminology discussed earlier, with the inclusion of some additional terms around risks and vulnerability. Across the projects and research studies reviewed, resilience was most often framed as or used synonymously with adaptation and adaptive capacity (see **Figure 3**). Framing resilience in relation to disturbance or a disruption was also popular, which hearkens to a history of resilience applied in the hazards and natural disasters field. In addition to the adaptation/adaptive capacity framing, absorbing and recovering from shocks were more frequently used to frame resilience within the Southeast Asian projects and studies (**Table 4**), whereas for PICTs, the generic term resilience was prominent, without a formal definition or indication of what was included in that conceptualization. This could reflect the need the Pacific Community has identified for developing its own working definition of the concept. Transformation was infrequently part of any of these conceptualizations.

Projects tended to use either ambiguous or amorphous conceptualizations of resilience, or they focused on responses to disturbance. On the other hand, research studies took a comparatively broad approach to resilience, more often including the avoid and absorb aspects mentioned earlier, and socially-oriented resilience concepts. This could be indicative of the stronger ties research has with theory and building on existing frameworks.

Formal Definitions

Conceptualizations of resilience may be inferred by the terminology employed in documents and descriptions; however, in order to accurately discern the intended vision of a resilient food system, explicitly defining the concept is critical. Yet definitions or frameworks of resilience were infrequently referenced, though this varied substantially between the research studies and projects reviewed. Formalized definitions were more likely to appear in research studies than in project descriptions or documents. Of the 53 research studies identified in Southeast Asia, just under half ($n = 25$) included some explicit definition, while nearly one-third of the 37 research studies ($n = 11$) in PICTs did. In contrast, of the 61 SEA projects identified about one-fifth ($n = 13$) included a definition of some sort, while less than ten percent ($n = 5$) of the 58 projects in PICTs included a definition or a framework. Although this discrepancy is not surprising, it does indicate a need for clearer notions of what resilience means in context, when applied to projects or on-the-ground activities.

While formalized definitions drawn from other work varied by study or project, certain scholars were more prominently cited than others. In research studies, works by Walker, Holling, Carpenter, and Folke were regularly referenced, drawing on the social-ecological systems perspective to situate resilience (Folke et al., 2002, 2010; Gunderson and Holling, 2002; Folke, 2003, 2006; Walker et al., 2004; Walker and Salt, 2006; Carpenter and Brock, 2008). Intergovernmental Panel on Climate Change (IPCC) definitions also appeared a few times in research studies (Denton, 2002; Denton et al., 2014), but were more specifically climate-focused and often refer to "climate-resilient pathways".

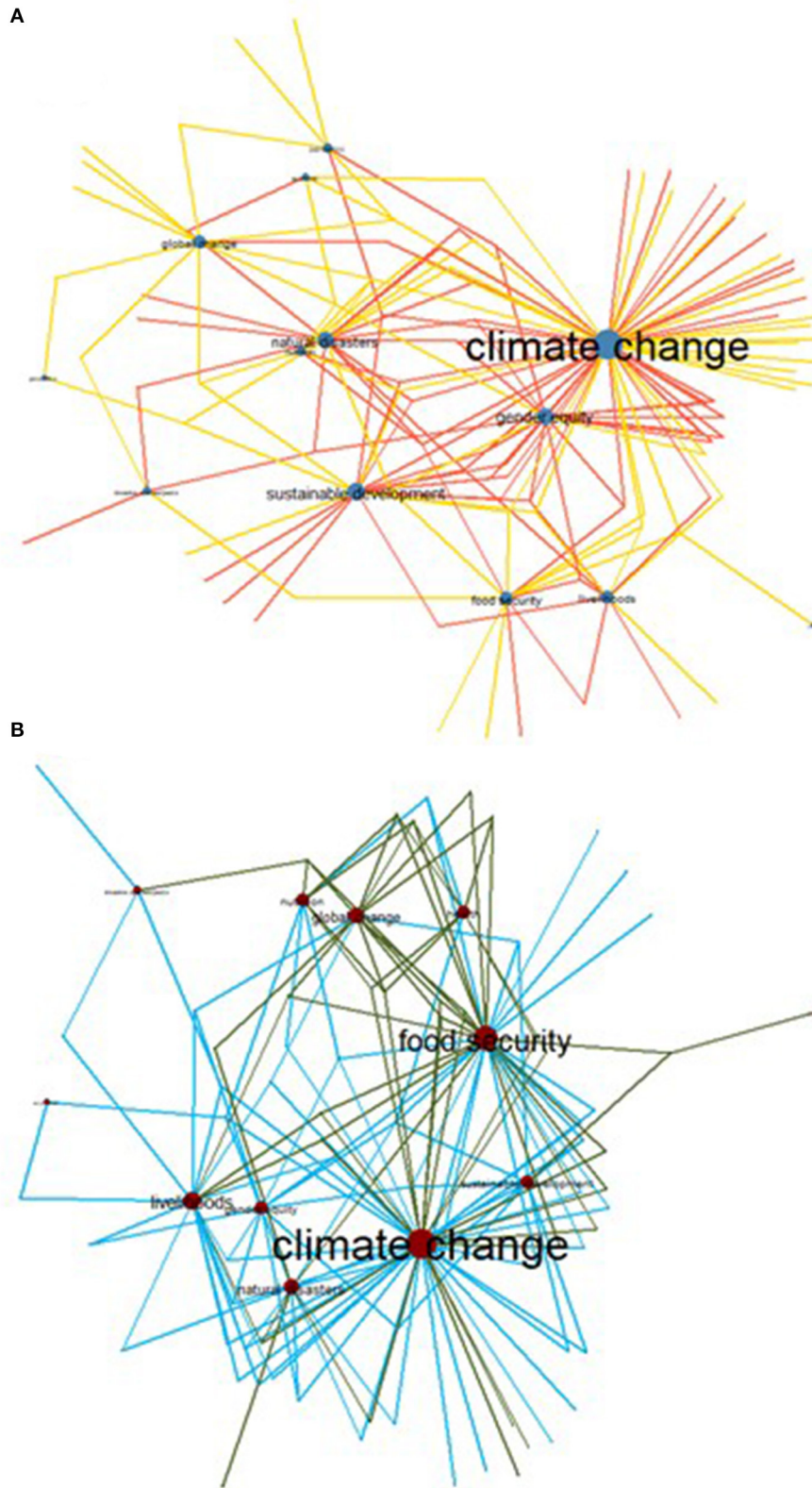


FIGURE 1 | Main topics in **(A)** Southeast Asian projects/initiatives (red) and research studies (yellow), and **(B)** PICTS projects/initiatives (blue) and research studies (green). Chart shows degree centrality scores based on networks disaggregated by region.

TABLE 2 | Main topics ordered by degree centrality score a) Southeast Asia and b) Pacific Island Countries and Territories, and for projects vs. studies.

a) Southeast Asia				b) Pacific Island Countries and Territories			
Topic	Total	Projects	Studies	Topic	Total	Projects	Studies
Climate change	0.60	0.61	0.48	Climate change	0.61	0.61	0.49
Sustainable development	0.20	0.25	0.11	Food security	0.41	0.32	0.46
Gender equity	0.18	0.26	0.05	Livelihoods	0.22	0.27	0.11
Natural disasters	0.17	0.21	0.09	Global change	0.16	0.05	0.30
Food Security	0.12	0.08	0.14	Natural disasters	0.16	0.16	0.14
Livelihoods	0.10	0.11	0.07	Gender equity	0.12	0.18	0.00
Global change	0.10	0.02	0.18	Sustainable development	0.12	0.16	0.03
Nutrition	0.07	0.03	0.09	Health	0.11	0.04	0.19
Pandemic	0.06	0.03	0.07	Nutrition	0.11	0.07	0.14
Invasive species/pests	0.05	0.05	0.04	Invasive species/pests	0.05	0.05	0.03
Economic	0.04	0.02	0.05	Economic	0.02	0.04	0.00
Geopolitics	0.02	0.00	0.04	Pandemic	0.01	0.00	0.03
Health	0.01	0.00	0.02	Geopolitics	0.00	0.00	0.00

Where projects provided a definition, no particular scholarly work was referenced. That said, these definitions for the most part depicted elements outlined in the literature discussed earlier, namely - avoiding, anticipating and preparing for, and recovering from or adapting to disturbance. In their definitions, only two mentioned transformations, and three included reference to social resilience through the importance of institutions, social networks, or community resources.

DISCUSSION AND CONCLUSIONS

Resilience Is More Than Responding to Climate Change

The results of this review indicate there is a heavy focus on climate change and natural disasters in food systems resilience narratives of the projects and studies examined for the regions. Yet resilience is more than preparing for and responding to climate change, and recognizing this is critical to ensuring that other non-climate stressors or drivers of vulnerability are accounted for in resilience planning (e.g. van der Ploeg et al., 2020). In research studies, we see a broadening of this perspective through examination of global change or globalization as a disturbance, but these studies are still in the minority and do not do justice to what has been broadly considered in the conceptual literature (Rockstrom et al., 2020). In addition to climate change, expert assessments have elaborated on other forces that shape global food systems, and could therefore be avenues for disturbances or building resilience. These include degradation of natural resources, urbanization and demographic change, globalization and industry growth, consumer behavior, culture and traditions, government policies and trade agreements, conflict and fragile states, and scientific and technological innovation (IAASTD, 2009; Denning and Fanzo, 2016).

Such a broad suite of forces shaping food systems, and the current focus of the reviewed projects and research studies on a limited set, suggests ample opportunity to expand the scope of resilience to address multiple or compounding stressors.

In fact, some researchers have argued that accounting for multiple stressors is necessary for resilience over time (Zanotti et al., 2020). The United Nations Conference on Trade and Development (UNCTAD, 2018) made the case that countries must grapple with multiple shocks in large part because of the complexities and interdependencies within a system, pointing to the concurrent impacts of the 2008–2009 financial crisis and natural disasters as an example. The Conference also noted that to address multiple stressors requires considering the impacts of shocks on vulnerable groups (e.g. women, children, impoverished). Although gender, for instance, appeared to some extent in this review, there is considerable room for research to understand how gender equity contributes to building resilience and addressing multiple stressors within food systems, especially beyond food production.

We have started to see more acknowledgment of the role of multiple stressors in undermining resilience with the emerging reflections on the COVID-19 pandemic. For instance, COVID-19 inevitably tied food systems resilience to health crises, as well as the social and economic challenges that arise as a consequence (Bisoffi et al., 2021; Davila et al., 2021). Noticeably, the pandemic has demonstrated how restrictions on people's movement both within and between countries can undermine a number of components of food systems, from the labor to produce food to household finances and capacity to access food (Béné, 2020). Others have pointed to the pandemic as bringing to light the opportunities to address social, economic, and environmental failings that have been systemically eroding food systems resilience (Savary et al., 2020; WEF, 2020). Integrating considerations for multiple stressors into large food systems projects and initiatives therefore has the potential to scale-up more comprehensive strategies for building resilience.

Taking a Systems Approach to Resilience

The heavy focus of the results from both Southeast Asia and the Pacific Islands on food production, whether on land or at sea, suggests there is still substantial opportunity for resilience

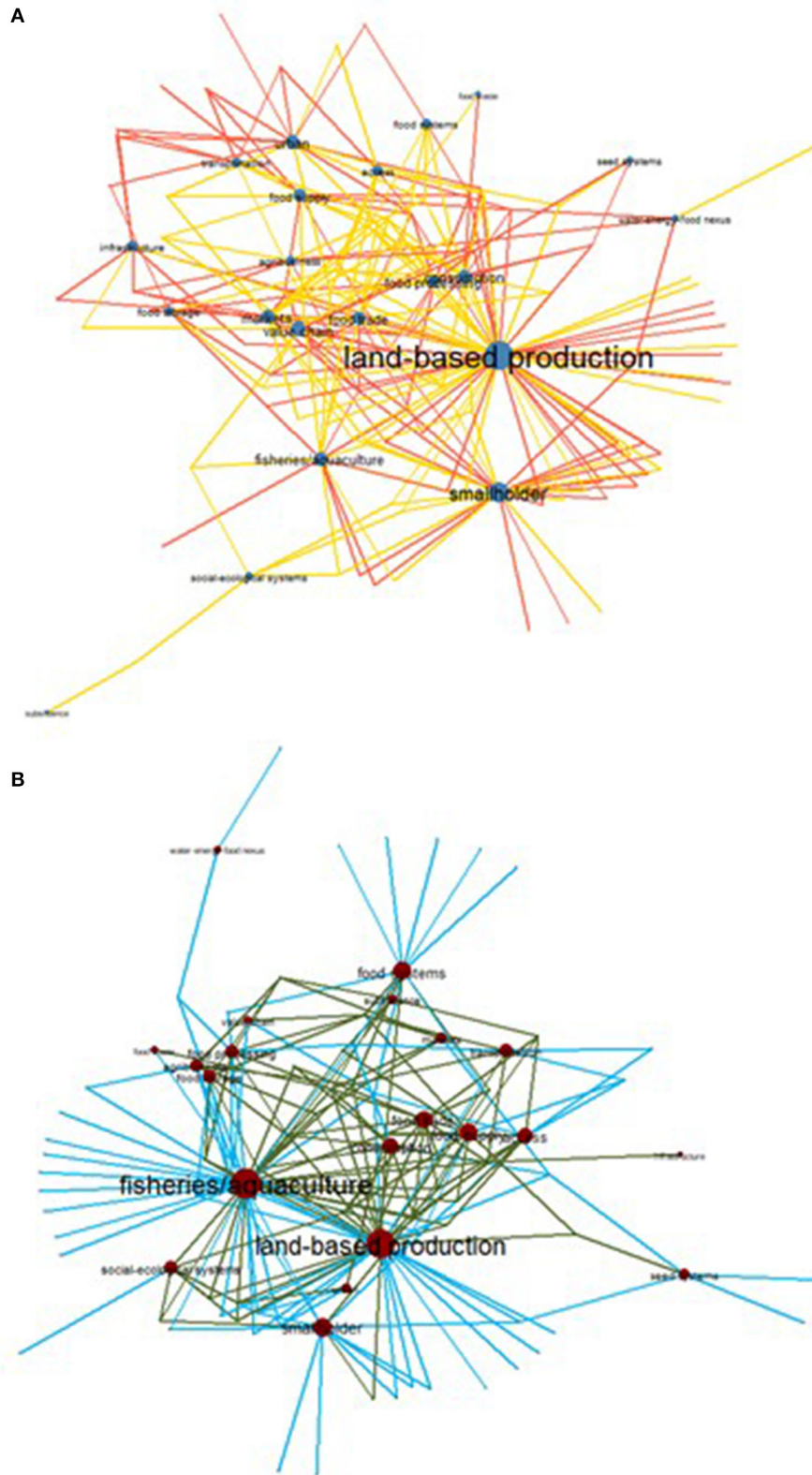


FIGURE 2 | Food systems definition codes used in **(A)** Southeast Asian projects/initiatives (red) and research studies (yellow), and **(B)** PICTS projects/initiatives (blue) and research studies (green). Chart shows degree centrality scores based on networks disaggregated by region.

TABLE 3 | Food systems codes ordered by degree centrality score a) Southeast Asia and b) Pacific Island Countries and Territories, and for projects vs. research studies.

a) Southeast Asia				b) Pacific Island Countries and Territories			
Code	Total	Projects	Studies	Code	Total	Projects	Studies
Land-based production	0.57	0.46	0.52	Fisheries/aquaculture	0.43	0.33	0.41
Smallholder	0.28	0.25	0.23	Land-based production	0.42	0.32	0.41
Value chain	0.14	0.15	0.10	Smallholder	0.17	0.21	0.07
Consumption	0.14	0.07	0.16	Food systems	0.15	0.14	0.11
Fisheries/aquaculture	0.14	0.10	0.13	Food supply	0.14	0.05	0.22
Markets	0.14	0.09	0.15	Food trade	0.13	0.00	0.26
Urban	0.14	0.13	0.10	Access	0.11	0.06	0.13
Food processing	0.11	0.12	0.06	Consumption	0.11	0.03	0.17
Food trade	0.11	0.07	0.11	Food processing	0.09	0.05	0.11
Food supply	0.10	0.10	0.06	Social-ecological systems	0.09	0.03	0.13
Access	0.07	0.04	0.08	Food storage	0.08	0.03	0.11
Infrastructure	0.07	0.09	0.03	Transportation	0.08	0.05	0.09
Agribusiness	0.06	0.07	0.03	Agribusiness	0.06	0.05	0.07
Transportation	0.06	0.06	0.05	Markets	0.05	0.02	0.09
Food storage	0.05	0.06	0.03	Seed systems	0.05	0.06	0.02
Food systems	0.05	0.03	0.06	Subsistence	0.04	0.00	0.09
Social-ecological systems	0.05	0.00	0.08	Urban	0.04	0.03	0.04
Water-energy-food nexus	0.04	0.04	0.02	Value chain	0.03	0.03	0.02
Seed systems	0.03	0.03	0.02	Food waste	0.02	0.02	0.02
Food waste	0.02	0.01	0.02	Water-energy-food nexus	0.02	0.03	0.00
Subsistence	0.01	0.00	0.02	Infrastructure	0.01	0.00	0.02

work to adopt a stronger “systems” perspective, in which the interactions between components of a system are considered and studied (Ericksen, 2008). In PICTs, the discrepancy between the reviewed research studies and projects is especially pronounced, with the latter generally framing food systems around only one or two components (primarily production), and the former taking a more holistic approach by examining multiple components of food systems. Less pronounced differences exist between the projects and research studies identified in Southeast Asia, although studies more regularly draw on social-ecological systems frameworks. Even still, social and ecological interactions are underrepresented in the food systems framings employed by the activities reviewed for this study. As such, there is understandably a strong need for more interdisciplinary, multi-scalar, and dynamic conceptualizations of food systems, particularly in the context of resilience (Doherty et al., 2019).

Not taking a systems perspective can have implications for how resilient a food system actually is, and whether multiple stressors can be addressed. For instance, Davis et al. (2021) outlines the different environmental and economic forces that affect each component of the food supply chain, and the cascading impacts and feedback loops that could result. Without accounting for the system as a whole, these interactions would be overlooked. Furthermore, a systems perspective allows for the consideration of trade-offs that may exist. For instance, trade can increase the diversity of options within a food system to complement domestic production, processing, and storage; however, an over-reliance on trade may lead to vulnerabilities

when a disturbance impedes trade flows (Kummu et al., 2020), or if imported foods are not socially or culturally appropriate.

One of the apparent omissions in food systems framings within the reviewed resilience research studies and projects in the Indo-Pacific deals with the relation of food loss and waste to resilience. Approximately one-third of food intended for human consumption is lost or wasted (FAO, 2017), contributing to greenhouse gas emissions and environmental degradation, as well as reducing food supply to meet food security needs. Yet our results showed that in terms of food systems conceptualizations, food loss, processing, and storage are all rarely included. Processing and storage are important for reducing the chance of food spoilage (Augustin et al., 2016), and food loss and waste can include both post-harvest and post-consumer waste (Hodges et al., 2011). In less developed countries, food loss mainly occurs during production, the post-harvest period, and storage or processing stages (Vilariño et al., 2017). For instance, in Southeast Asia, nearly three-quarters of food loss happens during agricultural production or right after harvest (Kummu et al., 2012). Conceptually, the role of food loss and waste in resilient food systems points to the importance of storage and processing, as well as the potential tensions between efficiency and resilience (Bajželj et al., 2020).

Finally, urban and peri-urban components of the food system not only account for a large portion of the population, but also draw on all other components. Including urban and peri-urban areas is particularly important considering the trend toward urbanization globally and the rapidity with which it

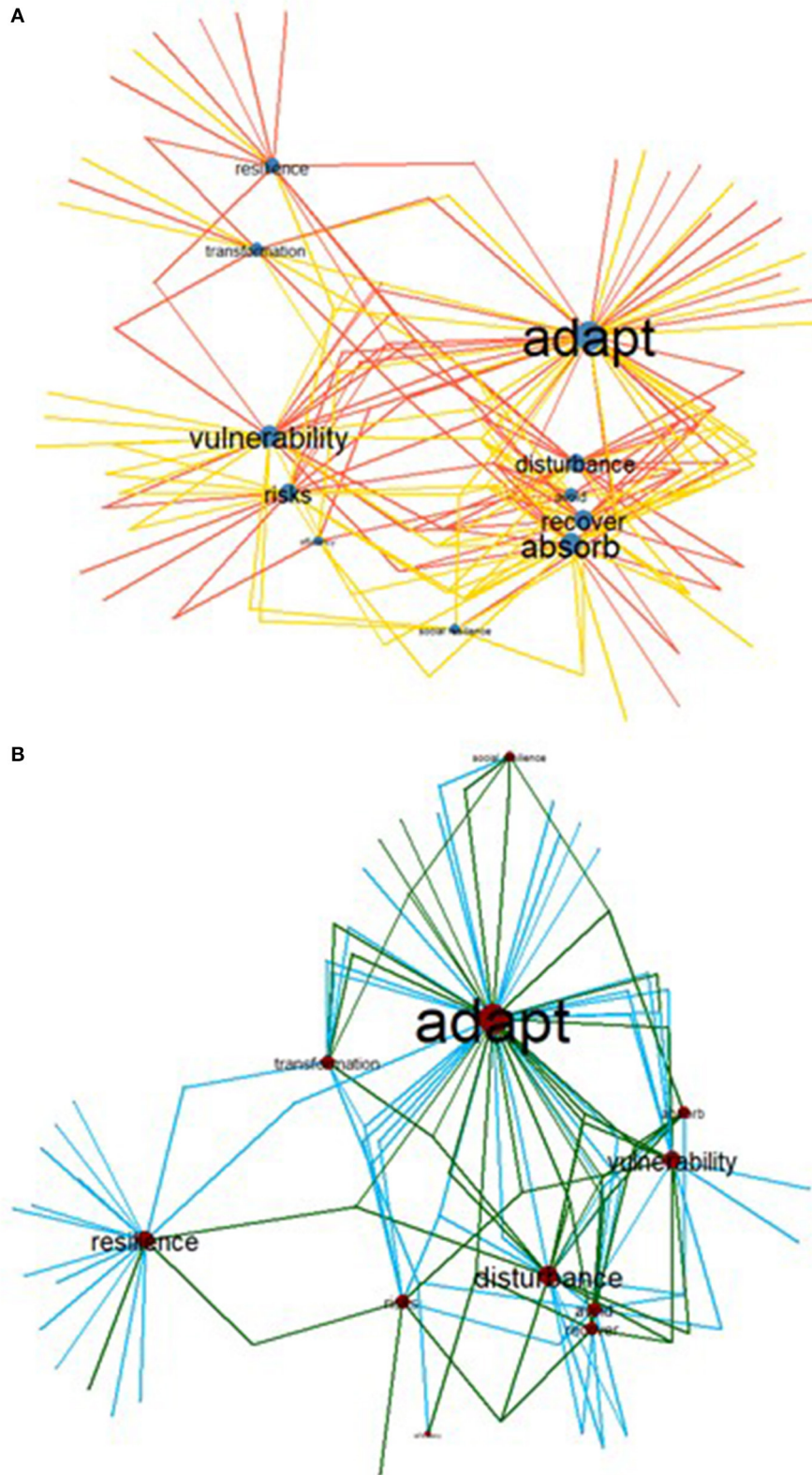


FIGURE 3 | Resilience definition codes used in **(A)** Southeast Asian projects/initiatives (red) and research studies (yellow), and **(B)** PICTS projects/initiatives (blue) and research studies (green). Chart shows degree centrality scores based on networks disaggregated by region.

TABLE 4 | Resilience codes ordered by degree centrality score a) Southeast Asia and b) Pacific Island Countries and Territories, and for projects vs. research studies.

a) Southeast Asia				b) Pacific Island Countries and Territories			
Code	Total	Projects	Studies	Code	Total	Projects	Studies
Adapt	0.48	0.47	0.41	Adapt	0.55	0.45	0.57
Absorb	0.28	0.18	0.33	Disturbance	0.24	0.16	0.30
Vulnerability	0.26	0.22	0.26	Resilience	0.20	0.24	0.08
Recover	0.21	0.20	0.19	Vulnerability	0.20	0.16	0.22
Disturbance	0.19	0.25	0.09	Avoid	0.12	0.14	0.05
Risks	0.19	0.17	0.19	Risks	0.12	0.10	0.11
Resilience	0.13	0.18	0.04	Transformation	0.12	0.10	0.11
Transformation	0.11	0.08	0.11	Recover	0.11	0.05	0.16
Avoid	0.10	0.08	0.09	Absorb	0.08	0.05	0.11
Social resilience	0.06	0.02	0.09	Social resilience	0.06	0.02	0.11
Efficiency	0.05	0.05	0.04	Efficiency	0.02	0.02	0.03

is taking place in the Indo-Pacific. However, it only plays a role in a small number of resilience projects and research studies examined in this paper. As Schipanski et al. (2016) notes, the urban components of food systems face particular challenges and vulnerabilities stemming from characteristics like dependency on imported (often internationally) food products and high incidence of social and economic inequality. Case studies in other parts of the world, such as the USA (Zeuli and Nijhuis, 2017), have shown how efforts to reduce food waste can contribute to urban food systems resilience by improving access for the food insecure and reducing strains on the environment. Similarly, Blay-Palmer et al. (2021) discussed how the City-Region Food System (CRFS) approach developed by the Food and Agriculture Organization of the United Nations facilitated resilience in the face of COVID-19, by supporting strong networks and multi-stakeholder groups, building necessary logistical infrastructure, and fostering coherent laws and policies.

Defining Resilience

Overall, establishing clear guiding resilience principles, modified according to contextual factors, could enable more streamlined resilience work in the Indo-Pacific's food systems, as well as provide clarity about the goals of projects and research. However, the projects we surveyed more often used resilience without definition or any indication of what was meant by the term, and the research studies cited a formal definition only around half the time. From the prevalence of references to adaptation in relation to resilience, and without clear indication of a definition, we might conclude that the terms are being used interchangeably. This conflation is evident even within policy documents at the international level, such as the UN Framework Convention on Climate Change's explanation of National Adaptation Plans, in which building adaptive capacity and resilience are used in tandem (United Nations Climate Change, 2021).

In relation to terms used to conceptualize resilience, transformation was underrepresented, which may be a reflection of how recently this term has come into use. However, it is also a growing area of interest in sustainability studies, and will

likely be an important component of food systems resilience research and programmes moving forward. Transformation involves fundamental structural, systemic, and enabling systems changes (Scoones et al., 2020), and it is also seen as necessary for long-term food systems sustainability (Lawrence et al., 2019; Sperling et al., 2020). A recent report of the Consultative Group on International Agricultural Research (CGIAR) illustrated the importance of mobilizing a large number of actions to achieve the required level of food system transformation (Steiner et al., 2020). This is further argued by Rockstrom et al. (2020), who call for food systems transformation in order to operate within planetary limits and meet sustainable development goals and climate change commitments. In their view, a global food system transformation entails shifting to diets that support both human health and ecological sustainability, altering policy and investments so they reconfigure food value chains and change consumption patterns, accounting for external environmental and social costs in the food system, and taking a truly interdisciplinary approach to food systems challenges.

Finally, social resilience was poorly represented in the resilience conceptualizations used in the reviewed projects and research studies. This observation aligns with the lack of inclusion of social components in the food systems framings, as well. While a socially-oriented resilience framing may be more common amongst grassroots and community-led activities not included in this review, it is also critical for projects and studies led by international and governmental institutions to broaden their approaches. Bringing in a social resilience perspective speaks to the importance of good governance and leadership, trust and social networks, empowerment, social justice, and collaborative learning and knowledge, in order to build capacities of individuals, groups, and organizations to respond and flourish in the face of adversity (Obrist et al., 2010; Maclean et al., 2014). The complex, multilayered, and inherently anthropogenic nature of food systems consequently requires attention for these social and cultural considerations. Expert panels have argued these social considerations, alongside embracing agro-ecological principles and innovations, are pivotal to ensuring sustainable transformations in food systems (HLPE, 2019).

Steps Forward and Caveats

This review provides a snapshot of the state of resilient food systems development projects and research studies carried out by academic, national, regional, or multilateral government, and non-governmental institutions in the Indo-Pacific region. It highlights areas to build on for future research and programs, particularly as the institutions scale up funding for sustainable development activities over the coming years. At this level, efforts to enhance food systems resilience in the PICTs require further attention to gender equity, whole value chains and markets, and urban-rural connections, while in SEA, more attention could go toward health and food security objectives, food storage and processing, and fisheries/aquaculture.

The results show an opportunity for future work to embrace complexity and interactions, as well as social considerations. Overall, resilience should be approached in a way that goes beyond adaptation and includes transformation and social resilience. Furthermore, considering that stressors can act as multipliers, and compounding disruptions can make those who are vulnerable even more so, systems approaches to understanding resilience are critical to developing and implementing appropriate interventions. Future research is also merited, which examines approaches that the private sector and local and traditional organizations offer to enhance resilience, which were not explicitly targeted in this review.

There are a number of caveats to this study that also point to areas of future work. First of all, this study is not exhaustive, and has likely overlooked some themes. For instance, some institutions have broad research programmes or themes on topics related to food systems resilience, but we only captured discrete initiatives, projects, and research studies. Examining these broader strategic priorities of lead and partner organizations could provide more guidance on future directions. Further research may also unearth additional themes related to political and social contexts - such as the state of participatory and democratic processes, land rights, and conflict - which were not evident in the projects and research studies included in this review.

Second, we focused on just two regions, and therefore did not capture opportunities that may apply more to South Asia

and beyond. This review could be expanded to other regions, for further comparison. Third, as a desktop analysis, this study took any documentation at face value, potentially overlooking what manifests on-the-ground in actuality. Complementing text analysis with key informant interviews would corroborate and enhance our understanding of the gaps and opportunities for resilience within Indo-Pacific food systems. Finally, while this study explored how researchers and project leads conceptualize food systems and resilience, this does not necessarily reflect how these concepts are understood and applied locally. An important next step would be to identify grassroots and community projects and to undertake qualitative research at local and community levels within the Indo-Pacific to gather how well the conceptualizations reviewed in this study reflect the local understandings and experiences.

AUTHOR CONTRIBUTIONS

SC and LL-C developed the original idea for the study. RF and RE designed and implemented the methods, analyzed the data, and wrote the manuscript. RF conducted the network analysis and created the figures. KR, LL-C, MW, and SC provided editorial input. All authors have read and approved the final manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fsufs.2022.714881/full#supplementary-material>

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