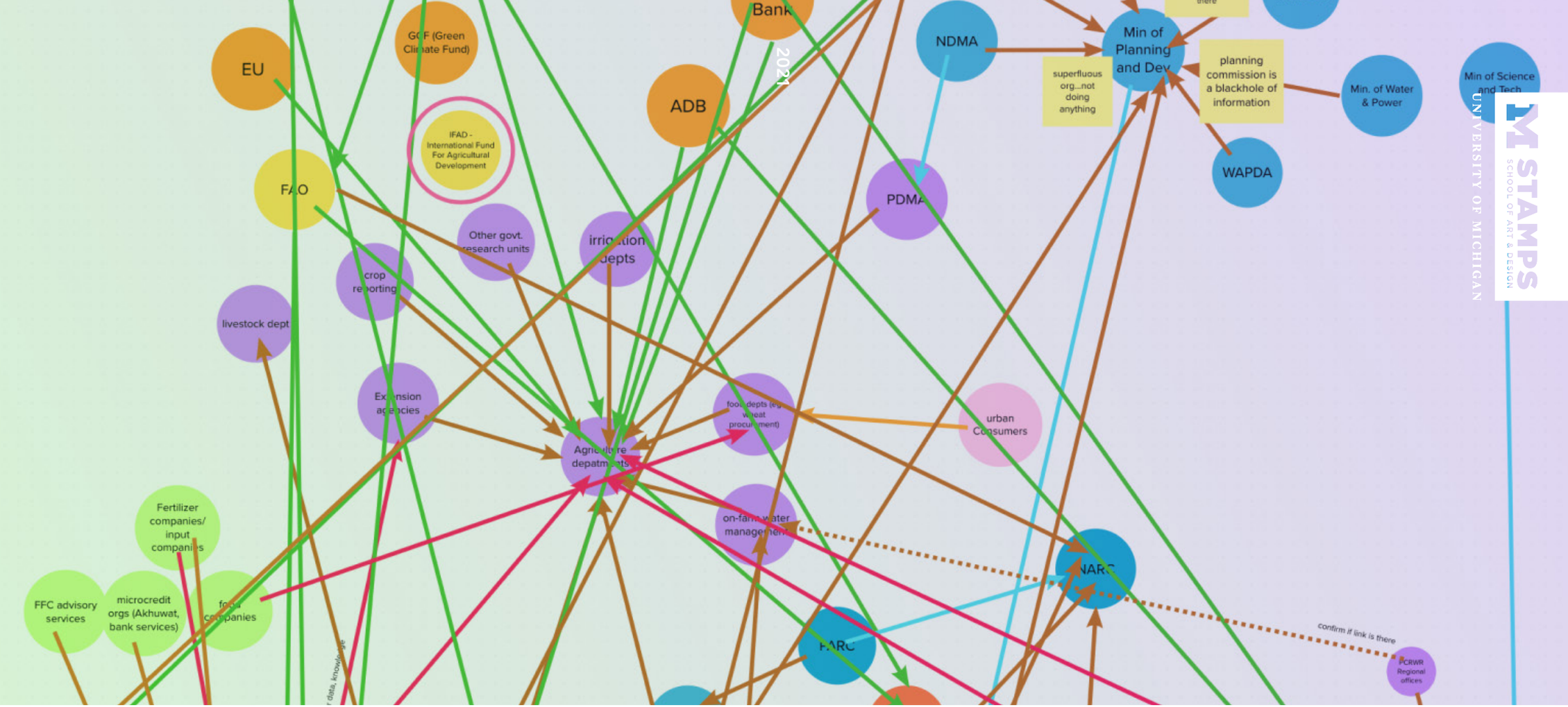

Najwat Rehman MDES '21

EQUITY AND ACCESS: FOOD SYSTEMS

ON THE SAME MAP: Gigamapping as a strategic tool to support Pakistan's policy response to climate change-induced food security vulnerabilities

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Candidates, MDes
University of Michigan
Spring 2021

STAMPS SCHOOL OF ART & DESIGN

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Contents

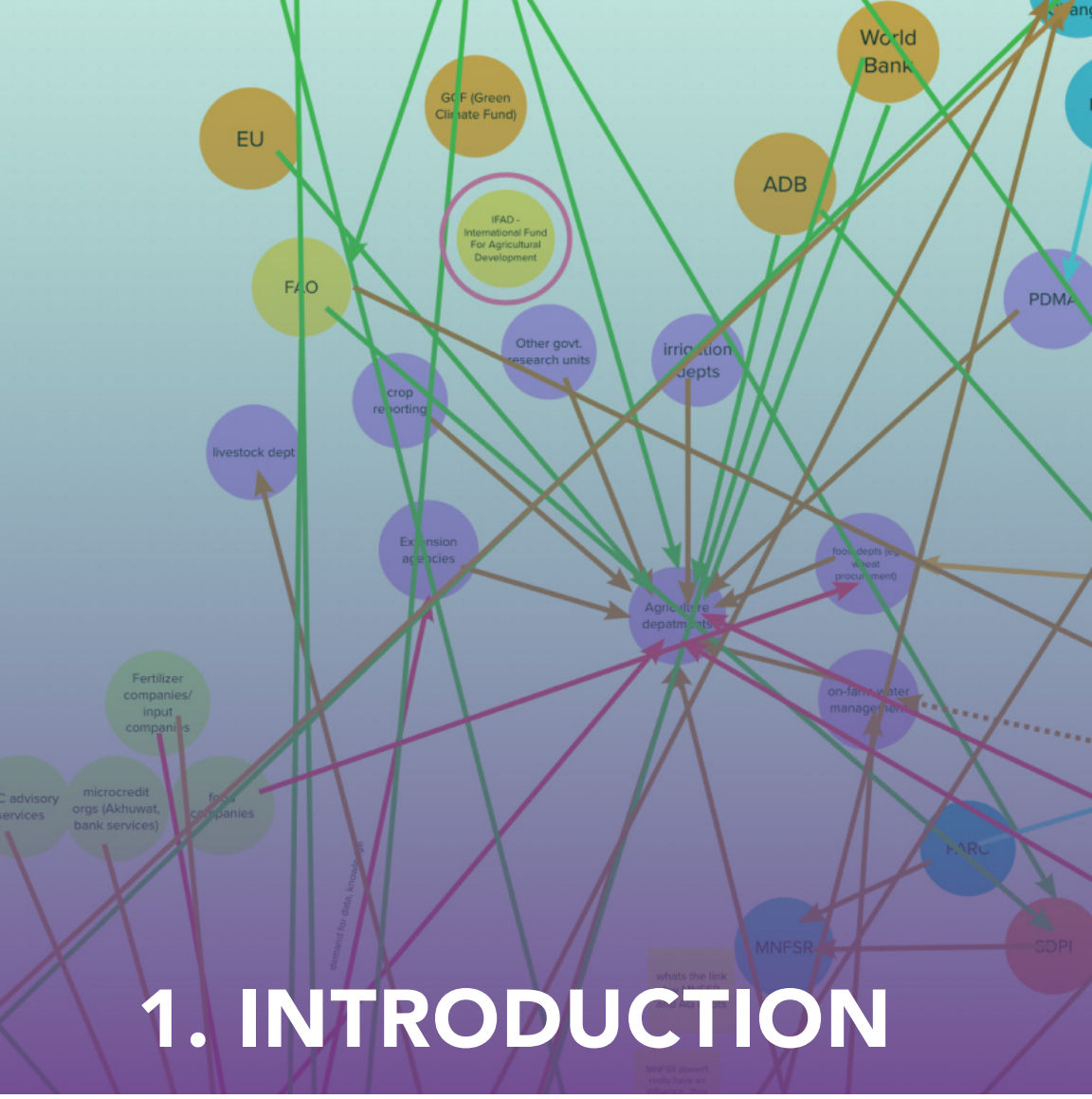
Abstract

Pakistan is the fifth-most vulnerable country to the long-term impacts of anthropogenic climate change, as reported in the 2018 Climate Risk Index by GermanWatch. In addition to posing other pressing challenges such as increasingly frequent heat waves and exceedingly devastating extreme weather events, climate change also threatens the bedrock of Pakistan's economy and society: agriculture. Changing weather patterns—unpredictable and unseasonable rains on the one hand and droughts on the other—affect sowing and harvesting schedules, impact water availability, and lead to events like last spring's locust swarm, jeopardizing the country's food security. Federal and provincial governments are drafting policies and programs to address these vulnerabilities, research institutes and academia are producing relevant, high-quality research, and a variety of donors are providing funding for many of these endeavors. Yet, experts contend that the country remains unprepared to effectively address its climate change-induced food security vulnerabilities. They identify a number of factors as contributors to this lack of preparedness: lack of effective collaboration between stakeholders, wavering political will, gaps in policy enforcement, and confusion about the effects of the Eighteenth Amendment which devolved some ministries from the federal to the provincial governments, including those in the agriculture and health sectors. Working in collaboration with food security researchers in Pakistan, this project explores whether a systemic design approach, and in particular gigamapping—a technique for collaboratively creating highly detailed maps of complex systems to understand them and find opportunities for interventions within—can help these researchers identify gaps and opportunities in the country's response to its climate change-induced food security vulnerabilities, allowing them to play a strategic role to support this decision making. The project also investigates the utility and viability of an interactive approach to gigamapping.

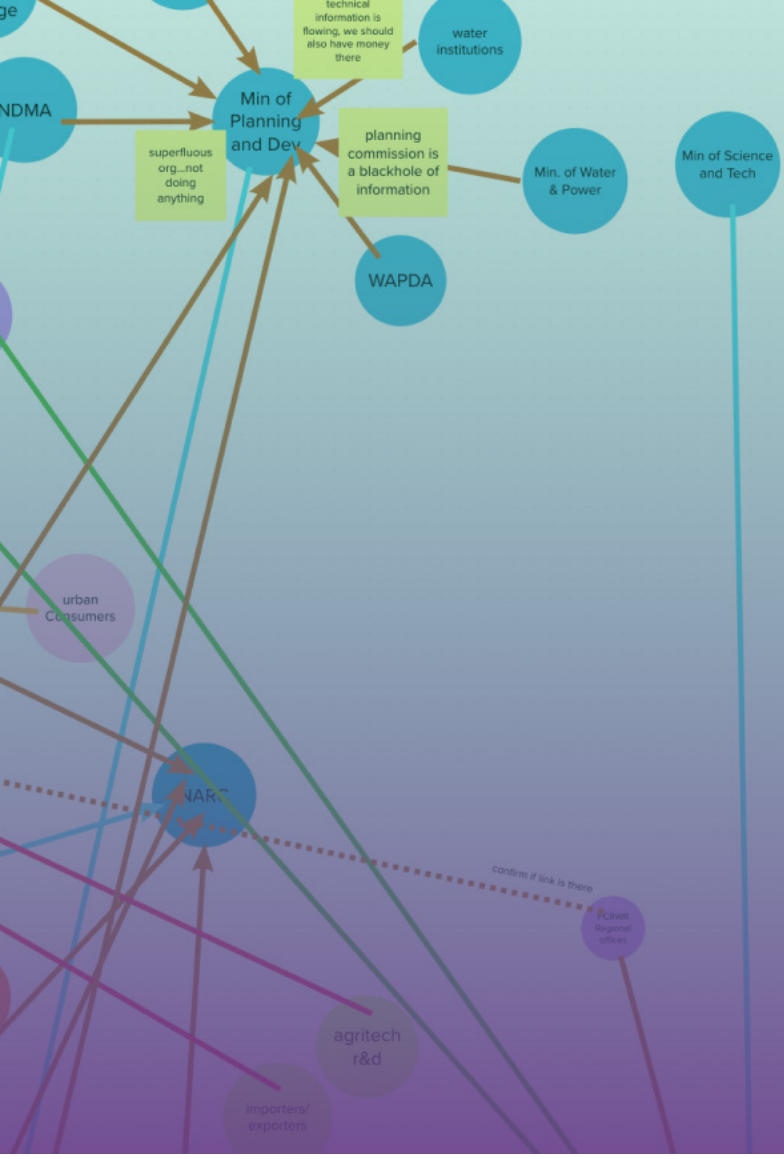
Keywords

Food security, climate change, systemic design, gigamaps, policy, policymaking, food systems, agriculture, pakistan, net-map, researcher

Figures



1. INTRODUCTION



Situated within the context of Pakistan's outsize vulnerability to climate change and the resulting threats to the country's food security, this project explores the value and viability of a systemic design approach, and in particular the gigamapping method, for food security researchers to understand the complex landscape of stakeholders and decision making to address the country's food security vulnerabilities. Systemic design is "a distinct practice emerging from the combination of systems thinking and design thinking [...], intended for situations

characterized by complexity, uniqueness, value conflict and ambiguity over objectives'' (Ryan 2014). Gigamapping, a key method in the systemic design toolkit, is a technique to "map out, contextualize, and relate complex systems, their environment and bigger landscape, their current state, as well as preferred future states" (Sevaldson 2018).

Responding to Pakistan's inadequate policy response to its climate change-induced food security vulnerabilities, this project creates, in partnership with food security researchers in Pakistan, a gigamap representing flows of research and technical information in the problem space and an interactive app to analyze and interact with gigamaps. The ultimate aim of the research and design outcomes is to help researchers support Pakistan's policy response to these vulnerabilities.

This project enriches integrative design practice by contributing a novel, virtually-mediated approach to mapping complex systems. Furthermore, the design outcomes and findings of this project contribute to the development of systemic design practice. As a recently developed practice, gigamapping offers opportunities for testing and development as a method of design inquiry and, along with the resulting maps as design artefacts, a way of understanding complex problem spaces and identifying gaps and opportunities for intervention.

1.1 Partner and Stakeholders

I did this project in partnership with Amna Ejaz, a seasoned researcher and development practitioner based in Islamabad, Pakistan. Up until recently, she was a Senior Research Analyst at the International Food Policy Research Institute (IFPRI), where her work centered around food and nutrition security and agriculture policy. She has worked on projects funded by organizations such as the United Nations Food and Agriculture Organization (FAO), United Nations World Food Program (WFP), United States Agency for International Development (USAID), and the European Union. She is currently Team Leader Research at the

Rural Support Programmes Network (RSPN) and is heading a randomized control trial centered around community-driven development.

In addition to Ejaz, I worked with a network of expert advisors that provided specific expertise and guidance on topics including soil science, water and irrigation, nutrition and health, hunger and access to food, climate change, and policy formation processes. This network features professionals on the ground as well as academics from organizations including the Government of Pakistan, Action Against Hunger, United Nations Food and Agriculture Organization, World Bank, International Food Policy and Research Institute (IFPRI), the University of Western Australia, COMSATS University and the University of British Columbia.

The stakeholders for this project are researchers working in the area of food security and climate change in Pakistan.

1.2 Project Context

Despite being a miniscule contributor to global carbon emissions, Pakistan is the fifth-most vulnerable country to the long-term effects of anthropogenic climate change. Rising temperatures, melting glaciers, catastrophic floods, and erratic rainfall have already ravaged the country socially, economically and ecologically: between 1999 and 2018, "Pakistan lost 9,989 lives, suffered economic losses worth USD 3.8 billion and witnessed 152 extreme weather events."(GermanWatch Global Climate Risk Index 2018). In addition to its many devastations, climate change also threatens agriculture (Chaudhry 2017), the bedrock of the country's economy and society (Arshad et al. 2017). Declining crop yields due to rising temperatures (Ali et al. 2017), falling fisheries productivity amid warming seas (Myers et al. 2017), and more dramatic events like last spring's locust swarm (Javed et al. 2020) are a few instances that presage the looming crisis of food insecurity. Given inadequate global action to limit carbon emissions and experts' increasingly dire predictions of rising temperatures, compounded by

the country's own limited financial and technical capacity to effectively address its vulnerabilities, this crisis will only grow worse: Dehlavi et al. (2015) report that with a +0.5°C–2°C rise in temperature, Pakistan's agricultural productivity will decline by roughly 8–10% by 2040. Other studies reached similarly concerning conclusions: International Institute for Applied Systems Analysis (IIASA) reports that by 2080, yield for all major crops will fall, forecasting a precipitous decline of 27% in wheat, by far the country's most important food crop. As noted in the ADB Climate Change Profile of Pakistan (Chaudhry 2017), "the yield changes, particularly in wheat production, are alarming for Pakistan, and likely require significant adaptation interventions."

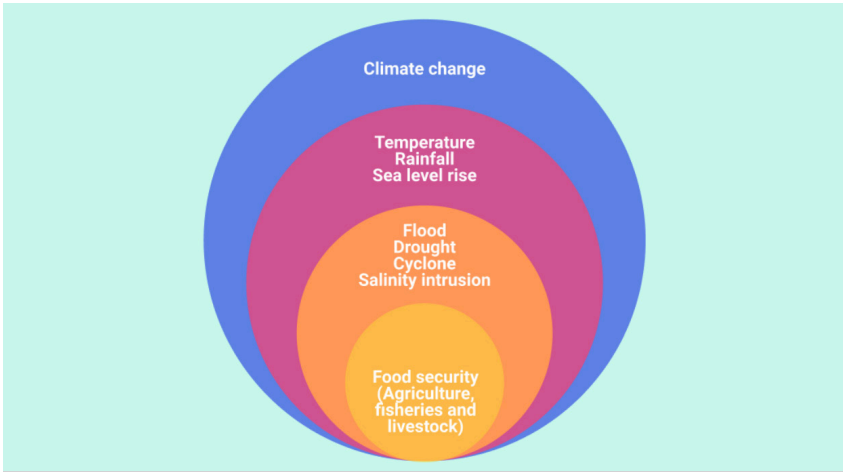


Figure 1: Impacts of climate change on food security (adapted from Rabbani et al. 2015)

Federal and provincial governments have enacted policies to address the food security impacts of climate change in the country. While the National Food Security Policy (Ministry of National Food Security and Research 2018) demonstrates an understanding of the importance of research-based policymaking and the intention of promoting the same, researchers point out the lack of on-ground action, citing a number of factors such as the policy workers' limited technical understanding, frequent personnel changes in government departments, political will

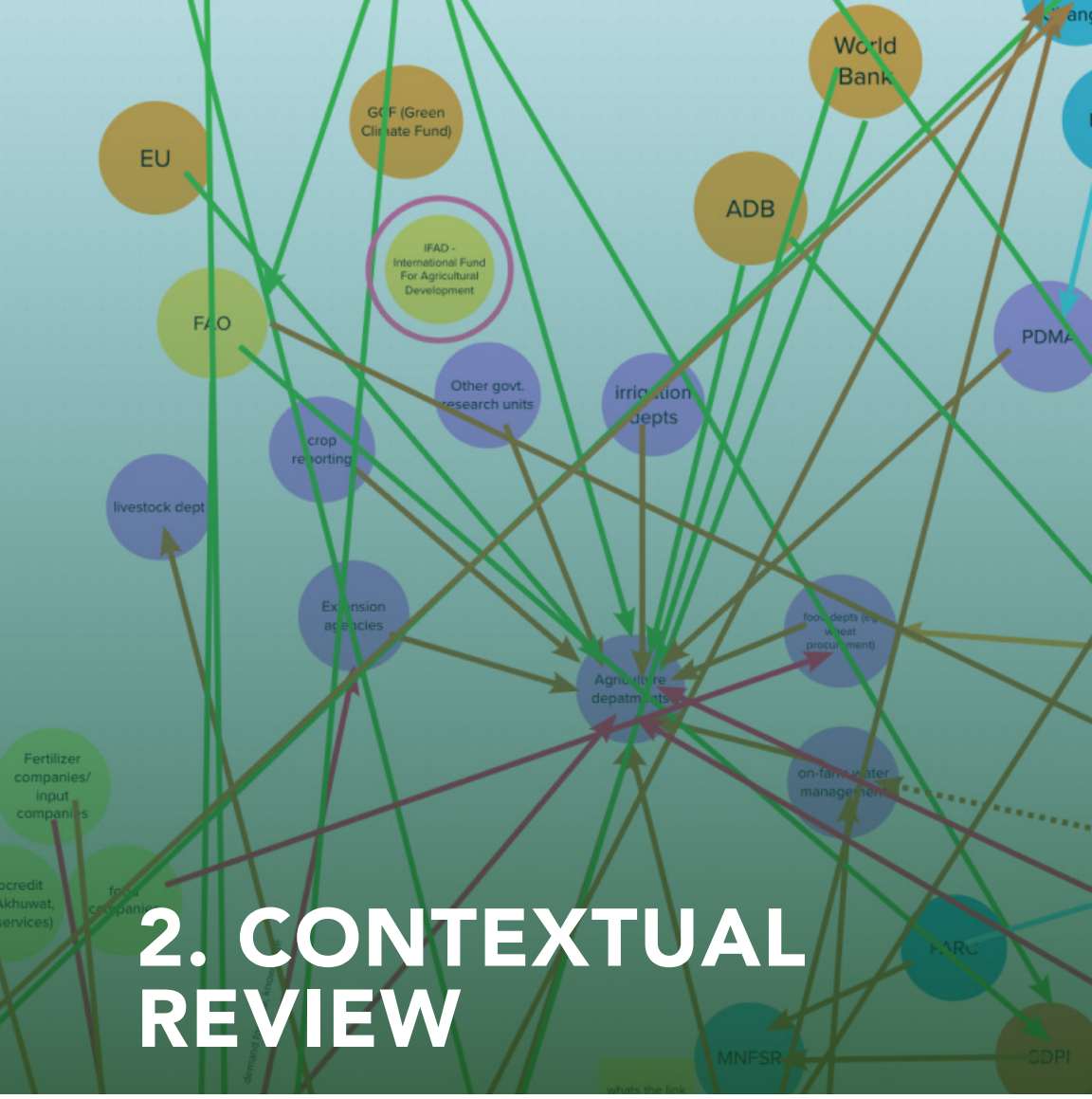
(or lack thereof), insufficient research budgets, and confusion about the effects of the Eighteenth Amendment which devolved some ministries from the federal to the provincial governments, including those in the agriculture and health sectors.

Furthermore, interviews with several stakeholders representing research and academia, local community organizations, funding institutes, government departments and non-government organizations working in areas such as soil science, water and irrigation, and hunger and malnutrition highlighted the lack of effective linkages between research and policy. This particular insight conflicts with the importance ascribed to linkages within policy documents and statements by prominent individuals. The National Food Security Policy, for one, repeatedly highlights the threats climate change poses to Pakistan's food security and emphasizes the need for better linkages between the various actors working in the field, including federal, provincial and local government units, academia, donor agencies, and research organizations (Ministry of National Food Security and Research 2018). Recognized experts such as Dr Abid Suleri, Executive Director of the Sustainable Development Policy Institute and a member of the Prime Minister's Economic Advisory Council, have highlighted the importance of these linkages (Suleri 2020), a point also echoed by current Prime Minister Imran Khan himself (Alvi 2020).

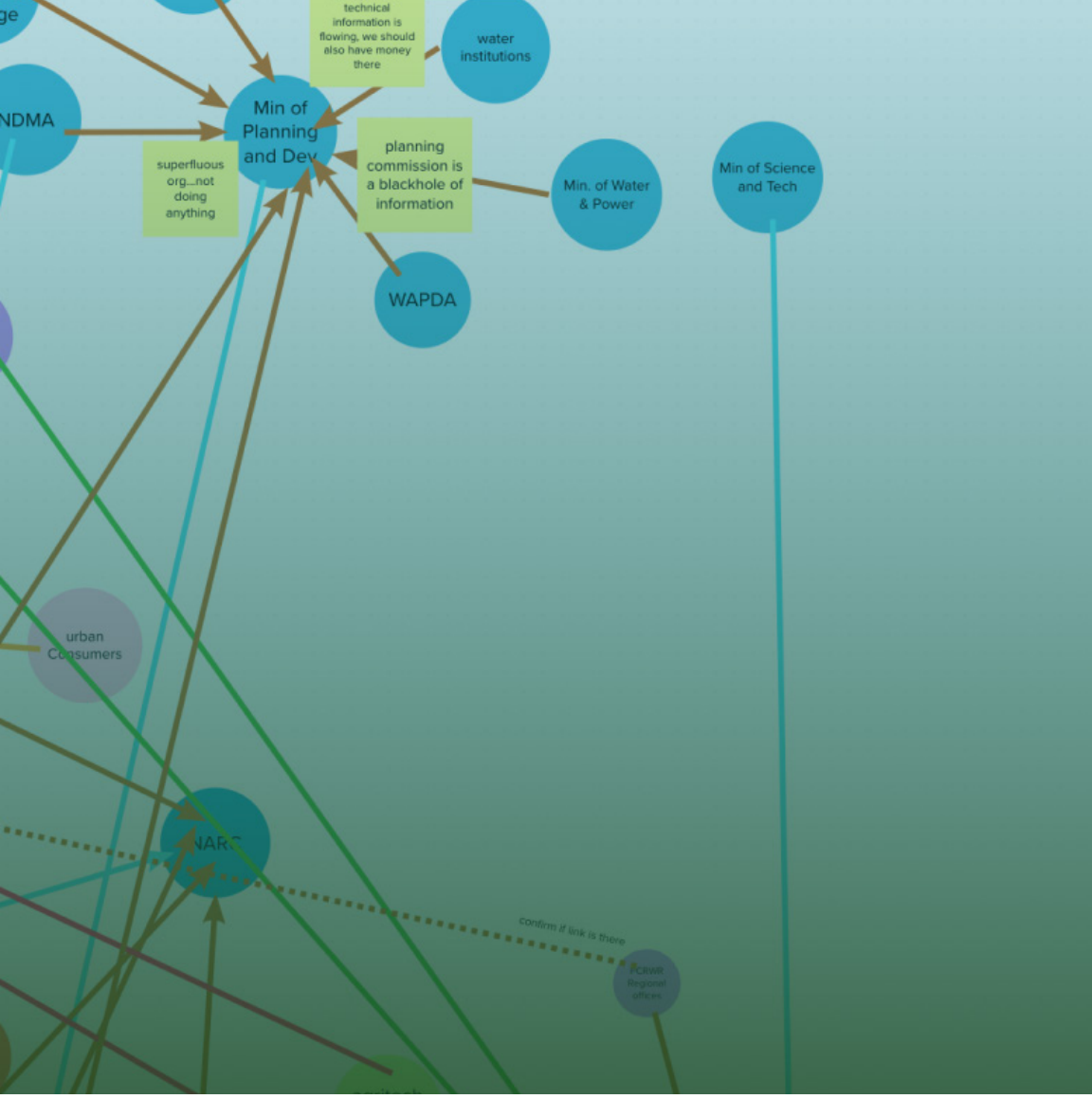
Our research, through interviews and generative design activities, helped us piece together a picture, necessarily incomplete yet revealing nevertheless, of the complex landscape of actors and their interactions. While the limited time frame of this project (under one year) is far too short a duration to understand the complete system, we framed our inquiry from the perspective of researchers—partners and constituents of this project—helping us go deeper into a few specific aspects of the system, such as the flow of research and technical information.

Researchers highlighted the challenges and frustrations of trying to

navigate this landscape, pointing out that it can often be hard to even know where a certain policy stands in terms of implementation, which ministry or agency is responsible for a certain aspect of food security (a researcher pointed out that it was unclear to her which government department controlled gas subsidies for the fertilizer sector), or how one can access reliable data on precipitation in Southern Punjab. Given this reality, it is important to first make sense of this complexity and understand the different actors, influences and other factors at play. Systemic design can help make sense of this landscape. Operating at the intersection of systems thinking and design thinking, systemic design allows us to adopt multiple scales of inquiry: at the macro level, systems thinking helps us understand the broader context, appreciate its complexities and identify patterns; and at the micro level design helps us zoom into people's experiences and stories to acquire a richer context. Furthermore, systemic design is flexible enough to accommodate methods from both systems and designerly realms, allowing us to map complex systems while simultaneously ideating and prototyping rapidly to improve the system as we are learning about it. Gigamapping, a key method within systemic design, focuses on mapping out and making sense of complex systems, helping identify gaps and areas of intervention. This thesis investigates: how can gigamapping help food security researchers in Pakistan identify gaps and opportunities in the country's response to its climate change-induced food security vulnerabilities?



2. CONTEXTUAL REVIEW



What is Food Security?

It is important to explain clearly what we mean by food security. Food security is a situation that exists "when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." (Ministry of National Food Security and Research 2018, quoting the World Food Summit Declaration 1996).

Figure 2: The four pillars of food security

Food security has "four main determinants, which are simultaneously improved to ensure adequate nourishment and nutrition for all segments of the population." These are:

Availability – "amount of food that is present in a country or area through all forms of domestic production, imports, food stocks and food aid. The agriculture sector is the mainstay of food availability in the country;"

Accessibility – "a household's ability to acquire adequate amounts of food regularly through a combination of produce, barter, borrowings, food assistance or gifts;"

Utilization – "safe and nutritious food which meets people's dietary needs. The food consumed has to provide sufficient energy to enable the consumer to carry out routine physical activities."

Stability – "stability must be present at all times in terms of availability, access and utilization for food security to exist." (Ministry of National Food Security and Research 2018)

Researching Pakistan's food security vulnerabilities arising from cli-

mate change, this project focuses on the fourth pillar of food security, stability. Pakistan's response to climate change-induced food security vulnerabilities is a complex web of policies at various stages of creation and implementation, varying flows of formal authority and informal influence, and stakeholders including myriad government units at the federal, provincial and regional levels, funding organizations pushing different interests and priorities, and research institutes producing substantial amounts of data and recommendations. My research with key informants across this landscape has highlighted numerous opportunities for design interventions, such as communicating research findings and clarifying the role of the Eighteenth Amendment. This particular amendment, passed in 2010, devolved powers from the federal to the provincial level in several areas such as agriculture and health.

However, given the immense complexity of this space (and wicked problems in general) any design interventions should only come after an intentional process of visualizing and making tangible the stakeholders, their interconnections, and the context within which these reside. Ezio Manzini (Manzini 2015) asserts that designers can contribute to making ecosystems more ready for active, collaborative and sustainable behavior not by changing the state of things, but by making them visible first. The issue of designing for visibility, Manzini notes, "is a broad one, ranging from catalogs and instruction manuals to maps and infographic systems." In this case, "given that we are dealing with complex problems and equally complex solutions, the issue of making them more accessible is certainly a crucial one" (Manzini 2015).

One way to visualize complex systems is through mapping them. "Making a map is a way to hold a domain still for long enough to be able to see the relationships between the various approaches, methods, and tools" (Sanders 2008). Sanders goes on to explain: "Maps are good for visualizing relationships. Maps can be useful for showing complexity and change." The value of maps is also highlighted by Fawcett-Tang (2008): "Maps give their readers the simple and magical

ability to see beyond the horizon."

While food security researchers in Pakistan have worked on visualizing this landscape and its dynamics through maps, these maps are outdated, relatively inaccessible and limited in scope. Most notable is the use of a method known as Net-Map to study the interconnections and linkages between stakeholders. Developed in 2007 by Eva Schiffer, a researcher at the International Food Policy Research Institute (IFPRI), Net-Map is "a social network analysis tool that uses interviews and mapping to help people understand, visualise, discuss, and improve situations in which many different actors influence outcomes" (Schiffer & Hauck, 2010). Blending a few different methods including social network analysis (Wasserman and Faust 1994), power mapping (Schiffer 2007) and stakeholder mapping, the maps are first co-created with system participants in a physical format, as pictured in Figure 3 and then turned into an image format representing complex systems including actors within them and their interconnections, as pictured in Figure 4.

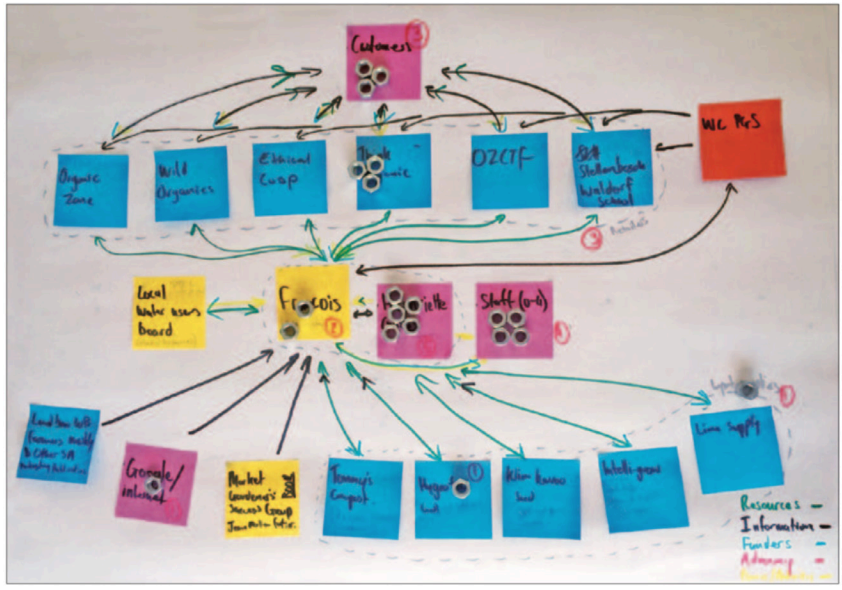


Figure 3: This picture from Metelerkamp and Schiffer (2020) shows the raw data collected for a net-map in a participatory design exercise

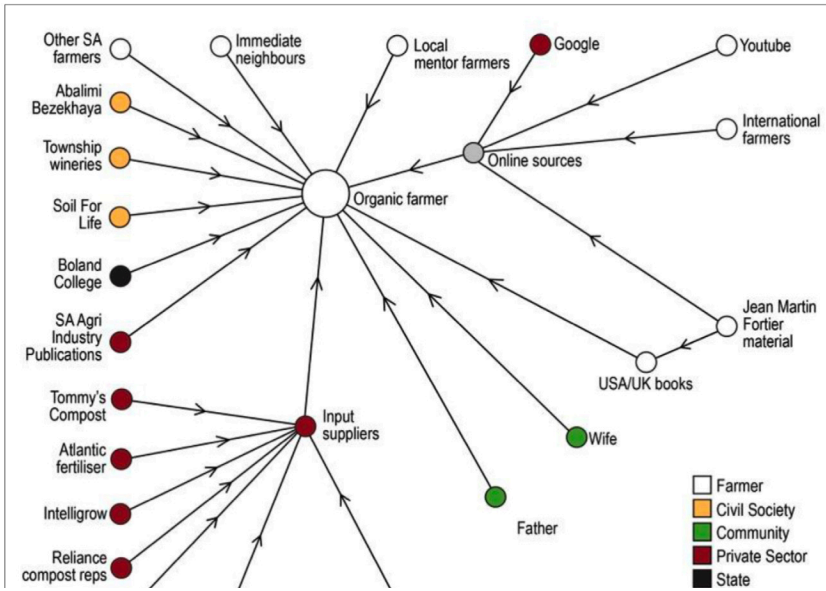


Figure 4: Combined Net-Map representing actors identified by farmers as their sources of information. Picture from Metelerkamp and Schiffer (2020)

Aberman (Aberman et al. 2013) notes:

"Net-Map helps people understand, visualize, discuss, and improve situations in which many different actors influence outcomes. By creating physical maps, individuals and groups can clarify their own view of a situation, foster discussion, and develop a strategic approach to their networking activities. The process can also help outsiders understand and monitor complex multi-stakeholder situations."

Undescoring Net-Map's potential utility for researchers, Schiffer (2007) highlights:

"Researchers often face frustration when their findings have low impact in policymaking processes. Net-Map can help users understand the flows of knowledge and the formal and informal ways in which policy decisions are made. Thus, researchers can become more strategic in linking their research with policy processes, thereby increasing its visibility and impact."

Aberman et al.'s 2013 study focused on irrigation and water policy in Pakistan and produced Net-Maps representing the Federal and Punjab levels. A Net-Map from this study is reproduced in Figure 5. In addition to the map, the study also identified key flows between stakeholders—formal authority, technical information, informal pressure, and funding. We also use these flows as a basis for our gigamap.

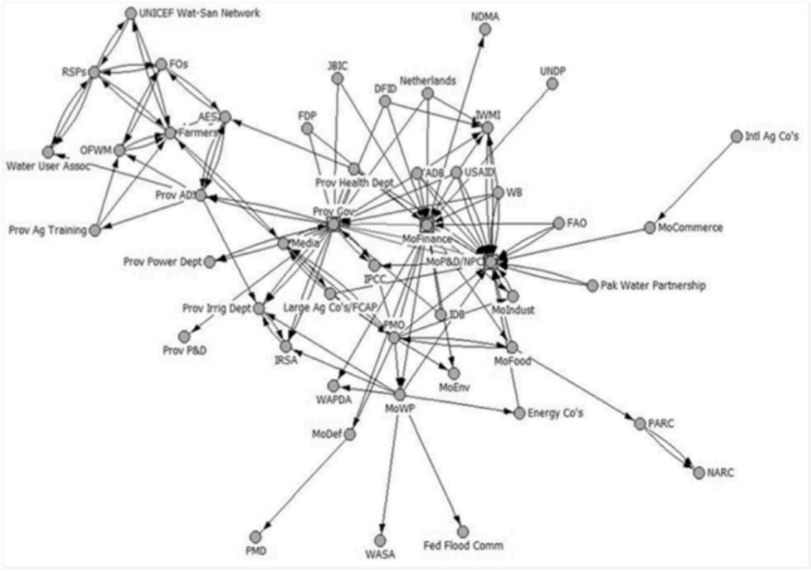


Figure 5: Aberman et al.'s 2013 study maps out the question: Who influences agricultural water management policy at the national level? (in Pakistan)

Another use of Net-Map can be seen in Mahmood et al.'s 2017 work on understanding infant and young child nutrition in Pakistan, in Figure 6.

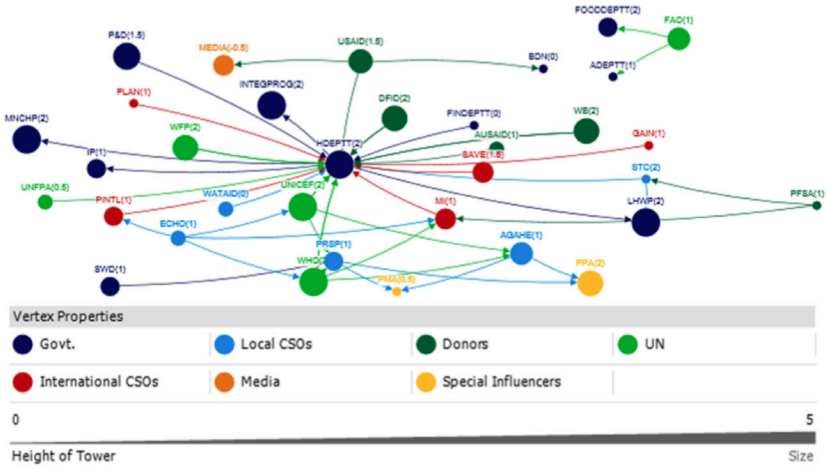


Figure 6. Net-Map from Mahmood et al. 2017

While the Net-Map methodology is useful for its collaborative nature and focus on highlighting complex interconnections and varying flows, the Net-Maps themselves are limited in impact because they only exist as static low-resolution images within academic papers or reports and are "hard to get much out of", as one of our research participants put it.

This leads us to ask: how can a design-led approach help in mapping complex systems to facilitate a better understanding of them? Systemic design, an emerging practice at the intersection of systems thinking—described as the science of interconnectedness—and design—described as the science and practice of "what might be" (Sevaldson 2018)—offers a way to make sense of the various actors and their interactions in this problem space. Sevaldson (2018) highlights the potential of this interdisciplinary approach, noting that while system thinking illustrates the interconnectedness of complex issues, design enables us to react and innovate as well as solve complex problems.

But before visualizing and intervening in a system, one must ask, "What is the system?" A system is "a set of interacting or connected

parts that form a whole. It is both its individual parts and the product of how those parts interact" (Systemic Design Field Guide). Jones (2017) posits that in systemic design a "predominant orientation to constructivist epistemology circumvents the issue of representation by understanding that all systems are defined by agreement rather than by their objective presence." In systemic design, the boundaries of the system are co-defined with system participants.

"The ultimate goal of systemic design is to co-design better policies, programs, and service systems with the participants in those systems" (Jones 2017). In pursuit of these better outcomes, systemic design takes a wide and diverse approach to adopting principles and methods from many schools of thought in systems and in design thinking. Jones (2017) further notes: "the objective of systemic design is to affirmatively integrate systems thinking and systems methods to guide human-centered design for complex, multi-system, and multi-stakeholder services and programs across society."

Given this focus on complex systems and an intention towards "what might be", systemic design is well-suited to investigate the landscape of decision making to address Pakistan's food security vulnerabilities arising from climate change.

Gigamaps — Embracing Complexity:

Within systemic design, a key method of inquiry is gigamapping (Ryan 2014), a technique to "map out, contextualize, and relate complex systems, their environment and bigger landscape, their current state, as well as preferred future states." (Sevaldson 2018). An inclusive, undogmatic and flexible tool (Sevaldson 2018), gigamaps help designers deal with complexity in expansive, multi-layered problem spaces. Birger Sevaldson of the Oslo School of Design and Architecture has pioneered gigamapping over the past decade and describes them as "rich multi-layered design artefacts that integrate systems thinking with designing as a way of developing and internalizing an understanding of

a complex field" (Sevaldson 2011).

There are a few crucial points that differentiate gigamaps from information and data visualizations and other approaches to mapping. Information and data visualizations typically are communicative artefacts that are meant to present information in ways that aid cognition; they are designed to improve the clarity, utility and persuasiveness of information (Ware 2019). Sevaldson (2011) notes that conventional diagrams, with exceptions, tend to represent information in limited ways, with a propensity to over-design to achieve tidiness and clarity. This overdesigning, however, comes at the cost of the complexity and richness that characterize the actual situations and problems these diagrams represent. Gigamapping does not share these goals of achieving clarity and 'cognitive efficiency' (Ware 2019). In contrast to conventional diagramming and information and data visualization, gigamaps are not communicative artefacts. They are representations of complex systems and processes in which complexity and unresolvedness is not only accepted but actually desired. Instead of simplifying or idealizing the reality they represent, gigamaps reflect the complexity of the reality as much as possible. The designerly urge to order information is not allowed to take over. While mapping and visualisation might be seen as ways to order, simplify and 'tame' problems, gigamapping is not a problem-taming methodology (Sevaldson 2018). "Wicked problems are not resolved through 'taming' and framing. Gigamaps try to grasp, embrace, and mirror the complexity and wickedness of real-life networks of interrelated problems" (Sevaldson 2018).

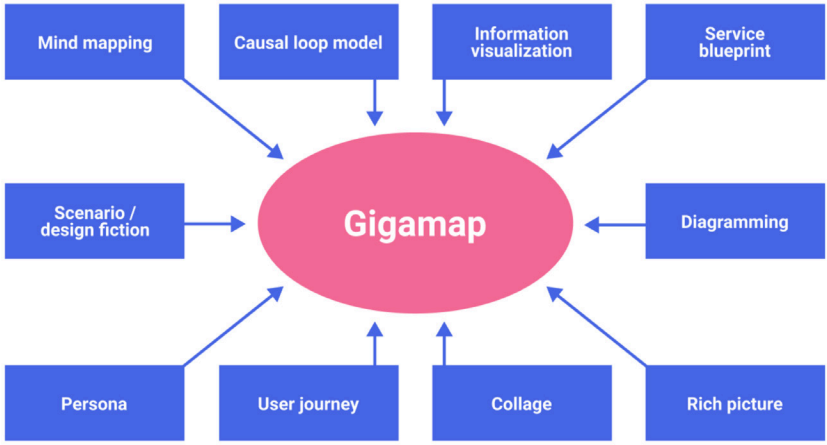


Figure 7: While there are several different ways of mapping complex problems, gigamapping is differentiated by its expansiveness and flexibility; a gigamap is a canvas that can contain any number or kinds of different information, including other maps. As this diagram shows, user journey maps, mind maps, personas and scenarios can be part of a gigamap, helping reflect the many different levels and kinds of facts, opinions and possibilities that characterize real world situations and systems that gigamaps seek to represent. Diagram adapted from Sevaldson (2018).

Gigamaps also differ from other approaches to mapping in their expansiveness. While elements of common mapping techniques such as stakeholder, ecosystem and journey maps can be found in gigamaps, gigamaps are flexible artefacts that can accommodate different kinds and levels of information: actors, linkages, processes, structures, and imagery, as well as insights drawn from the map and propositions to improve the system, all in one thick description of the problem space (Ryan 2014). Gigamaps are essentially versatile canvases that can be simultaneously descriptive and generative: as they describe the current situation, they can also contain ideas and insights for improving that situation. These ideas or insights may be in the form of written notes, visual scenarios or another form altogether. While the gigamap can be used as a source of information for generating other maps and artefacts that might be used as communicative or persuasive devices, the gigamap itself remains a vague and unresolved (Sevaldson 2018) collection of rich, complex information that can inform further insights and communicative artefacts.

Finally, while gigamaps are design artefacts that represent complex problem spaces, the process of creating gigamaps is an exercise in design inquiry that is just as important as the resulting artefact. Positioning gigamapping as a tool for design inquiry, Sevaldson (2018) uses Nelson and Stolterman (2012)'s definition: "Design inquiry is a special form of knowledge production at the same level as scientific and artistic inquiry. Design is concerned with different kinds of knowledges, including the sciences and arts, but what sets it apart is its focus on "what ought to be" rather than describing, analysing, and understanding "what is."" Moreover, the gigamaps created through an iterative process of research through design—a "research approach that employs methods and processes from design practice as a legitimate method of inquiry" (Zimmerman, Stolterman, and Forlizzi 2010)—are design artefacts that can aid further learning and inquiry into the system.

Leveraging their dual role as method of inquiry and design artefact, gigamaps can be used in a number of ways. Sevaldson (2011) highlights a few:

- "Learning: Mapping and coordinating pre-existing knowledge
- Research: Including and organizing knowledge gained from targeted research
- Imagination: Generative, iterative design
- Innovation: Defining areas and points for intervention and innovation"

The following examples of gigamaps demonstrate their versatility and richness:

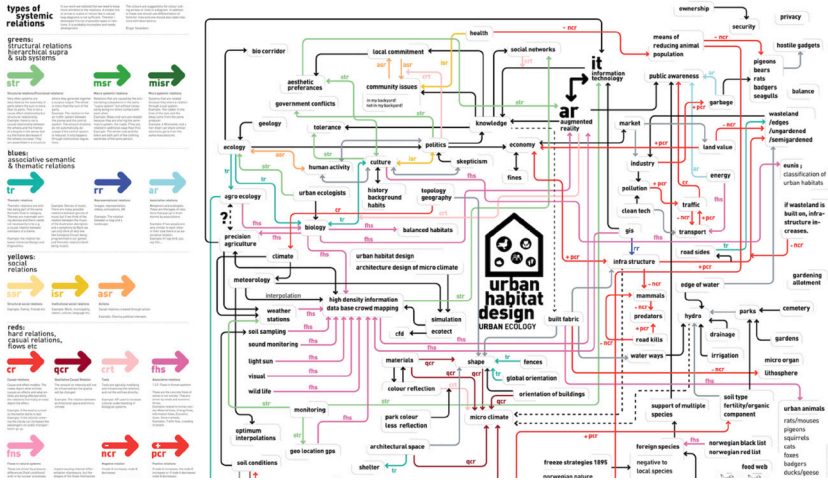


Figure 8: 'Types of Systemic Relations' (Young Eun Choi, Birger Sevaldson, AHO 2013)

The gigamap in Figure 8, 'Types of Systemic Relations' represents a variety of relationships entities on a map could have. For example, entities could have a causal relationship, as in the relationship between increasing the temperature on a thermostat and feeling warm, or a thematic relationship, such as the one between universal design and ergonomics.

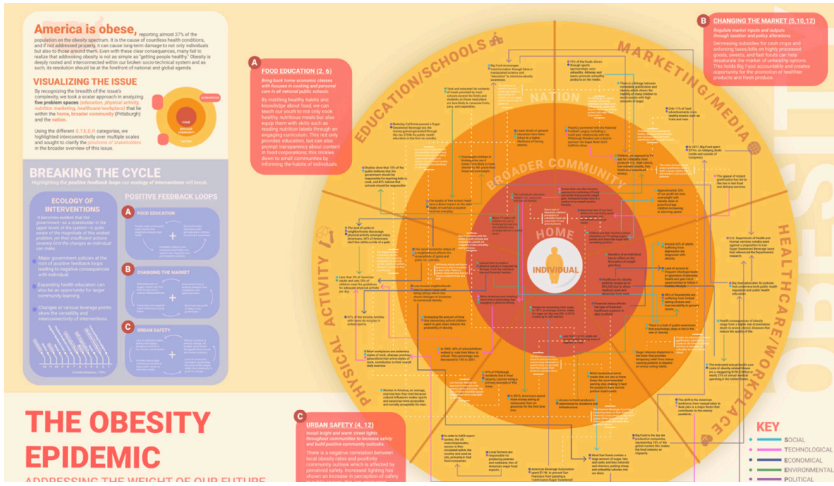


Figure 9: 'The Obesity Epidemic: Addressing the Weight of Our Future.' (by Bhakapol Bhakdibhumi, Chris Han, Jasmin Kim, Holly Liu, Francis Park)

Figure 9 shows a map created by a group of Carnegie Mellon University students representing a perspective on the obesity epidemic in Western Pennsylvania. Highlighting five "problem spaces" that play a role in the obesity epidemic (marketing/media, healthcare/workplace, nutrition, physical activity and education/schools), the map draws social, technological, economical, environmental and political connections as well as highlights case and effect relationships. In addition to representing information about the problem space, including stakeholders and flows of value, the map also offers recommendations, such as installing street lightning to increase urban safety, which can in turn encourage healthier behaviors within communities.

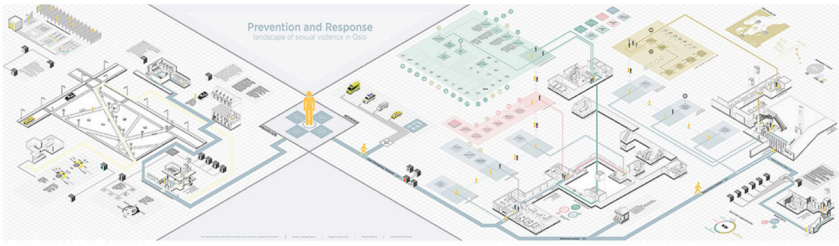


Figure 10: 'Prevention and Response: Landscape of Sexual Violence in Oslo'. For Legevakten, Manuela Aguirre Ulluoa and Jan Kristian Strømsnes, AHO 2012

The map in Figure 10 represents a patient's journey through the Sexual Assault Center in Oslo. The map combines information about infrastructure (such as transport options, qualities of physical facilities) with details about the emotional and social experience of an assault victim as they interact with the legal and medical systems.

As these examples demonstrate, gigamaps can take any visual and structural form, based on the nature of the problem/issue being explored.

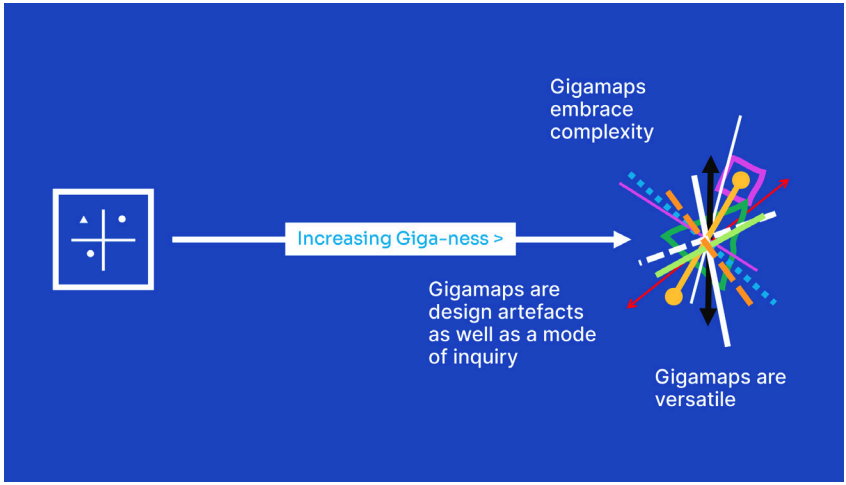


Figure 11: Key qualities of gigamaps.

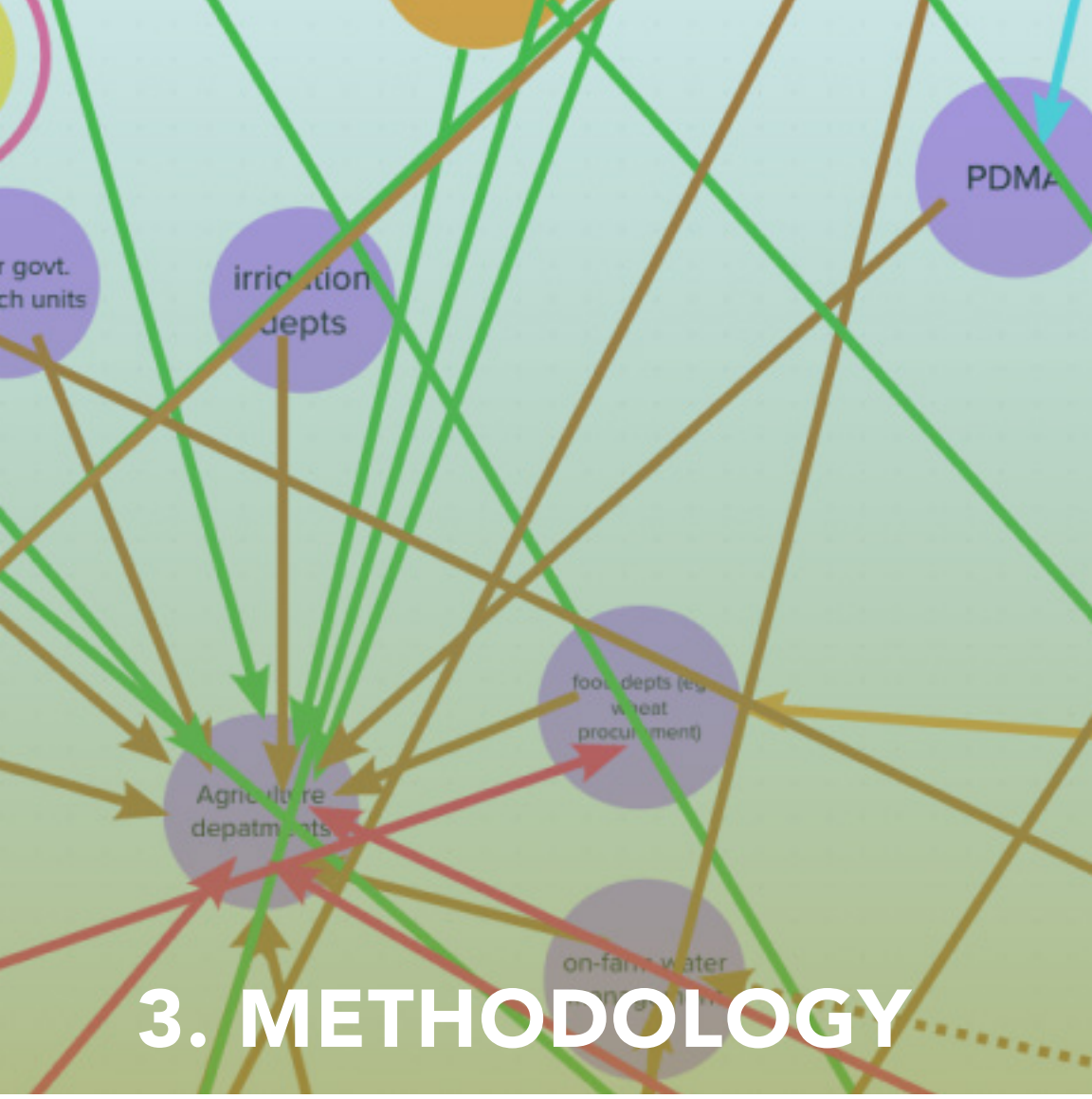
As a still relatively new practice, gigamapping offers opportunities for testing and development as a method of design inquiry and as a design artefact for understanding complex problem spaces. While the gigamaps shown here exemplify the diversity and flexibility of the practice, there are also opportunities to improve them. In particular, Sevaldson (2011) highlights animation and interaction in gigamapping as areas of potential development. Interactivity can help in navigating the complex, dense nature of gigamaps, which can make them unwieldy and defeat their very purpose of facilitating understanding of complex problem spaces. In this project we develop dynamic, interactive gigamaps using collaborative mapping software. Keeping gigamaps scalable and editable, we are able to dynamically represent the fraught, emergent nature of complex systems the maps represent. This is in contrast to the comparatively polished, finished gigamaps presented above which, in their static format, imply a certain sense of finishedness in representing their respective problem spaces.

About virtual design research

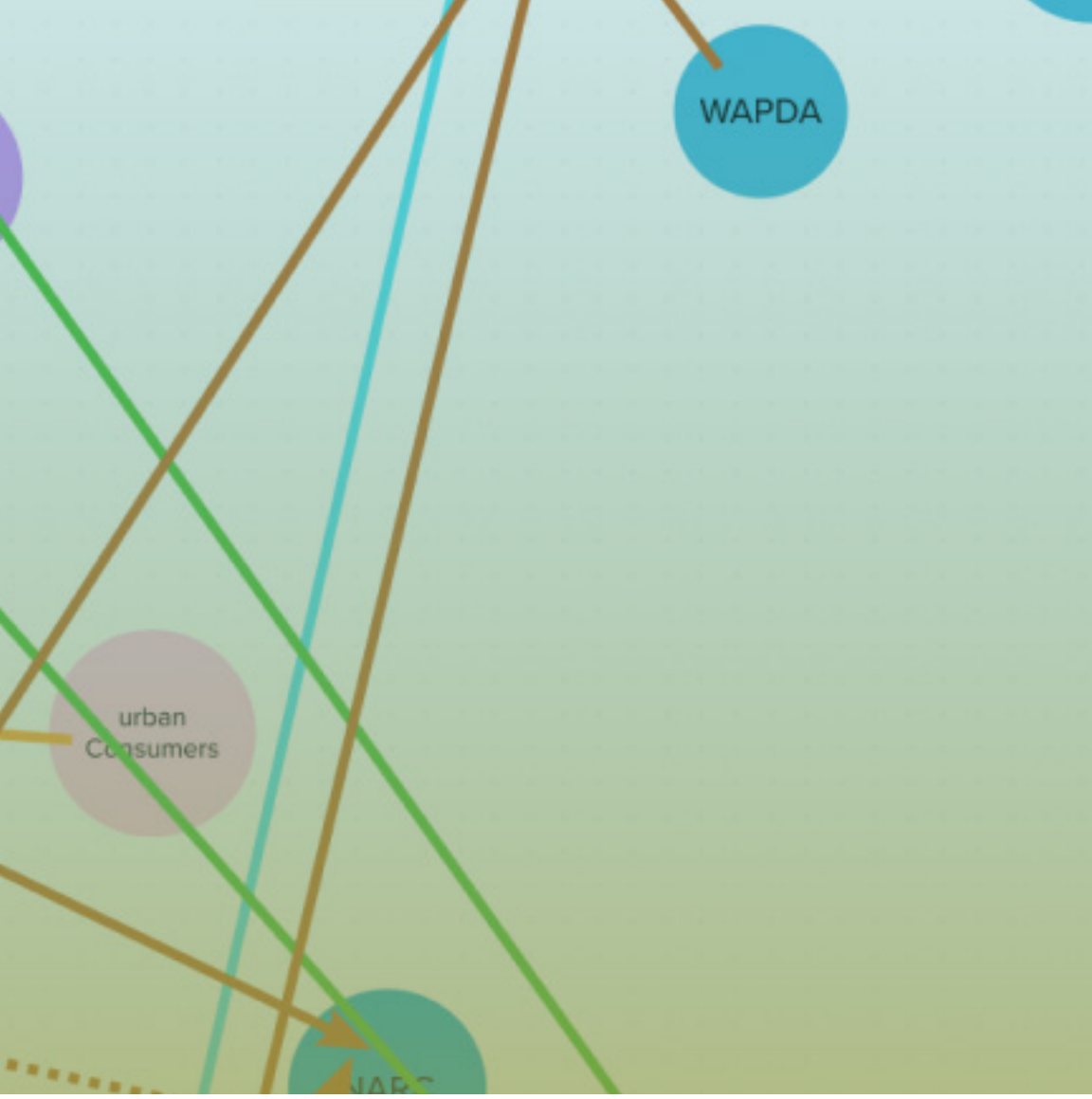
The pandemic required this research to be done remotely and, as a result, we developed new virtual ways to facilitate generative design

research activities. While online design research offers a way to engage broader, more diverse audiences in general, it is an especially important topic of inquiry in the context of the current pandemic and its likely lasting effects on how people work, collaborate and learn.

Perhaps in part due to the pandemic's recency—indeed, it is still ongoing at the time of this writing—there is a dearth of published research on the strengths and limitations of virtual generative design research, particularly that using collaborative workspaces like Mural, which was used in this project. While the Mural website features a number of case studies of the software in use, most of these are about distributed design teams collaborating remotely, rather than designers facilitating workshops with non-design participants, as was the case in this project.



3. METHODOLOGY



To reiterate, our research question is: how can gigamapping help food security researchers in Pakistan identify gaps and opportunities for interventions in Pakistan's response to its climate change-induced food security vulnerabilities. The virtual nature of the project influenced the research strategy, selection of methods and approach to facilitation. We discuss these considerations and detail our research framework in this section.

3.1 - Design Framework: Systemic Design

Given the complex network of actors and linkages that characterize the project's problem space, we chose systemic design as the guiding discipline and within that used a framework of mindset, methodology and methods (Ryan 2014) to shape our research strategy, inform our design decisions and underline our cycles of reflection.

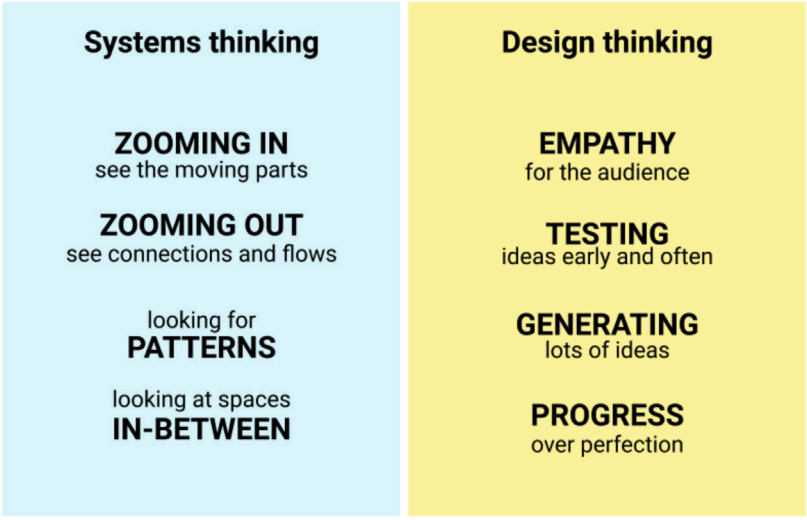


Figure 12: Qualities of systems thinking and design thinking (Adapted from Think-JarCollective.com)

Situated at the intersection of systems thinking and design thinking, systemic design is a practice "intended for situations characterized by complexity, uniqueness, value conflict and ambiguity over objectives" (Ryan 2014). While systems thinking allows us to investigate complex systems and understand how parts interact to form the whole and how the whole interacts with the wider context, design thinking focuses on the people-level experiences within the system and excels in ideating and prototyping solutions. When combined into systemic design, we are able to operate at multiple scales: at the macro level, systems thinking helps us understand the broader context, appreciate its com-

plexities and identify patterns; and at the micro level design helps us zoom into experiences and stories to acquire a richer context.

Furthermore, systemic design is a pluralistic, flexible practice that can accommodate methods from both systems and designerly realms. Gigamapping is an example of a method that is both systemic with its focus on the big picture and interactions and, with its focus on visualization, designerly.

Figure 13: The three levels of systemic design. Adapted from Ryan 2014

The three interrelated components of this framework, mindset, methodology and a set of methods, are discussed in the following sections.

3.1.1 - Mindset

Ryan (2014) posits that systemic designers must be inquiring, open, integrative, collaborative, and centered. These characteristics—and mindsets associated with each as shown in Figure 14—are crucial as systemic designers work on challenges and situations marked by complexity, emergence, and uncertainty.

Figure 14: Characteristics and values of systemic designers. Adapted from Ryan (2014)

Mindset is defined as "the values and habits the systemic designer brings to the challenge, which guide judgement during the application of methodology and shape selection of methods" (Ryan 2014). Values are defined as "conceptions of the desirable that guide the way social actors (e.g. organisational leaders, policy-makers, individual persons) select actions, evaluate people and events, and explain their actions and evaluations'' (Schwartz, 1999).

These characteristics also help achieve a diversity of perspectives and ideas in a systemic design project. By remaining open to new information and framings, through engaged and integrative collaboration with

diverse stakeholders, and through regular reflection, systemic designers can avoid approaching complex problems through binary, limiting lenses.

Enabling me to approach the challenge with both courage and humility (Ryan 2014), this mindset allowed me to inquire frequently, remain open to reframing as I was constantly forced to widen my perspective, consider new pieces of information, and interrogate ideas and assumptions I had formed up until that point. An integrative and collaborative approach was central to this project as I set out to build a meaningful and productive partnership with research participants and the project partner, Amna Ejaz. Finally, being centered is something I have learned to be constantly in the context of this project.

3.1.2 - Methodology

Informed by the systemic design mindset and supporting it in turn is a methodology—"a logic for selecting and combining methods in a coherent sequence to move between deepening understanding of the challenge and generating actions to improve the situation." (Ryan 2014). Having its origins in Shimon Naveh's theory of systemic operational design (Naveh et al. 2009) and adapted from (Ryan 2014) this methodology is made up of five activities carried out in a recursive cycle: asking, framing, formulating, reflecting, and facilitating.

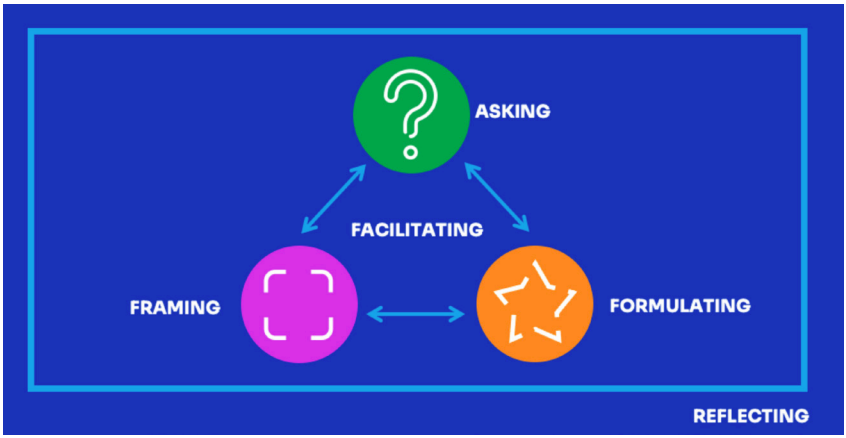


Figure 15: Systemic design methodology. Adapted from Ryan 2014

A brief description of each activity follows:

Asking refers to the process of seeking outside knowledge and perspective to inform and enrich the designers' knowledge base. More than gathering information, asking exposes external information and differing worldviews, offering opportunities for reframing (Ryan 2014). At the outset of the project and all through its course, I reached out to experts working on food security, climate change and related topics and learned about key issues in Pakistan's response to its food security vulnerabilities. Each new perspective helped expand and enrich my understanding of the issues: researchers identified the frustrations of communicating with decision makers while non-governmental organizations highlighted the difficulty of understanding the long-term impact of projects undertaken by government agencies. Given that I was an outsider to the highly specialized and technical problem space, deep inquiry was crucial in developing a robust enough understanding of the space to be able to propose relevant and meaningful design directions.

Framing is "a way of selecting, organising, interpreting, and making sense of a complex reality so as to provide guideposts for knowing, analysing, persuading, and acting. A frame is a perspective from which an amorphous, ill-defined problematic situation can be made sense of

and acted upon" (Schön and Rein, 1994). This activity provides a shared frame of reference and understanding for the design team. The framing of this project was informed by the role of the project partner and our research network. This project went through a few reframings before arriving at the current frame, which views the system through the perspective of researchers and investigates the value of the gigamapping method in helping them identify gaps and areas of opportunity within it.

Formulating shifts the team's focus from understanding what is, to imagining and testing what could be. This activity deals with prototyping ideas and visions to improve the situation and testing them in the real world. I formulated future visions throughout the research process. At the earlier stages, I focused on research communication as the main design opportunity and prototyped a highly visual, speculative method for researchers to communicate their findings to policymakers (Figure 16). As the project progressed, however, I zoomed out and started looking at the broader system of decision making, focusing on stakeholders and their interactions within it. At this point, I started prototyping mapping platforms, at varying levels of fidelity, to help make sense of the space and learn about different actors and their roles within it. Deploying the prototypes in the world serves two purposes: potentially affecting change on the system and providing learning opportunities for the team. Figure 17 shows an early prototype of the interactive mapping app which is discussed in detail in the design outcomes section.

Facilitating "regulates how the team moves between each of the other activities, as well as managing the process by which each individual activity is performed." (Ryan 2014). Facilitation was an important part of the project given the highly collaborative nature of the research activities and the fact that the project is situated at the intersection of two very different fields: design and food security research and policymaking. In addition to helping the team move between research activities,

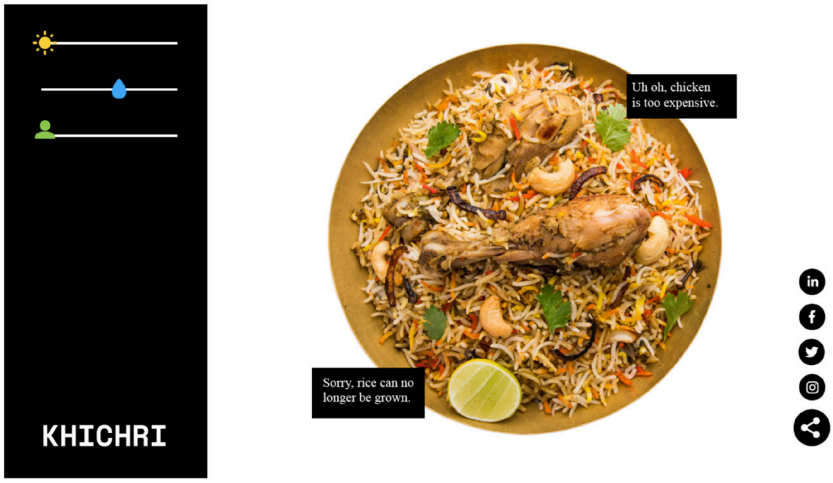


Figure 16: Early mockup of an app for researchers to communicate findings about food security vulnerabilities arising from climate change (Stock photo: Shutterstock)

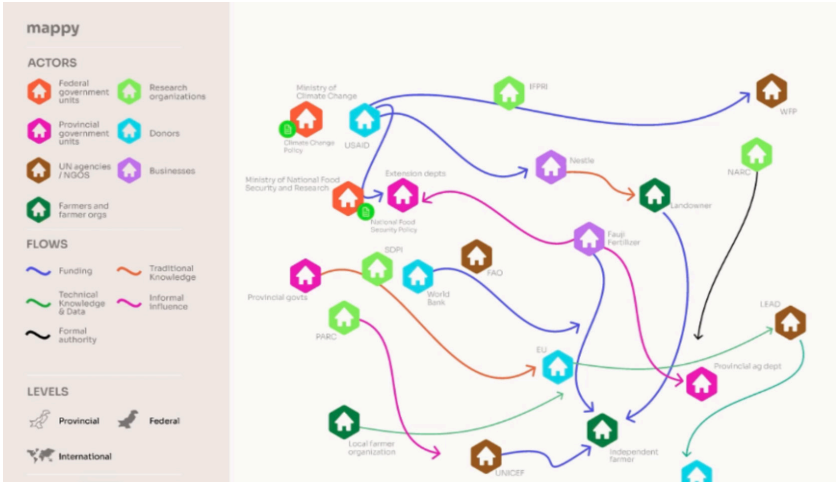


Figure 17: Early prototype of interactive gigamapping app.

facilitation is also concerned with how participants are involved in the research: how they are selected, how they are interviewed, led through design activities, which methods are used and how documentation is carried out.

Reflecting is an integral part of the systemic design process. Carried out as a team (Ejaz and I), reflecting helped us achieve a deeper understanding of the space we were designing in as well as the actions we were taking and the strengths and limitations of those actions. While reflection underpinned the course of our project, it was particularly prominent after the first design workshop, which was roughly the midpoint in the project timeline. We realized that working in the complex space, we had to first understand it before proposing any design intervention. Ryan (2014) notes: "reflection enables reframing, reformulating, and learning from generative actions."

These five activities combine fluidly to form a dynamic systemic design methodology. Reflection underpins the core activities of framing and formulating, often leading to changes in direction and focus as new insights are discovered and processed. Inquiring and facilitating help the project team stay aligned with the internal and external context.

In the course of the project, this fluid methodology is "not a closed circle but a spiral" (Carr and Kemis, 1986) where the "process of reflection directly informs the next stage of planning, and so on" (Carey et al. 2017). This project has been punctuated with regular reflection cycles (McNiff & Whitehead, 2006) and pivots of (re)orientation, particularly as the team learned more about the problem space and situated itself within it. In particular, the first workshop in November led to a phase of deep reflection: as the team processed the data generated through the workshop and collated it with earlier insights gathered through literature and interviews, it also examined the big picture of the project and its goals. This process led to the realization that before attempting any kind of design intervention, it is critical to fully explore and understand the problem space. We realized that before we could problem solve, we

had to problem *find*.

3.1.3 - Methods

In keeping with the idea of methodology as a spiral, the selection and execution of methods was also a fluid process, guided by and responding to the new insights and understanding I was developing throughout the research phase. “As tools, methods provide a set of criteria and constraints on task performance, which yields improved control both in terms of outcome and the structure of the task” (Baber 2003).

The systemic design framework I adopted is flexible enough to accommodate a variety of methods, including those from the realm of design and systems thinking. Design methods, having low barriers to entry, allow for playful, generative engagement in creating new possibilities. Building on this quality, systemic design methods “amplify or augment natural human capacities to facilitate collaborative reasoning, visualising, modelling, and making” (Ryan 2014).

While they are a critical component of research, Ryan (2014) warns against too much focus on methods, noting that an inflexible approach to methods can defeat the very purpose of systemic design. “Systemic design is intended to help teams to see a complex challenge in a different way, and to translate this ‘new seeing’ into novel interventions” (Ryan 2014). Applying the same procedures in the same order to every challenge is unlikely to yield new insights or disruptive results. The systemic design mindset supports the methodology and methods to ensure that there is unstructured space for exploration and divergence. An overreliance on methods can preclude the team from discovering unexpected results and can turn the dynamic process of systemic design into a mechanistic proceduralization.

Informed by this thinking, and responding to the project needs and trajectory, I used the following methods at different stages:

- Semi-structured interviews
- Design fictions
- Gigamapping
- Design workshops
- Online surveys

Semi-structured interviews

I used semi-structured interviews to gain a deep, contextual and nuanced understanding of the issues in the problem space. Representatives from academia, research institutions, funding organizations, non-governmental organizations, local community organizations and government units at the federal and provincial levels participated in these interviews. Main topics of inquiry were an assessment of Pakistan's climate change/food security vulnerabilities, the country's policy response, and the gaps and opportunities therein. I chose semi-structured interviews as a key research method because it offers flexibility. In the interviews, the predetermined question structure gave way to organic conversation as participants would point out an issue or topic that wasn't part of the guide but was nonetheless relevant to the discussion.

Due to the virtual nature of our project, Ejaz and I were able to reach a wide range of participants representing different stakeholder groups including government departments and community organizations. We spoke with people working in the federal ministries situated in Islamabad as well as small local organizations based in rural Sindh, one of the country's most impoverished parts.

The audio/video recordings, transcripts and field notes from these interviews were analyzed using affinity mapping: insights were placed on flipcharts and organized into themes as they emerged. Eventually, insights were grouped into six major themes: research communication,

lack of funding for research, government instability/churn, effects of the Eighteenth Amendment, political will (or lack thereof), and proactive/reactive approach of the government.

Online surveys

Online surveys were used to collect feedback on design prototypes. These short surveys were conducted via Google Forms.

Design fictions

Borrowed from the toolkit of discursive design, a practice in which "the primary design intention is not utilitarian in the typical sense but rather to communicate particular ideas and to rouse reflection" (Tharp and Tharp, 2018), design fiction, "the creation and use of real-seeming hypothetical objects, and other media, to explore imaginary narratives and contexts" (Hanington and Martin, 82), is a powerful tool to encourage generative thinking in participants. While not strictly a systemic design method, design fiction helped enrich the process of inquiry through its narrative and imaginative qualities. I used two design fictions during the first workshop as aids to help the participants get into a generative, design mindset and imagine future stakeholder maps that would reflect the scenarios depicted in the fictions.

The design fictions were made to appear realistic. It wasn't immediately obvious that the newspaper clipping and UN report were fake. Only upon closer examination did it become clear that the reports carried a future date and represented a scenario that appeared too good to be true for the present.

Gigamapping

An example of a method that is both systemic and designerly, gigamapping is "a technique to map out, contextualize, and relate complex systems, their environment and bigger landscape, their current state, as well as preferred future states" (Sevaldson 2018). Both a process of inquiry and a design outcome, gigamaps are "rich multi-layered

design artefacts that integrate systems thinking with designing as a way of developing and internalizing an understanding of a complex field" (Sevaldson 2011). Gigamaps are unique in their flexibility: they can combine actors, linkages, processes, structures, imagery, insights drawn from the map and propositions to improve the system, all in one thick description of the problem space.

Design workshops

A design workshop is a "form of participatory design consolidating creative co-design methods into organized sessions for several participants to work with design team members" (Hanington and Martin 2019). I conducted three workshops over the course of the project, employing research through design, a "research approach that employs methods and processes from design practice as a legitimate method of inquiry" (Zimmerman, Stolterman, and Forlizzi 2010). Through generative activities such as making stakeholder maps and gigamaps, we explored the problem space and created design artefacts. The online nature of this project allowed us to recruit a wide variety of participants representing different professional backgrounds as well as geographical locations. We had a PhD researcher in Australia, a government representative in interior Sindh, a researcher in Vancouver, and a representative from a non-governmental organization in Islamabad, in addition to others. In addition to providing this richness, facilitating workshops online also presented challenges, particularly in relation to generative design activities that were the key component of all workshops. These challenges and associated learnings are discussed in the Results and Discussion section.

Workshop 1 — November 2020

The first workshop featured participants from the Sindh provincial government, a non-governmental organization and a donor agency. Roughly two hours long, the workshop asked participants to work individually and in groups on design activities with the objective of uncov-

ering insights and values about the gaps present in the way research and policy interface in the area of climate change and food security. The main outcome of this workshop was a set of stakeholder maps depicting areas of concern and opportunity in the food security and climate change sector in Pakistan. Participants were asked to make two maps, one representing the current situation and one reflecting the future scenario depicted in design fictions. These design fictions included a fictitious newspaper clipping from the year 2030 representing a favorable scenario in terms of food security in Pakistan. The news clipping reports that not only has Pakistan overcome its food security vulnerabilities, it is also a model for other countries. This news report is supported by a similarly fictitious UN report from the same year that reports on highly positive indicators achieved by Pakistan.

Figure 18: Snapshot of the Mural board used for the online design charette, showing the stakeholder maps participants were asked to complete.

Using these design fictions, participants were asked to draw a stakeholder map from the future that represented this fictional scenario. Participants were also asked to draw connections using three kinds of arrows: green arrows represented strong connections, red arrows represented weak/poor connections and orange arrows presented connections that fell somewhere between the two. The participants

could also group/ungroup stakeholders, add/delete stakeholders and place them along the axes. The y-axis represented 'influence' on the problem space and x-axis represented 'interest' in the problem space. Finally, participants were asked to annotate the connections they made, using virtual post-its with descriptions such as 'technical know-how', 'budgets' and more, based on prior interviews with experts from the area. hand annotate the connections between stakeholders. Due to technical challenges (discussed in detail in the Findings section), only two participants completed their stakeholder maps and one had to leave before she completed the future stakeholder map. Nonetheless, the workshop yielded two stakeholder maps which helped our understanding of the actors and their linkages. I also followed up with other registrants who could not attend the workshop and scheduled one-on-one Zoom calls in which they completed the activity. Eventually, we were able to generate eight maps through one-on-one sessions and the workshop. Examples of stakeholder maps completed by some participants are shown below:

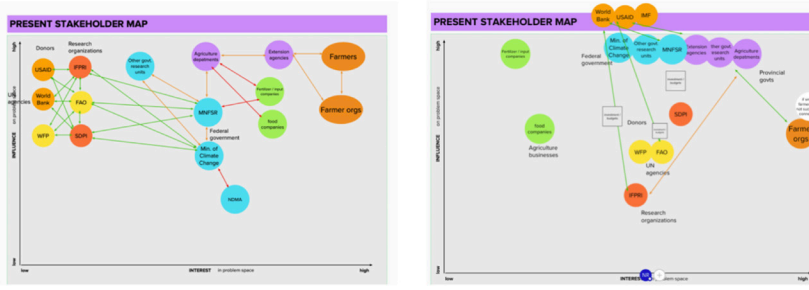


Figure 19: Stakeholder maps completed by participants of the design workshop

Workshop 2 — March 2021

The learnings from the first workshop guided the second workshop in March 2021. This workshop featured more interaction and discussion than the first one. Participants collaboratively created a gigamap representing the question "issues and opportunities in the way research is communicated to decision makers (from the perspective of research-

ers)."

The workshop underscored the value of rich, detailed and open-ended gigamapping as a tool for design inquiry. Participants reported that they found the activity to be useful in understanding the flows of information, authority and funding, and in discovering gaps and opportunities in the landscape.

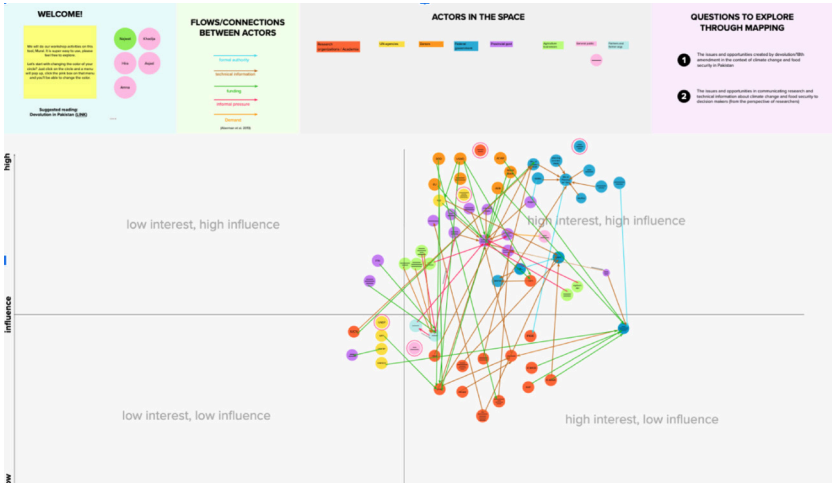


Figure 20: The Mural board used for workshop 2, with the gigamap created by participants

The second workshop was designed to take us deeper into two questions that we identified in our earlier phases of research: the issues and opportunities in communication scientific research (from the perspective of researchers) and the issues and opportunities in understanding the impacts of the Eighteenth Amendment. The gigamapping exercise took much longer than we had anticipated—a two-hour workshop scheduled to address both questions stretched to almost four hours, and only allowed us to cover the first question. The gigamapping generated in return, though, was rich with information on actors, their interactions and their relative influence on, and interest in, in the problem space.

We started the workshop with a prepared Mural board with a com-

prehensive list of actors (all the actors identified in our research so far), color-coded and categorized by kind (federal government actors, provincial government actors, research and academia, etc.) We also provided an organizing scheme to help participants get started on the activity as well as to understand the power dynamics of the landscape. This organizing scheme followed a standard stakeholder map quadrant model: interest from low to high on the x-axis and influence from low to high on the y-axis.

I invited four participants, and three were able to attend. Of these, one was about 45 minutes late, so the other two participants started the activity and briefed the third participant when she arrived. One striking difference between this workshop and the first one in November was the ease with which participants interacted with the technology, activity and each other. There was extensive, open discussion about the placement and connections of actors.

The outcome of this workshop was a detailed gigamap representing actors and their interactions in the context of Pakistan's food security landscape.

Workshop 3 — April 2021

A third design workshop was organized to analyze the gigamap built in the second workshop. Three participants, two returning from the previous workshop, participated in a roughly hour-and-a-half session.

Figure 21: The Mural board after the third workshop. Participants used ZIP analysis to mark areas of the map that needed more research, areas representing opportunities and areas highlighting apparent problems.

More focused than the previous workshops, which were more exploratory, we used ZIP analysis to draw insights from the gigamap. ZIP is an analysis method used in systems thinking; Sevaldson (2018) suggests that it can be used while, or after, making a gigamap. ZIP stands for: Zoom into areas of the map that need more research, innovations and interventions to improve the system and problems, potentials in the system.

In the workshop, we used color-coded diamond shapes for participants to help frame areas of the map according to the relevant issue.

The snapshot in Figure 23 shows an area of the map with all three kinds of diamonds visible. The ZIP analysis method helped the participants adopt a critical approach to the map and identify gaps and opportunities (uptil now it was more focused on laying out information and facts). In addition to the straightforwardness of the concept, the simple visual metaphor of using the color coded frames helped in critically evaluating the map.

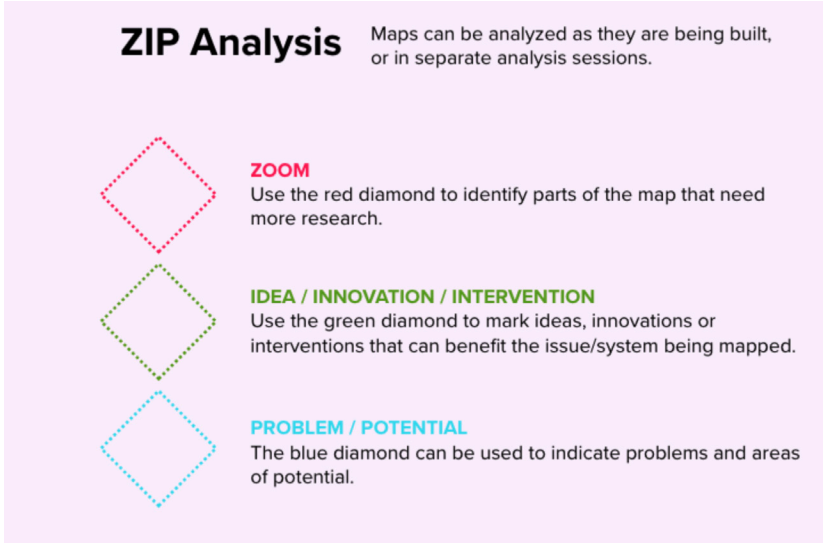


Figure 22: Instructions for ZIP analysis

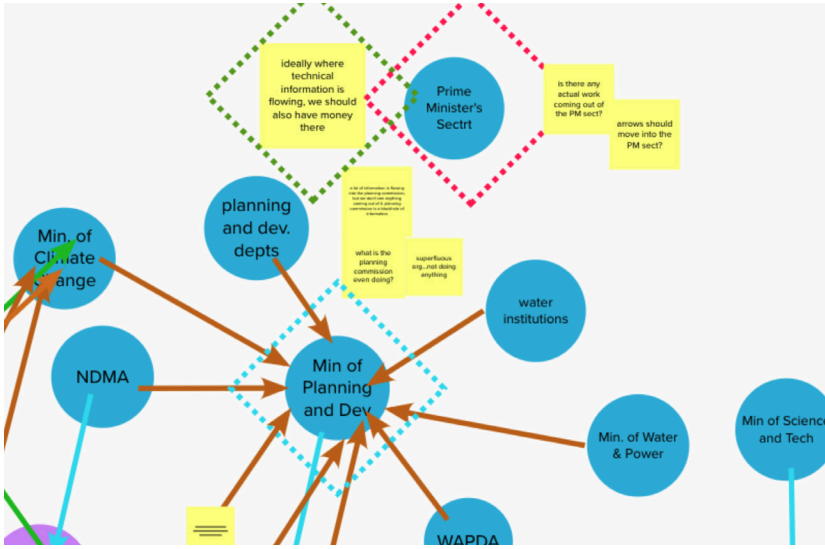
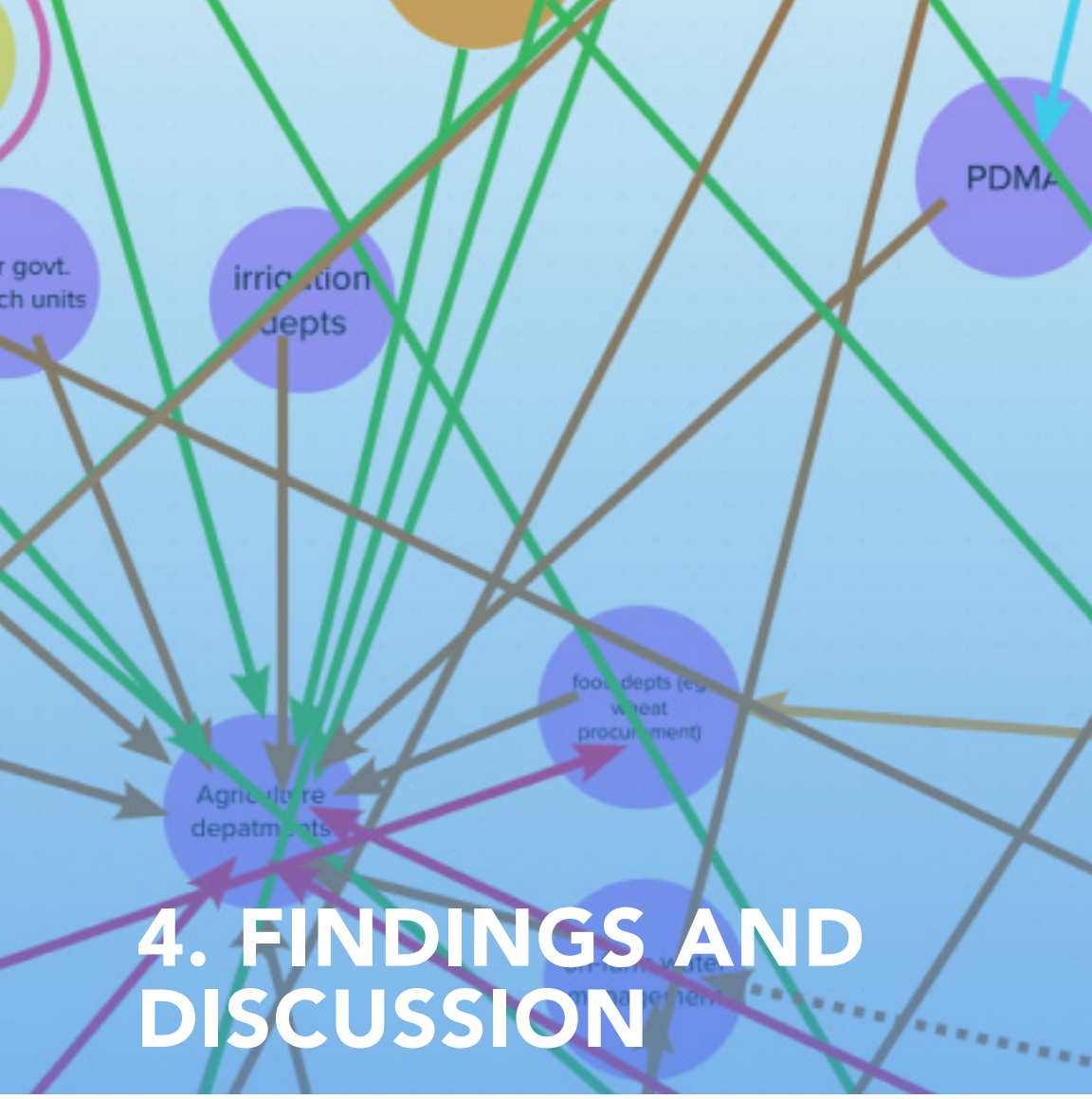
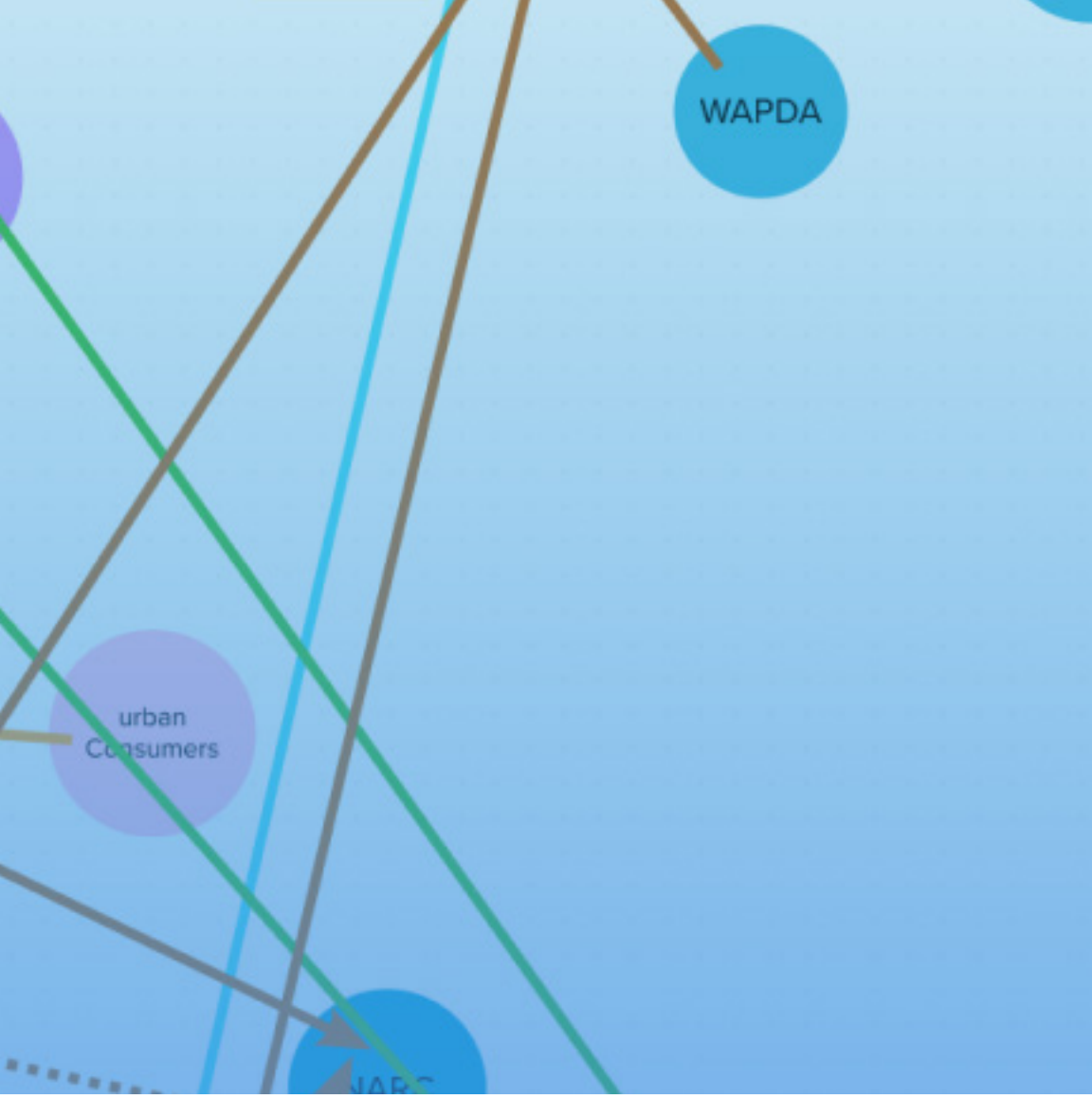


Figure 23: A zoomed-in view of the map showing the three kinds of diamonds representing Zoom, Intervention and Problem areas.



4. FINDINGS AND DISCUSSION



Gaps and opportunities in the problem space:

Gigamapping surfaced a number of important insights about the problem space. A key discovery was the limits to researchers' knowledge and understanding of the landscape, a fact acknowledged by the researchers and highlighted by a number of pink diamonds indicating a need for more research. Having mapped out the flow of research and technical information between the stakeholders, the participants noted that they had reached a point where they weren't able to add more

information to the map on their own. This is a fascinating discovery: gigamapping can help researchers identify the gaps in their knowledge and seek collaboration with other stakeholders such as government departments. Highlighting this point, a participant in the third workshop commented: "I think it's a good exercise because it [...] helps you identify where you might not know stuff [...]. It's good to see that you have arrows coming in but nothing coming out."

Another finding was the lack of outflows from certain presumably important actors. The Ministry of Planning, Development and Special Initiatives, for example, is the destination of several brown arrows, representing technical information and research, but few arrows originate from the Ministry. Participants noted that while there might very well be outgoing arrows that people with more information about the organization and the broader system can point out, they didn't have enough information to draw these connections. This also suggested that research participants did not have a big-picture view of their work: while they contribute rigorous research to the Ministry of Planning, they don't know if and how this research impacts national policymaking, something the Ministry plays an important role in.

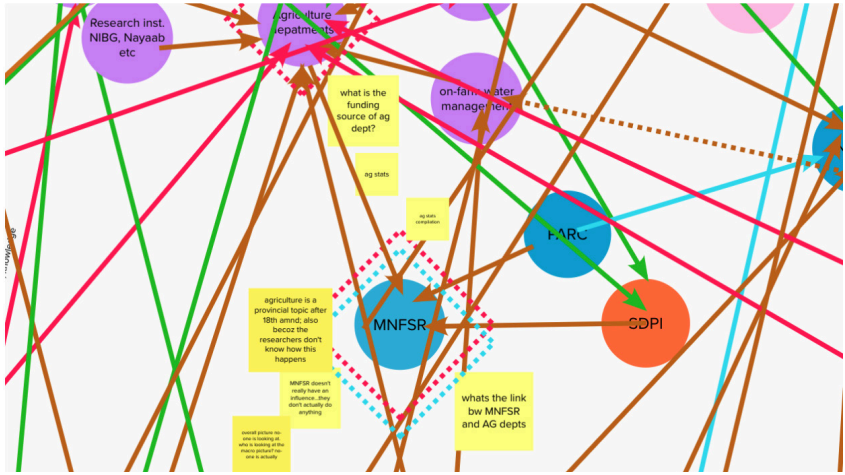


Figure 24: Zooming into the Ministry of National Ministry of Food Security and Research (MNFSR)

A similar insight emerged about the role and activities of the Ministry of National Food Security and Research (MNFSR). Although this map is concerned with the flow of research in the space of food security decision making, the circle representing the MNFSR, the federal ministry dedicated to ensuring the country's food security, is rather isolated, with few inflows and just one outflow. Discussing this fact, participants brought up the Eighteenth Amendment, which devolved certain ministries from the federal to the provincial level, including those in agriculture and health. Participants noted that with provinces controlling their own policies and strategies in key areas such as agriculture, the MNFSR actually does not have a lot of leverage in the country's food security decision making. In highlighting these limitations, the participants also acknowledged that they don't know the workings of the ministry well enough, underscoring once again a key premise of this research project: people working within the area have trouble grasping the complex interplay between stakeholders, and policies and flows of authority and knowledge.

Another learning was about the existence of silos in the map, highlighted by the absence of any links between the Climate Change and Food Security ministries. Compared to the isolated placement of the latter, the former occupies a position of higher influence on the map and is more connected. The absence of connections between the two (or at least those that the researchers are aware of), points to the need for better linkages between actors, something pointed out in the food security policy as well as statements by government representatives.

The map also visualized the perceived power dynamics of the space, showing that many of the highly influential actors were foreign donors such as USAID and the World Bank, highlighting the outsize influence these donors could have on policy direction.

Gigamapping is an effective tool for inquiry:

Gigamapping was shown to be an effective tool to interrogate and explore the complex landscape of decision making in the context of Pakistan's climate change-induced food security vulnerabilities. Workshop participants found the process to be enlightening and useful in explicitly laying out gaps and opportunities for interventions. A participant of the second workshop noted: "It's one thing to have things written down on paper, but it's another thing to have a visual...it can save so much time. I definitely see the value in this."

Using digital tools for generative design activities, we were able to produce dynamic, scalable artefacts. The gigamap we built is an inherently interactive artefact that can be shared, expanded and edited with an unlimited number of people, unlimited times. After the second workshop in March, we (the researcher and project partner) revisited the map multiple times to draw insights from it and add clarifications. This dynamic mapping process would have been a lot less straightforward if we had one physical map in a specific location.

I also suggest that the 'living', 'never-complete' nature of our dynamic map is more reflective of the real-world system it represents as opposed to the relatively more polished and 'finished' quality of many gigamaps currently available in static PDF or image formats.

Virtual research offers opportunities but has notable drawbacks:

The research for this project was conducted entirely remotely due to the COVID-19 pandemic. This proved both an opportunity and an obstacle. I discuss the opportunities and limitations of virtually facilitated research activities with a particular focus on generative design activities, a key part of our research. Overall, conducting this research remotely has been an instructive experience. On the one hand, being virtual afforded us the opportunity to reach people anywhere in the

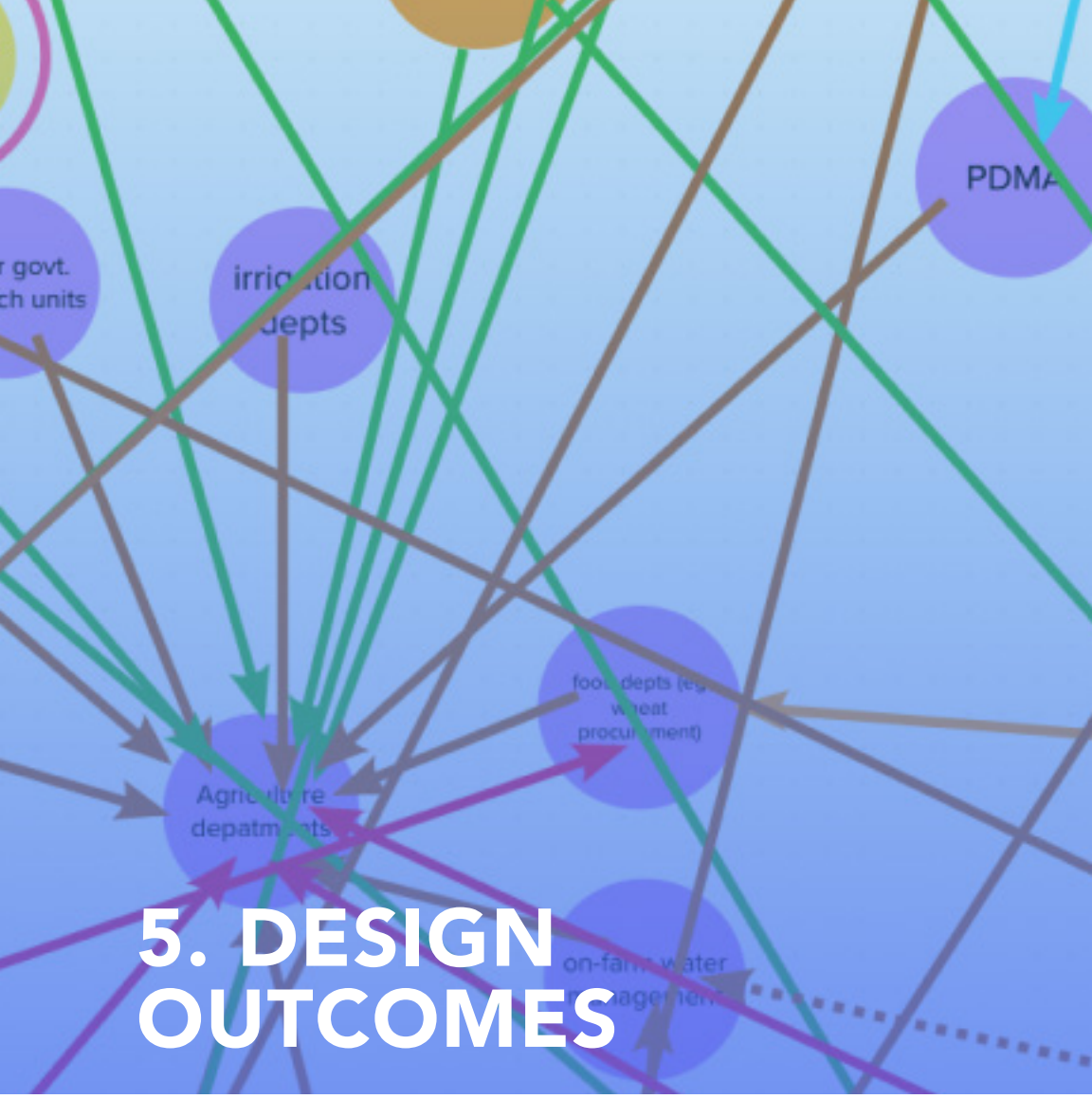
world: we had participants form three continents: North America, Asia and Australasia. This strength of virtual research was particularly conspicuous in the second design workshop during which all four participants (including the researcher) were situated in different time zones, from Vacouver, BC to Perth, Australia.

While virtual research allowed access to a wide range of participants, it also presented limitations. One of these limitations is the technology available for online collaboration. In the first workshop, participants struggled with technology and some were entirely unable to participate in the activity either due to internet connection issues or difficulty using the mapping software, Mural. Current collaborative software still has a learning curve even for the researcher, who is an experienced visual designer. We need more than just simpler, more intuitive software interfaces: there are limitations to our current hardware, as well. Tools such as trackpads and mice are, even after decades of development, way less flexible in allowing free expression. Although tablets such as Wacoms exist, they are niche products primarily used by designers/illustrators and even then not universally. Touchscreen-based interfaces, such as tablets, do offer more possibilities but there, too, is the limitation of accessibility. Especially when working with constituents from the general public or the government, the availability and accessibility of these tools is a hurdle in the way of truly inclusive and engaging virtual mapping activities.

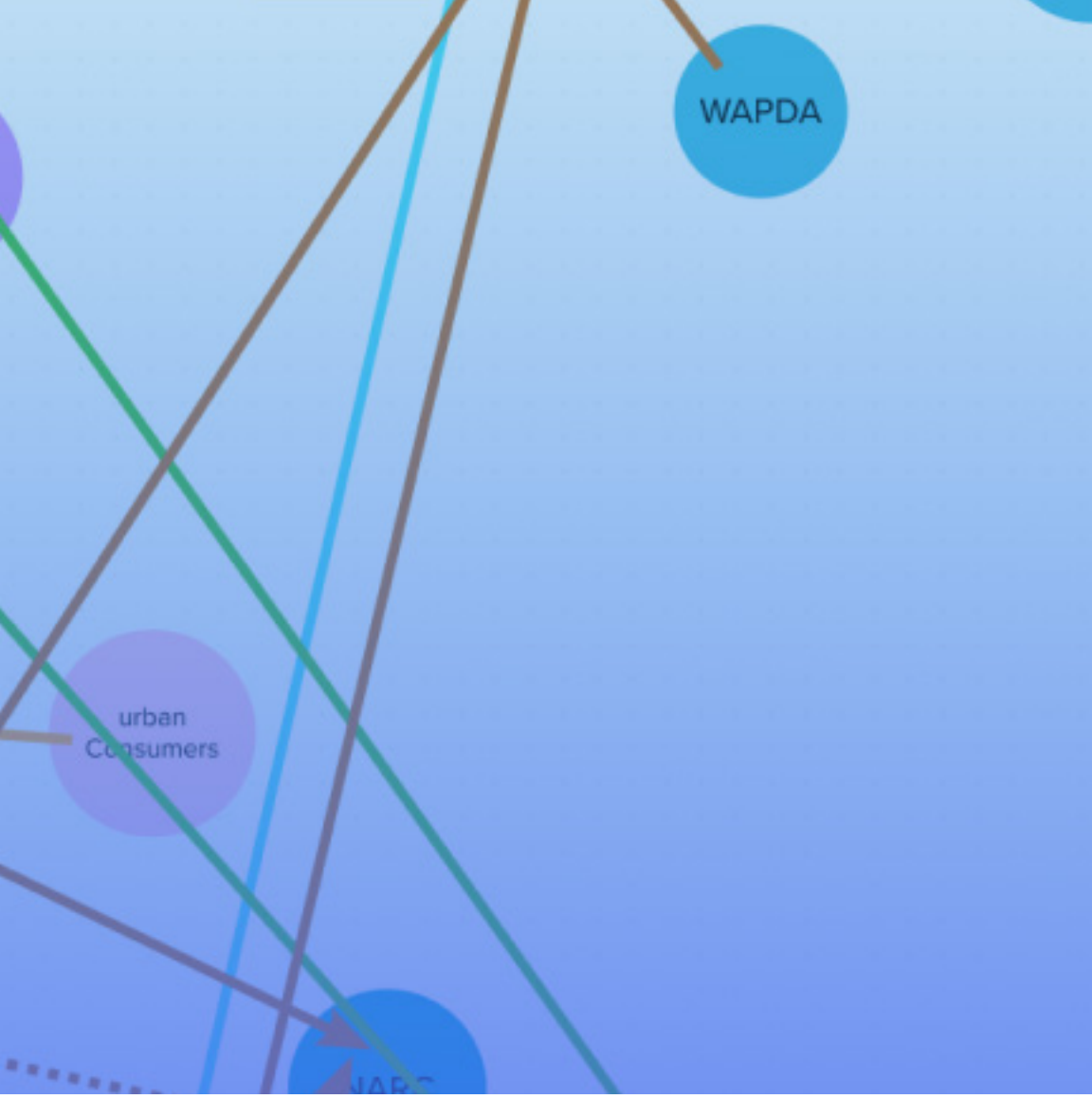
In addition to the limitations of technology, I also learned about interpersonal and group dynamics in collaborative online research. The first workshop, in November 2020, featured participants from the Sindh provincial government, a non-governmental organization and a donor agency. While eleven participants were invited out of whom nine confirmed, eventually only four could attend. This had implications for the collaborative aspect of the workshop. While two participants were from the same organization, the rest of the group did not know each other. Moreover, they had a wide gap in their contexts and experiences:

one was a senior employee at Action Against Hunger based in Islamabad, the other person from this organization was a junior employee from a smaller city in Sindh. One person represented the Sindh government and the final participant was a World Bank economist based in Washington, DC and focusing on Latin America (joining the workshop from Karachi). This lack of familiarity, combined with the impersonal, cameras-off dynamic of the Zoom meeting contributed to minimizing the amount of collaboration and discussion that I had hoped and planned for. The learnings from the first workshop guided the second workshop in March 2021. The three participants in this case had more in common: they were all researchers and each had a PhD, in adjacent topics such as soil research, agricultural economics and food security and food pricing. Two of the participants also had worked in the same organization and knew each other well and had at least one common connection with the third participant. This workshop saw a high level of engagement: participants freely discussed and debated their opinions, talked out their choices as they built the map, and had a high level of comfort with the software. Originally planned for two hours, the workshop took a total of three and a half hours to complete.

This suggests that if the online activity is intended to be highly collaborative, it might be a better idea to recruit participants with some shared experiences, contexts, etc. I hesitate to make this a recommendation because for one, I don't have enough data to make a conclusive claim. I also recognize the serious pitfalls of such an approach: the last thing we want is for design research to recruit homogeneous groups of participants who have a certain level of comfort with technology and, presumably, a certain level of confidence to voice out their thoughts and opinions.



5. DESIGN OUTCOMES



5.1 - Design outcomes

This project produced two design outcomes:

- Gigamap about flows of research and technical information co-created with researchers
- Interactive platform for gigamapping

5.1.1 - Current outcomes:

5.1.1.A - Co-created gigamap:

The first outcome of this project is a gigamap co-created with researchers over two virtual design workshops in March and April. The gigamap explores, from the perspective of researchers, the flows of technical knowledge and research between different stakeholders involved in strategic decision making around food security in Pakistan. This map is a dynamic, open-source artefact that can be continually built upon, expanded, and shared widely. As detailed in the Findings section, the map surfaces several insights, such as questions about the roles of actors like the MNFSR and the Planning Commission, as well as the limits to the knowledge and understanding of the researchers.

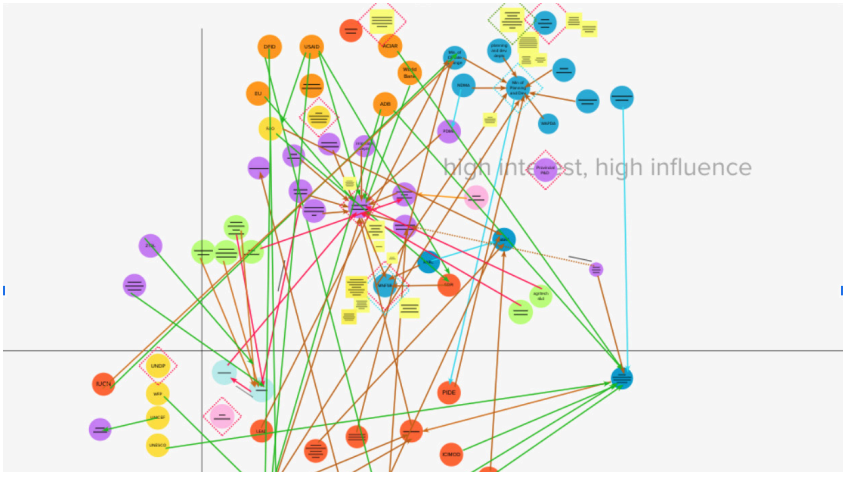


Figure 25: Gigamap co-created with researchers over two online workshops in March and April 2021

5.1.1.B - Interactive mapping platform:

Considering the complex, dense nature of gigamaps, Sevaldson (2011) highlights animation and interaction in gigamapping as areas of potential investigation. This makes sense because gigamaps can rapidly become unwieldy, defeating their very purpose of facilitating understanding of complex problem spaces. Leveraging the virtual and digital nature of this project and the gigamaps generated through it, I explored the utility and viability of interactive gigamapping. Based on the primary gigamap generated in Mural, which itself has certain interactive features such as searching for specific actors and filtering out groups of stakeholders, I developed an interactive version that offers a broader range of interactive features: turning labels on or off, linking to policy documents, and highlighting specific flows, such as funding or formal authority.

The interactive gigamapping platform has also been well-received as a potential 'orientation tool' to educate/prime someone working on a new topic or a new geographic area. This idea was repeated by three separate participants. The following quote from a participant highlights the specific utility of such a tool: "For somebody who doesn't know a lot of these things, I think this would get them up to speed pretty quickly." Another participant noted: "I like this idea...something like this would have been useful in trying to understand the fertilizer gas subsidy landscape." This tool can also be considered what Maznini (2015) describes as 'digital platforms', the "spread of which has led to the emergence of a new generation of enabling solutions that is changing the functionality and, in many ways, the very nature of collaborative organizations." (Manzini 2015, 169).

Figure 26: sketch mockup of interactive mapping platform

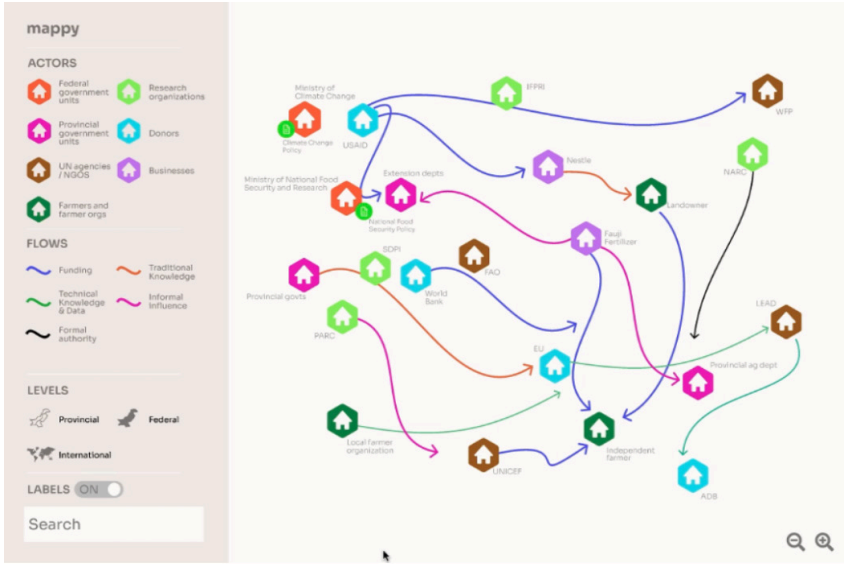


Figure 27: Initial prototype of interactive gigamapping platform

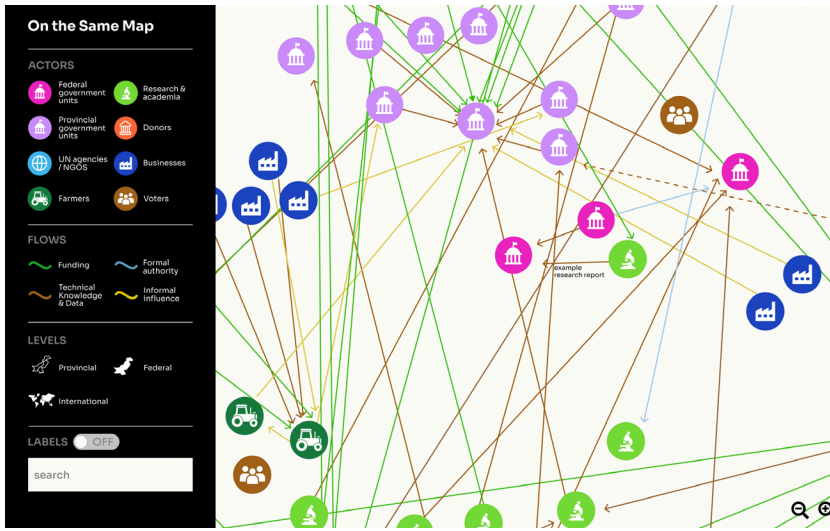


Figure 28: Current prototype of the interactive gigamapping platform (Icons from The Noun Project, Freepik, Those Icons, and Box Icons)

5.1.1.C - Who uses gigamapping? Persona:

Based on primary research, I created user personas to illustrate who in our target audience—food security researchers in Pakistan—would use gigamapping and how. A common design tool, personas "consolidate archetypal descriptions of user behavior patterns into representative profiles, to humanize design focus, test scenarios, and aid design communication" (Cooper 2004). One of these personas, describing a real need and scenario but using a fictitious identity, is presented below.

Persona: Huda Ejaz

About Huda: Huda is a researcher working with a leading international food security research institute in its Islamabad office. Her work focuses on using research to support and positively influence the country's policy making regarding agriculture and food security.

Scenario: Huda wants to be able to know which government bodies are responsible for enacting and enforcing certain policies. In particular, she wants to know who controls gas subsidies for the fertilizer sector;

this information will help direct her work to the right audience. She is currently working on a proposal that argues for limiting or eliminating gas subsidies for the fertilizer sector. While these subsidies are designed to lower fertilizer prices for farmers, her proposal argues against incentivizing fertilizer use, noting that this can lead to fertilizer overuse, which can in turn have negative environmental impacts. She also suggests better uses for the government's funds, such as promoting drip irrigation technology on small-scale farms, which can lead to increased yields as well as address the persistent issue of water overuse.

However, she has realized that it is hard to pinpoint who controls the fertilizer gas subsidy: the provincial agriculture department, the provincial department of energy, a federal body, or another entity altogether. As it stands, she is unsure as to who the right/best audience for her proposal is. Using gigamapping with her team, she can help draw out the stakeholders and their interactions in this space, helping highlight the key actors she should target while also being cognizant of the efforts the fertilizer industry and/or lobbying groups might be putting into influencing the policymaking process.

5.1.2 - Future work:

5.1.2.A - Gigamapping template:

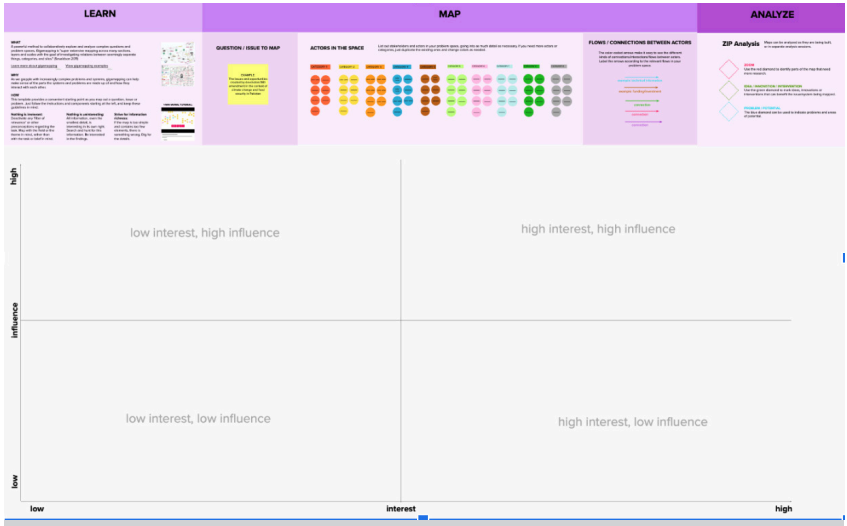
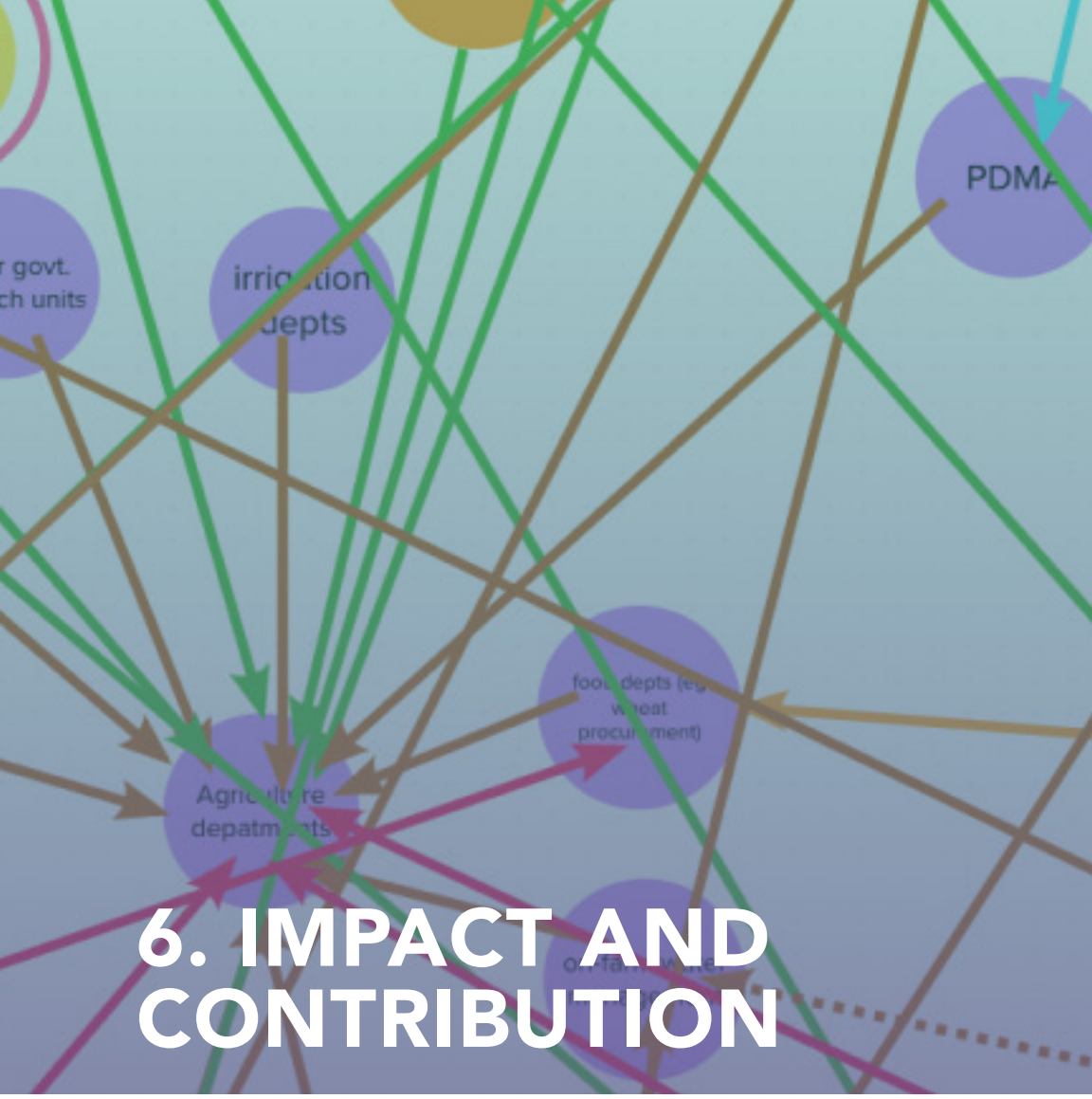
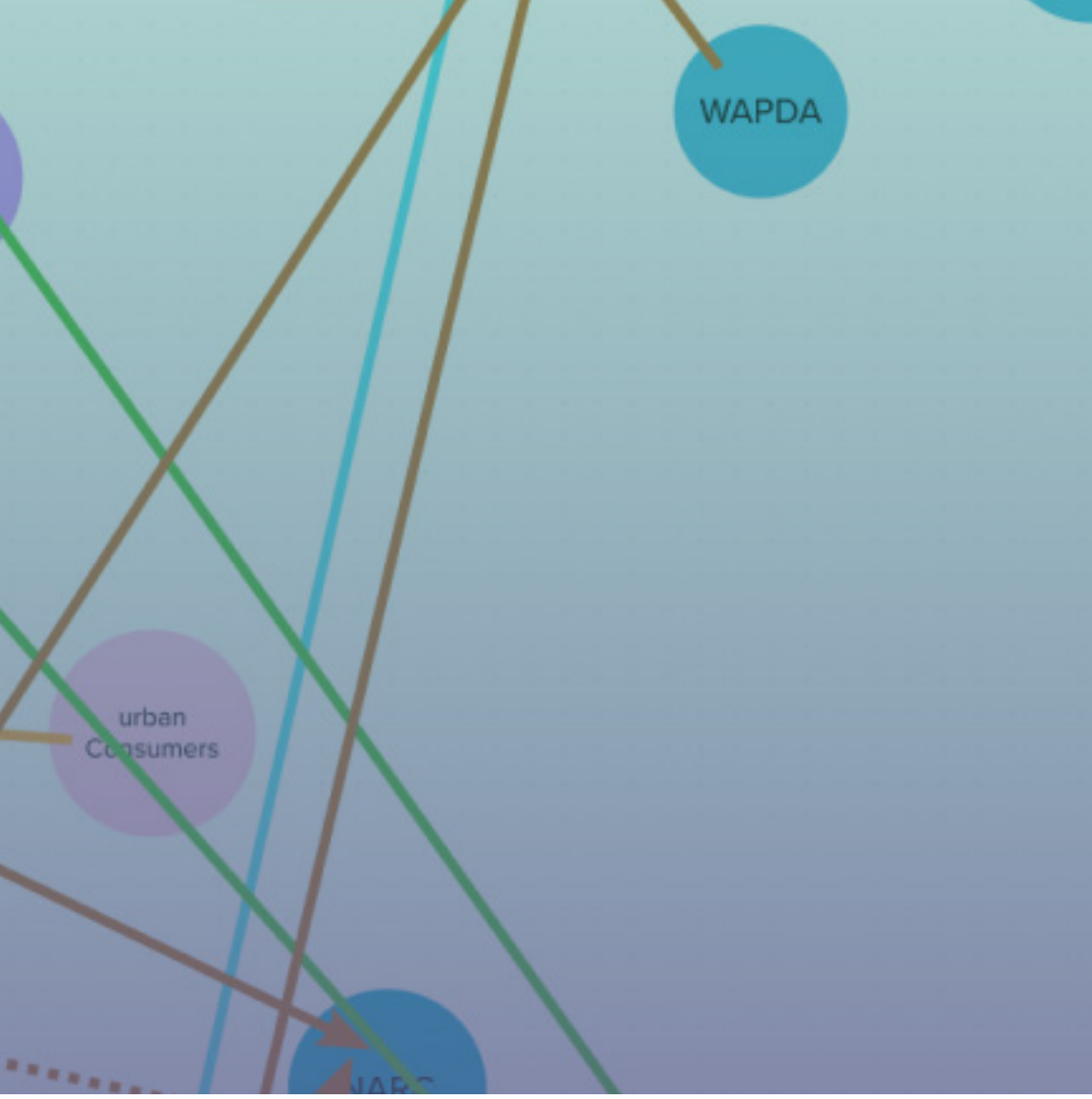


Figure 29: Gigamap template that researchers can use on their own

Through the course of the project, I facilitated two gigamapping sessions. I provided a brief overview of the logic and theory of the practice, and offered examples and guidelines on how to do it. Moreover, I provided technical assistance in using the software tool, Mural. Realizing the need for a way for researchers (and other audiences) to be able to map on their own, I developed a template to facilitate this process. This simple template, currently available for Mural, includes an overview and guidelines for gigamapping, instructions on using the software tool, links to theory and examples, a collection of visual components that can be used to represent actors and flows in the system, and a scheme for analyzing the map: ZIP analysis. The prototype includes a stakeholder map template, which is familiar and common in the food security research landscape. There is no limit to the organizing principles (such as timelines and journey maps) that can be used to structure gigamaps; other templates can be developed as needed in the future.



6. IMPACT AND CONTRIBUTION



Contribution to the Food Security Problem Space in Pakistan:

This project assesses the value and viability of gigamapping as a method of inquiry into complex systems. Given the emergent nature of wicked problems such as the one this project deals with, tools that can help constituents situate themselves, see beyond their own perspective, and identify opportunities for meaningful interventions are essential. The outcomes of this project—a gigamap representing the flow of technical information and research, a gigamapping template for

researchers and an interactive gigamapping platform prototype—are such tools.

The gigamap co-created with researchers is an example of an enabling solution—"product-service systems providing cognitive, technical and organizational instruments that increase people's capacities to achieve a result they value." (Manzini 2015). Already, the map has helped reveal opportunities for further research and ideas for interventions. For example, analyzing the map led to questions about the roles and effectiveness of the Ministry of Planning and the Ministry of National Food Security and Research, identified through the unusually few number of outflows from both these entities even though they are recipients of high levels of research knowledge.

The mapping process and the resulting artefact have been identified as especially useful as so-called 'orientation tools' for researchers new to a particular topic or a geographic area. A participant in the third workshop commented: "[In my opinion] a key benefit of a tool like this is that when you are researching a new country or a new sector, to kind of have this information handy...with this kind of activity you can see where and what kind of linkages [are there]...so it makes a lot of sense." The map has also highlighted the limits to researchers' knowledge of the problem space, indicating the need to incorporate more perspectives into the gigamap, particularly those of the government agencies.

The process of gigamapping developed in the course of this project can be used to further this research or be applied to interrogate other topics in this area, for example the effects of the Eighteenth Amendment. The gigamapping template can be used by researchers (and other stakeholders) on their own as they try to understand the problem space and identify areas of opportunity.

The interactive mapping platform prototype is aligned with the Government of Pakistan's focus on developing and acquiring digital platforms to connect different stakeholders, which is an oft-repeated

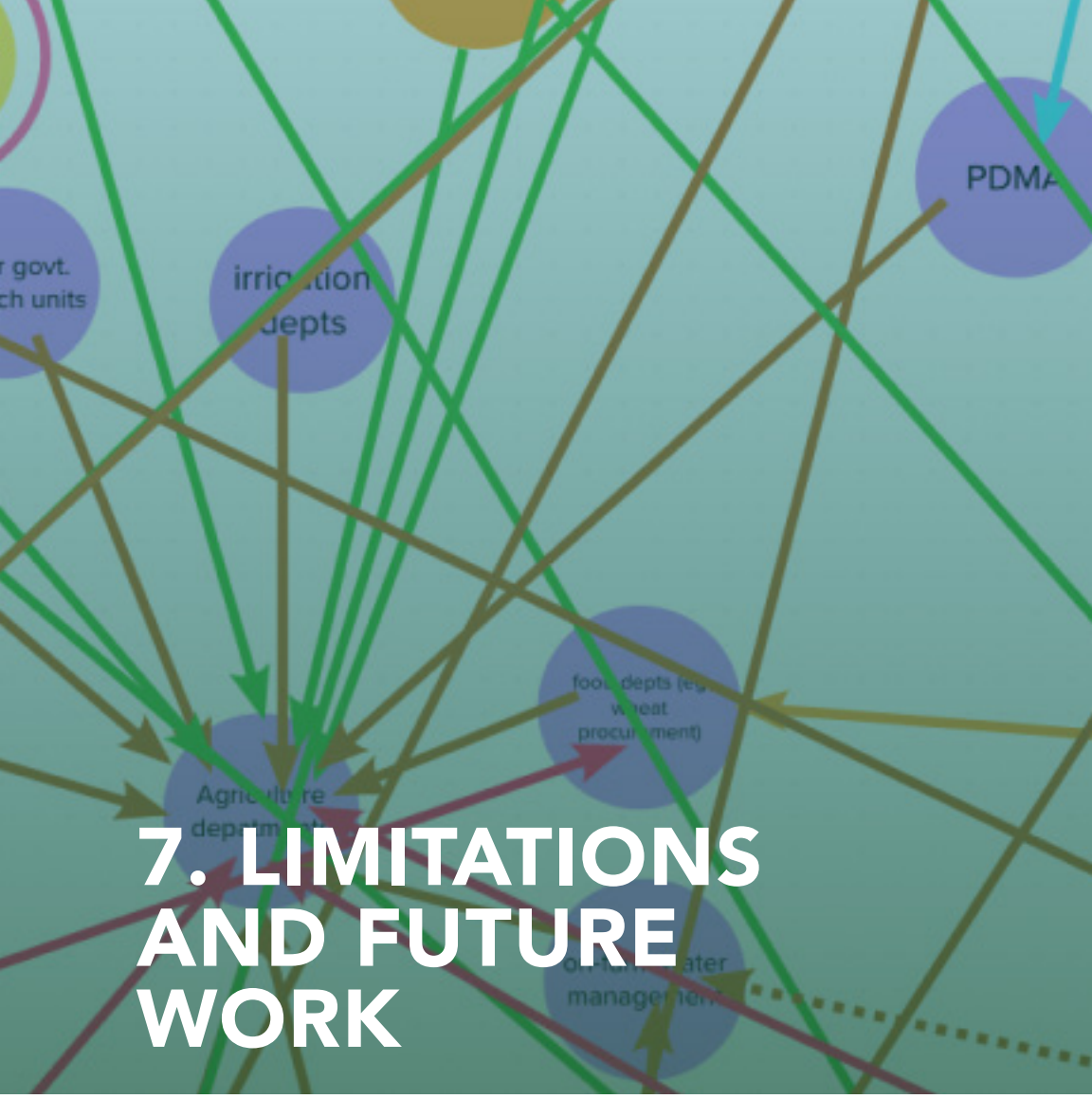
strategic priority in the country's food security policy. Popularly known as 'dashboards', these are interactive online portals that consolidate data on numerous sub-areas, such as nutrition, agriculture markets and health indicators. Developed by government units, independent organizations and a combination of both, a number of these dashboards are currently active or in development: the Ministry of National Health Services Regulations and Coordination maintains two separate dashboards: the Pakistan Health Information System (PHIS) and the SDG3 dashboard. The Agriculture Market Information System, maintained by the United Nations, is a mainstay of the field, regularly used by researchers and government units. A recent addition has been the Food Systems Dashboard, a collaborative effort by multiple organizations including Johns Hopkins University and the University of Michigan. Yet another dashboard, Food Security and Nutrition Information System (FSNIS) is currently being developed by the Food and Agriculture Organization of the United Nations (FAO) in partnership with the National Ministry of Food Security and Research. As an online 'dashboard', the gigamapping tool prototyped in this project can help in building better linkages between different stakeholders in Pakistan's food security landscape.

Contribution to integrative design:

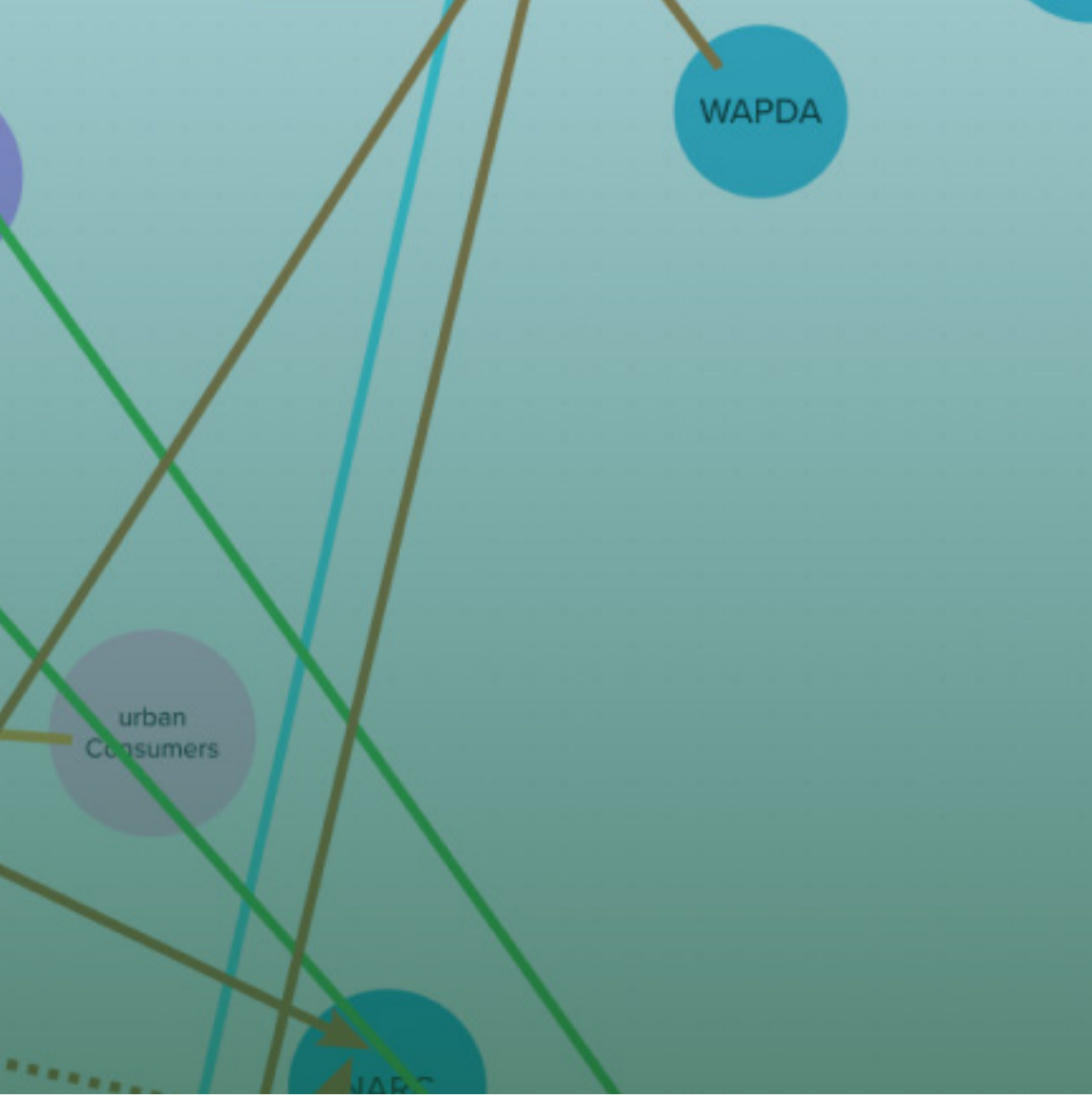
Gigamapping is a powerful tool for inquiry. In deploying and testing gigamapping in remote research in an international context, this project informs its use for future integrative design research. This knowledge is particularly useful for comprehending and interrogating complex, wicked problems, the kind that are the focus of integrative design inquiry. Interactive gigamapping, in particular, is a potentially powerful tool of inquiry as well as analysis. More research is needed to inform best practices regarding the technology and facilitation aspects of online gigamapping workshops.

Contribution to gigamapping practice:

Gigamaps, by definition, are highly detailed representations of complex sociotechnical systems. This detail and complexity can quickly render gigamaps unwieldy, defeating their very purpose of facilitating understanding of complex spaces. In using a virtual research mode and a collaborative mapping program, Mural, this project contributes a new, interactive and dynamic way of making gigamaps. While in-person and virtual generative research differ widely with the latter having higher potential for richness and participant engagement, there surely are instances where a virtual approach is necessary or preferable. This project was one such instance. The resulting map is a dynamic artefact that can be continually built upon, expanded and modified as the real-world situation it represents changes. This is in contrast to the comparatively polished, finished gigamaps presented above which, in their static format, imply a certain sense of finishedness in representing their respective problem spaces.



7. LIMITATIONS AND FUTURE WORK



This project is centered on the perspective of researchers. While we spoke to representatives from government departments, funding agencies and local community organizations, the gigamaps have been built and tested primarily with researchers. Furthermore, we did not have any meaningful interactions with, or input from, a few of the important groups of stakeholders identified through our mapping exercise: businesses related to food and agriculture, representatives from the ministry of food security (although we spoke to a number of experts

with years of experience working in or alongside policy), and farmers and farmer organizations.

This highlights an important limitation to this work. In gigamapping practice, multiple voices and perspectives enrich the understanding of the problem space; gigamapping enables groups with varied views, experiences and goals to understand, expand, and challenge each other's positions, helping them arrive at shared frames of reference. These shared frames can then facilitate action to address issues and opportunities within the problem space. Further research, integrating a wider range of perspectives, will help round-out and enrich the findings and outcomes of this project. It would be useful to build upon this gigamap—or create comparison gigamaps—reflecting perspectives from other stakeholder groups. This opportunity is noted in a comment from a participant in the third workshop: "Once this tool is completed, it can be taken to organizations like the Ministry of Food Security [and] Planning Commission so they can actually point out their own linkages in this map because we may be unaware of [...] lot of stuff which is happening."

The project's entirely virtual modality, in precluding the researchers from engaging more directly with the problem space, also presents a limitation. For example, physically visiting the food security ministry or the office of a research organization or university department might have yielded insights into the culture and 'way of doing things' which could inform ideation on improving the interface between researchers and policymakers. Further research can take the insights and artefacts from this project and build upon and/or recreate them in a physical setting. This exercise may also highlight if and how in-person and virtual set-ups render different results in the context of gigamapping.

The design and facilitation of virtual research, particularly generative design activities, is another promising topic of further inquiry. While this project was carried out during the COVID-19 pandemic, rendering in-person research nearly impossible, the post-pandemic world will

surely see significantly more virtual collaboration. Technology platforms, audience size and composition and facilitation methodologies are ripe areas for research.

This project focuses on assessing the value and viability of gigamapping as a method of inquiry. It does not pursue design interventions in the problem area, such as those identified in the earlier phases of research: improving research communication and clarifying the role of the 18th amendment, and those identified in the later stages: how to enable researchers to understand the broader impact of their work, how to help government agencies communicate how they use research. These topics are also ready for further research. This project enables the future exploration of intervention opportunities in the problem space through its findings and design outcomes.

Another area of future inquiry and development is educating researchers about the importance of complexity and how it relates to gigamapping. This need was highlighted in responses to an online survey seeking feedback on the interactive gigamapping prototype. To the question "What changes or additions to the app will make it more useful for you?", two responses were: "Making it less complex, too many nodes overlapping" and "Anything that makes it cleaner to view... because actually a lot if data gets packed into it." These indicate that the respondents viewed the complexity and density of the map as a drawback. These qualities are, in fact, key strengths of gigamapping. However, it is clear that more work is needed to help people understand and appreciate these qualities. While gigamapping is a flexible tool with few rules, it still requires a certain mindset—characterized by openness and comfort with ambiguity and complexity—before one can truly benefit from it. While the gigamapping template developed in this project can help researchers deploy gigamapping in their own work, training is also needed to help researchers in adopting the right mindset. One way to make this mindset and thinking more accessible is through developing an online course or a series of video tutorials. This is an area of

research and development that I would like to pursue in the near future.

Works Cited

Aberman, Noora-Lisa, Fatima Zaidi, Claudia Ringler, Agha Akram, Andrew Bell, Maikel Issermann, and Benjamin Wielgosz. 2013. "The Policy Landscape of Agricultural Water Management in Pakistan." SSRN Electronic Journal, April. https://doi.org/10.2139/ssrn.2252915.

Ali, Sajjad, Ying Liu, Muhammad Ishaq, Tariq Shah, Abdullah, Aasir Ilyas, and Izhar Din. 2017. "Climate Change and Its Impact on the Yield of Major Food Crops: Evidence from Pakistan." Foods 6 (6): 39. https://doi.org/10.3390/foods6060039.

Alvi, Mumtaz. 2020. "Food Security Top Priority: PM Imran Khan." The News, September 24, 2020. https://www.thenews.com.pk/amp/719312-food-security-top-priority-pm.

Arshad, Muhammad, Harald Kächele, Timothy J. Krupnik, T. S. Amjath-Babu, Sreejith Aravindakshan, Azhar Abbas, Yasir Mehmood, and Klaus Müller. 2017. "Climate Variability, Farmland Value, and Farmers' Perceptions of Climate Change: Implications for Adaptation in Rural Pakistan." International Journal of Sustainable Development & World Ecology 24 (6): 532–44. https://doi.org/10.1080/13504509.2016.1254689.

Baber, C. 2003. Cognition and Tool Use: Forms of Engagement in Human and Animal Use of Tools. London: Taylor & Francis.

Bhakapol Bhakdibhumi, Chris Han, Jasmin Kim, Holly Liu, Francis Park 'Obesity Epidemic'.

Carey, Daniel, Andy Tennant, Paul Rodgers, and Katie Dodd. 2017. "User-Designed Dementia Care Pathways. A Disruptive Approach to Mapping Dementia Support Services." The Design Journal 20 (sup1): S2534–50. https://doi.org/10.1080/14606925.2017.1352766.

Carr, Wilfred, and Stephen Kemmis. 1986. Becoming Critical: Education Knowledge and Action Research. 1st edition. London; Philadelphia: The Falmer Press.

Chaudhry, Qamar-uz-Zaman. 2017. Climate Change Profile of Pakistan. Manila: Asian Development Bank Institute. http://public.eblib.com/choice/publicfullrecord.aspx?p=5214651.

Cooper, Alan. 2004. The Inmates Are Running the Asylum: Why High Tech Products Drive Us Crazy and How to Restore the Sanity. 1st edition. Indianapolis, IN: Sams - Pearson Education.

Dehlavi, Ali, Ashley Gorst, Ben Groom, and Farrukh Zaman. 2015. Climate Change Adaptation in the Indus Ecoregion: A Microeconometric Study of the Determinants, Impacts, and Cost Effectiveness of Adaptation Strategies. Islamabad: World Wide Fund for Nature (WWF) Pakistan.

Eckstein, David, Vera Künzel, Laura Schäfer, and Germanwatch. 2017. Global Climate Risk Index 2018 Who Suffers Most From Extreme Weather Events? Weather-Related Loss Events in 2016 and 1997 to 2016.

Fawcett-Tang, Roger. 2008. Mapping Graphic Navigational Systems. Revised edition. Mies: Rockport Publishers.

For Legevakten, Manuela Aguirre Ulluoa and Jan Kristian Strømsnes, AHO 2012

Hanington, Bruce M., and Bella Martin. Universal Methods of Design: 125 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions. Beverly, MA: Rockport, 2019.

International Institute for Applied Systems Analysis (IIASA) report

Javed, Muhammad Wajid, Mansoor ul Hasan, and Muhammad Usman. 2020. “Pakistan and India: Don’t Let Squabbling Impede Locust Control.” Nature 582 (7811): 184–184. https://doi.org/10.1038/d41586-020-01709-7.

Jones, Peter. 2017. “The Systemic Turn: Leverage for World Changing.” She Ji: The Journal of Design, Economics, and Innovation 3 (3): 157–63. https://doi.org/10.1016/j.sheji.2017.11.001.

Mahmood, Hana, Yasmeen Suleman, Tabish Hazir, Durre Samin Akram, Shahadat Uddin, Michael J Dibley, Saleem Abassi, Amara Shakeel, Narjis Kazmi, and Anne Marie Thow. 2017. “Overview of the Infant and Young Child Feeding Policy Environment in Pakistan: Federal, Sindh and Punjab Context.” BMC Public Health 17 (S2): 474. https://doi.org/10.1186/s12889-017-4341-5.

Manzini, Ezio. 2015. Design, When Everybody Designs: An Introduction to Design for Social Innovation. Design Thinking, Design Theory. Cambridge, Massachusetts: The MIT Press.

McNiff, Jean, and Jack Whitehead. 2006. All You Need To Know About Action Research. SAGE Publications.

Metelerkamp, Luke, and Eva Schiffer. 2020. “Epistemic Cartography: Evaluating Net-Map as a Frontline Tool for Navigating Informal Knowledge Networks.” Southern African Journal of Environmental Education 36 (December). https://doi.org/10.4314/sajee.v36i1.11.

Ministry of National Food Security and Research, Government of Pakistan, “National Food Security Policy”, 2018. Retrieved April 18, 2021 from: http://www.mnfsr.gov.pk/userfiles1/file/National%20Food%20Security%20Policy%20%202018%20(1).pdf

Myers, Samuel S., Matthew R. Smith, Sarah Guth, Christopher D. Golden, Bapu Vaitla, Nathaniel D. Mueller, Alan D. Dangour, and Peter Huybers. 2017. “Climate Change and Global Food Systems: Potential Impacts on Food Security and Undernutrition.” Annual

Review of Public Health 38 (1): 259–77. https://doi.org/10.1146/annurev-publhealth-031816-044356.

Naveh, S., Schneider, J., & Challans, T. (2009). The Structure of Operational Revolution: A Prolegomena. Leavenworth: Booz Allen Hamilton.

Nelson, Harold G., and Erik Stolterman. 2012. The Design Way: Intentional Change in an Unpredictable World. Second edition. Cambridge, Massachusestts ; London, England: The MIT Press.

Rabbani, GOLAM, A. Rahman, Ishtiaque Shoef, and Zoheb Khan. 2015. "Climate Change and Food Security in Vulnerable Coastal Zones of Bangladesh." In , 173–85. https://doi.org/10.1007/978-4-431-55411-0_10.

Ryan, Alex. 2014. "A Framework for Systemic Design." FormAkademisk - Forskningstidsskrift for Design Og Designdidaktikk 7 (4). https://doi.org/10.7577/formakademisk.787.

Sanders, Liz. 2008. "An Evolving Map of Design Practice and Design Research." Interactions 15 (November): 13–17. https://doi.org/10.1145/1409040.1409043.

Schiffer, Eva, and Jennifer Hauck. 2010. "Net-Map: Collecting Social Network Data and Facilitating Network Learning through Participatory Influence Network Mapping." Field Methods 22 (3): 231–49. https://doi.org/10.1177/1525822X10374798.

Schiffer, Eva. 2007. "Net-Map Toolbox (Brochure)."

Schön, D. A., & Rein, M. (1994). Frame reflection: toward the resolution of intractable policy controversies. In P. Wagner, C. H. Weiss, B. Wittrock, & H. Wollman (eds.), Social sciences and modern states: national experiences and theoretical crossroads. Cambridge: Cambridge

University Press, 263.

Schwartz, S. H. (1999). A theory of cultural values and some implications for work. Applied Psychology: An International Review, 48 (1), 23-47.

Sevaldson, Birger. (2011). GIGA-Mapping: Visualisation for complexity and systems thinking in design. Retrieved April 18, 2021, from https://www.researchgate.net/publication/319930894_Giga-mapping_Visualisation_for_Complexity_and_systems_thinking_in_design

Sevaldson, Birger. 2018. "Visualizing Complex Design: The Evolution of Gigamaps." In Systemic Design, edited by Peter Jones and Kyoichi Kijima, 8:243–69. Translational Systems Sciences. Tokyo: Springer Japan. https://doi.org/10.1007/978-4-431-55639-8_8.

Suleri, Abid Qaiyum. 2020. "Turning to Agriculture." The News, July 19, 2020. https://www.thenews.com.pk/print/688737-turning-to-agriculture.

Tharp, Bruce M., and Stephanie M. Tharp. 2018. Discursive Design: Critical, Speculative, and Alternative Things. Design Thinking, Design Theory. Cambridge, MA: The MIT Press.

Ware, Colin. 2019. Information Visualization: Perception for Design. Interactive Technologies. Morgan Kaufmann.

Wasserman, S., & Faust, K. (1994). Structural analysis in the social sciences.Social network analysis: Methods and applications. Cambridge University Press. https://doi.org/10.1017/CBO9780511815478

Young Eun Choi, Birger Sevaldson, AHO 2013 'Library of Systemic Relations'

Zimmerman, John, Erik Stolterman, and Jodi Forlizzi. 2010. "An Analysis and Critique of Research through Design: Towards a Formalization of a Research Approach." In , 2010:310–19. https://doi.org/10.1145/1858171.1858228.