LENSES OF INNOVATION

Sustainable solutions for socio-ecological challenges - 1.0

Co-created by:
Andre Nogueira, PhD Candidate at IIT - Institute of Design
Dr. Carlos Teixeira, Associate Professor at IIT - Institute of Design
Dr. Weslynne Ashton, Associate Professor at IIT - Stuart School of Business

Sponsored by:
Illinois Institute of Technology
Educational and Research Initiative Fund (ERIF)

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SUMMARY

INTRODUCTION

ABOUT

This playbook is a work in progress to support the design of sustainable solutions for socio-ecological complex challenges. It provides eight innovation lenses (human, networks, cultural, governance, financial, built, digital, and ecological) that together inform alternative pathways for systemic intervention by (1) amplifying actor's understanding of the dynamic interactions in the situation of interest, (2) expanding the opportunities for integrating the social and the ecological systems, (3) providing new possibilities for interventions.

This playbook is not appropriate for designing in spaces where the solution is known, where best practices can solve social complex problems, or where solutions require only the integration and coordination of existing operations or services. Rather, it provides alternative paths to embed principles of sustainability in innovation practices for intervening in socio-ecological systems.

WORK IN PROGRESS

This work starts from the premise that fragmented innovation is increasing complexity for sustainable solutions because they lack understanding of the dynamic interactions between actors shaping socio-ecological systems. New tools and frameworks are required not only to expand actor's perceptions about the system at play, but also to provide alternative paths for transitioning towards more sustainable futures. This playbook is being designed considering contributions from diverse disciplines capable of advancing the practice of design focused on socio-ecological complex challenges. Its application has been prototyped during decision-making processes in three different levels and situations: at the facility level in local circular economies, at the city level in food systems, and at a regional level in brownfields redevelopment. We welcome feedbacks, suggestions, and concerns. This is intended to be a living document to be improved over time. Please send feedback to Andre Nogueira at anogueira@id.iit.edu.

KEY TERMS

Socio-ecological systems are ecological systems intertwined with and impacted by one or more social systems. A complex challenge in these systems emerge from non-obvious, web-related, adaptive interactions between human and non-human actants creating disturbances that compromise the integrity of the socio-ecological system[1].

Actors are individuals and human entities involved in or impacted by the design process. Stakeholders are everyone who has a stake in the successful outcome of the project.

Actants can be human and non-human actors. Non-human actors can be technical (e.g. entities, organizations, products, etc.) or biological (non-human species, temperature, water, etc.)[2].

Interactions is a particular way in which actants affect one another given unique circumstances of reciprocal action or influence.

Intervention is an action taken to improve a situation.

Problems are human-made interpretations about unwelcome or harmful situations that need to be addressed by humans.

Challenges refers to frictions between autonomous behaviors of human and non-human actants and the intentionality of human actants.

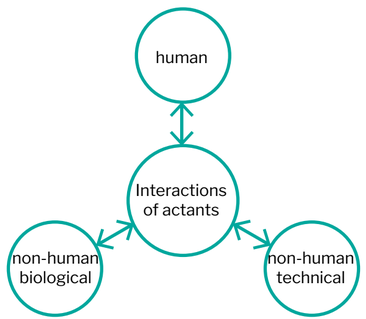
Resources are stocks of materials, attributes and Things that can be drawn by agents in order to maintain a function of a system.

Assets are valuable resources that should be maintained.

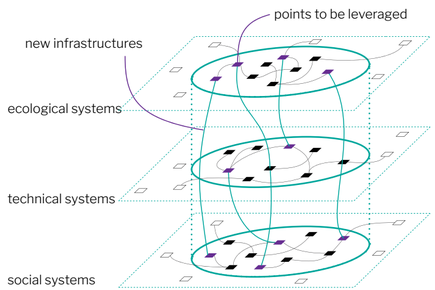
Capitals are "any type of resource capable of producing additional resources"[3].

Things are socio-material assemblages that deals with "matters of concern"[4].

Interactions of actants



Interventions for multi-systems integration



Sustainable solutions are goal-oriented, adaptive interventions situated in the interplay of social and ecological systems. They are not focused on designing entire new systems, but on contributing to the sustainability of existing interactions between the actants in socio-ecological systems over time. In order to do so, they should incorporate the multiple systems involved in specific challenges, considering the interconnectivity of three different levels (micro, meso, macro) in these systems, and the dynamic interactions between their actants. While not extensive, there are four properties of sustainable solutions that can be identified in the design practice:

Challenges are defined by transdisciplinary approach
Because contemporary complex challenges have never been faced at the speed and scale of impact as in the current state, the current knowledge derived from isolated efforts seems to be limited in defining them.

The locus of interventions is infrastructures
Because existing infrastructures were not established considering logics of interconnectivity of levels in multiple systems and co-evolution, they are limited in recognizing and adapting to the emerging properties shaping complex challenges in socio-ecological systems.

Interventions are driven by sustainable goals
Interventions in infrastructures will not lead to sustainability if they are not oriented towards it. Without sustainable goals, the specification of both common and unrelated objectives of different disciplines will continue to support the design of unsustainable infrastructures.

Solutions incorporate macro level complexities in micro level situations
While complex challenges tend to be presented in the macro level, they should be understood as aggregated consequences of unsustainable interactions shaping unique situations in the local context.

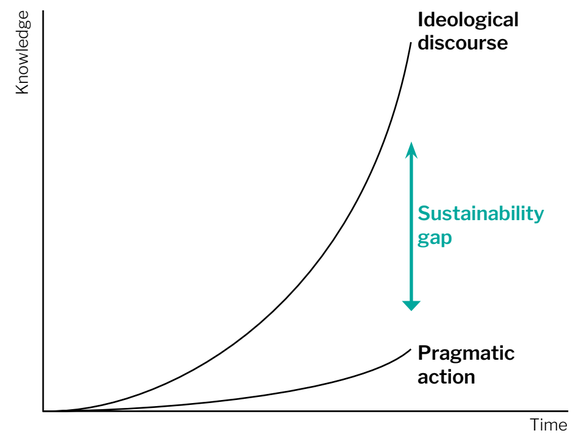
ADVANCING THE FIELD

Despite notable advances that discourses around sustainability-centered innovation practices have achieved, they are still leaving an exponentially growing environmental and social degenerative footprint across socio-ecological systems. As a discipline capable of integrating dispersed knowledge to advance innovation practices, design still lacks tools and frameworks to promote interventions towards sustainability. Innovation lenses that were reliable in the twentieth century are not providing the proper focus in the blurring world of dynamic technologies, and socio-ecological complex challenges [5]. With regards to the environment, several efforts in the light of design for reverse logistics, extension of life, search for new materials, and the exploration of more circular systems have been done. But increasingly sophisticated products and services, (including or not new digital technologies) are being designed to exploit new opportunities without considering the interconnectivity of their development and implementation with the environmental impacts they generate.

Similarly, the design field started to explore its contributions in new levels of complexity, and is trying to embrace diverse social concerns, calling upon social innovation methods for the design of solutions for large, complex societal problems. However, just like environmental disturbances, social problems are also increasing with high rates of depression and suicides, anxiety, obesity, health challenges, emerging pandemics, social expulsions, etc. Without understanding the interconnectivity between the complex network in which humans are engaged and the environment in which action is taken, isolated efforts merely adapt existing practices towards less harmful ones. While incremental isolated changes are expanding the sustainability of products and services, there is greater opportunity to prompt paradigm shifts towards sustainable socio-ecological systems.

BY BRIDGING THE GAP

A significant gap still remains to connect ideological discourses of sustainability-centered innovation practices to the pragmatism required to intervene in specific situations, and support transitions towards sustainable systems. This playbook aims to advance the field of design in the pursuit of bridging this gap by providing eight lenses of innovation capable of integrating both environmental and social concerns in the design of sustainable solutions for socio-ecological complex challenges.



LENSES OF INNOVATION

The eight lenses of innovation framework integrates considerations from socio-ecological systems theory[6,7,8], knowledge brokering methodologies[9], the Community Capitals Framework[3], Industrial Symbiosis principles of stocks and flows[10] and the Whole View Model approach[5]. While some contributions are implicit, others are more explicit. For example, the "Community Capitals Framework" (CCF) created in the context of rural community development, considering seven types of capital (natural, financial, manufactured, human, social, cultural, political) into the analysis of existing hard and soft infrastructures in a given system[3]. The framework is being applied to understand how decisions in the past shaped the current situations. This work considers the seven capitals of the CCF as "innovation lenses" and utilizes industrial symbiosis principles to explore how might future interventions consider these flows by informing more integrative design practices. It also adds the "digital" lens due to its contemporary role in shaping innovation practices.

As a result, the eight lenses of innovation presents a framework to map and understand the multiple types of resources and assets to be considered in design practices. If applied in existing tools and methods, or even in the development of new ones, they can support designers to uncover often hidden variables as well as points to be leveraged through new interventions for dealing with socio-ecological complex challenges. Because socio-ecological systems are contextual and adaptive, the establishment of what variables should be considered and what points should be leveraged vary according to each situation and actants shaping in the dynamics of the system. However, by utilizing the eight lenses framework throughout the entire process, designers can expand their perception about these dynamics, and intervene considering a broader range of variables that are shaping socio-ecological complex challenges.

HUMAN

The ability and capability of individuals to produce, and manage their well-being. It includes individual health, knowledge, skills and motivation.

NETWORKS

The professional and the social connections among actors. It includes partnerships and collaborations, as well as informal gatherings.

CULTURAL

Values and beliefs inherent in social practices, or incorporated by communities. It also includes ethnicity, spirituality, heritage, traditions, and daily practices.

GOVERNANCE

Structure in organizations that determines how decisions are made and power is distributed. It involves hierarchy, inclusion, equity, transparency, access, and participation.

FINANCIAL

Objective correlation between the elements of the other lenses translated into monetary units. It includes mechanisms for credits and loans, as well as measurement of the productive power and monetary support.

BUILT

All material goods. It includes human-made elements such as physical infrastructures, roads, artefacts, and machines.

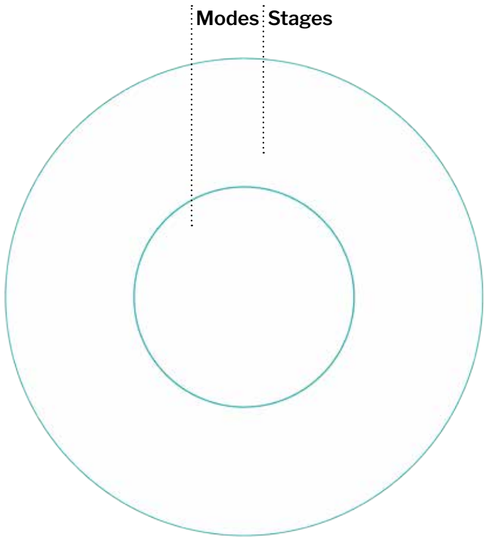
DIGITAL

Digital infrastructure and data. It includes digital platforms, as well as the mechanisms of data collection, analysis, and storage.

ECOLOGICAL

Comprises natural resources, both renewable and nonrenewable. It also includes fauna and flora, as well as their life supporting systems.

METHODOLOGY



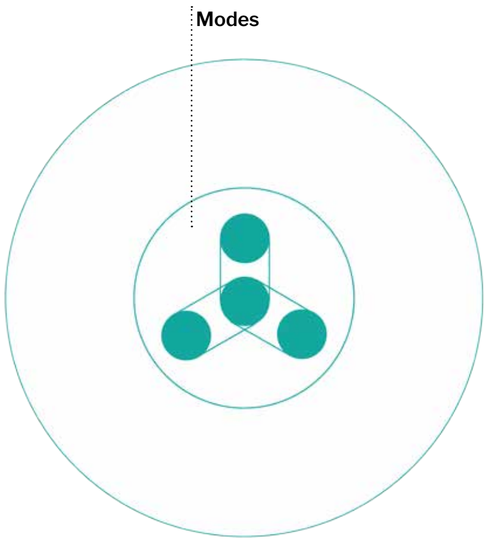
This methodology assumes the design practice as an iterative learning process, where participants are continuously gathering new information about the socio-ecological system at play. Because the goal relies on intervening in the flows of different types of resources, actors will have to explore opportunities for shaping new interactions between actants sustaining these flows. In order to do so, participants involved in the process have to engage with both a diverse group of actors (as participatory design methods have suggested) and the actants in the situation of interest.

This requires new approaches to understand the different types of interactions shaping the dynamics of the system at play. The more actors immerse themselves in the situation, the more they will be able to embed information about the actants and the dynamics of the system into new interventions. While participatory methodologies have advanced the field of design with techniques for better understanding complex social dynamics, there is still opportunity to explore how actors should incorporate considerations of the socio-ecological realm.

Rather than presenting a design process with a set of techniques to be widely applied, this work is structured on modular thinking, and therefore, can be explored through typologies, here divided into four modes, and eight stages. The modes will determine the focus of actors within each stage. Stages are intended to situate the actors given the different steps of exploration in their design process.

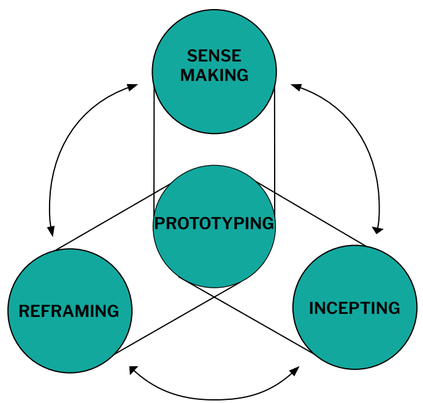
This methodology is useful when leading actors have already stated an initial framing about the challenges and the systems at play, and determined their intentionality considering the overall goals. While such directions are likely to change as new actants are involved and new dynamics are surfaced, it is useful to have a starting point for engaging in this process, as the methodology does not provide support for serendipitous explorations.

MODES



We propose prototyping as the main mode of exploration because the design of sustainable solutions for socio-ecological complex challenges requires continuous and iterative learning methods. Prototypes are artifices through which one can learn about the context, do research, test hypotheses and concepts (associated with artifacts or knowledge), and explore alternative futures through faster and cheaper experiments. Rather than linear, they present a dialectic learning process that can inform alternative paths to traditional logic of knowledge creation and dissemination.

Although prototypes will serve different purposes in relation to the other modes of exploration, they are generative activities that enables the exploration of previously unarticulated (and often hidden) connections, the creation of new concepts, the framing of new opportunities, and even the speculation about different futures. As any human activity, they can also carry politics and bias that can either be revised, or transferred into the proposed interventions. However, if properly designed, they can continuously inform actors about the socio-ecological systems they are involved in.



Prototyping

actors are thinking by doing, and learning by intervening. This mode involves interacting with others and the environment, validating assumptions about existing dynamics, exploring multiple functions actors assume and the influence of actants, showing intentions of interventions, uncovering tensions among actants, gathering feedbacks, provoking reflections and reactions, among others. Because this mode is highly contextual, questions should also be specific to the situation of interest, the stage of the process, and the goal of the intervention.

Sense making

actors are focused on gathering information given their intended goals, and reflecting about the system and the situation of interest. This mode involves developing consciousness through critical questioning and analysis about the situation and the self to map the dynamics shaping the context. Questions should involve: What are the challenges? How are they manifested? Who is involved, and why? When and where it happens?

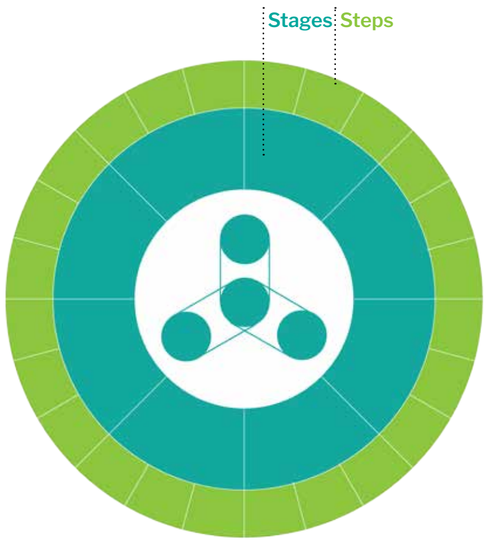
Reframing

actors are focused on challenging the existing order, the current comprehension of the context, and the status quo. This mode involves raising different questions that can inform not only the fundamental barriers to be overcomed, but also new points of view and even new paths for interventions. Questions related to this mode are related to: What if ? How might we's?

Incepting

actors are focused on embedding sustainable solutions in socio-ecological complex challenges to increase the fitness of interactions among actants. This mode involves collaborative activities to co-design interventions, and is centered on answering what should be done and what could happen, including desirables and non-desirables outcomes.

STAGES



The proposed methodology consists of eight stages, each with its own steps. Because all of the stages present opportunities for amplifying actor's understanding of the dynamic interactions in the situation of interest, they will somehow contribute to expanding the opportunities for integrating the social and the ecological systems, as well as providing new possibilities for interventions.

When intervening in systems, there is no single, linear path. So, the structure presented in this playbook offers one of the many possibilities for going about these stages. For the same reason, the steps presented are meant to be guiding activities, and should not be understood as tasks or the only focus for every stage. Rather, they indicate relevant paths to the design of sustainable solutions in socio-ecological systems.

It is assumed that actors involved in these stages will rely on existing design methods to complement their innovation processes. For example, this playbook does not provide the necessary support to guide actors in moving from observation to insights. This is a fundamental step in innovation processes that the field has already develop rigorous techniques to guide actors. Several examples can be found in Vijay Kumar's book, 101 Design Methods[11].

UNDERSTAND CONTEXT

Understand major decisions and narratives that shaped the context, and how innovation is currently contributing to the challenge.

Identify resources in the context, including human and non-human actants, the constraints and the underutilized assets.

Map the values being exchanged between actants in the context, and their activities and experiences.

UNCOVER TENSIONS

Map and represent elements of the system considering the features, affordances, impacts and goals.

Map and represent the morphology, physiology, and anatomy of the infrastructures in the systems.

Sketch dynamic interactions among actants considering the variables in the systems, and main activities.

CHALLENGE PRACTICES

Surface patterns of degenerative dynamics shaping tensions, and validate assumptions with others.

Outline assets that should be maintained, leveraged, or regenerated. Validate with others.

Understand the distribution of capabilities among actors and explore limitations for interventions.

FRAME OPPORTUNITIES

Confront isolated modes of interventions and be strategic about team composition.

Collaboratively agree on desirable impacts based on opportunities for collaboration.

Identify spaces with high demand for intervention given the assets and capabilities to be leveraged.

DEFINE PRINCIPLES

Clearly state the expectations of the collaborations among actors, including roles and responsibilities.

Surface individual beliefs, and discuss among actors which ones should sustain the interactions among the collaborators.

Collaboratively define principles to guide innovation processes, and make sure they are surfaced throughout the engagements.

EXPLORE ALTERNATIVES

Considering the set of criteria, build on existing initiatives, and explore how interventions can expand their impact through prototypes.

Develop interventions that embrace existing paradoxes considering the principles previously defined.

Explore other laverages points considering uncertainties in the system.

MOBILIZE ACTIONS

Sketch platforms for interventions and prototype new infrastructures to support their development. Refine, pivot, or iterate on previous versions.

Identify indicators of fitness and explore potential consequences, including new activities, values and experiences.

Explore how interventions will contribute to and consider the overall robustness of the system.

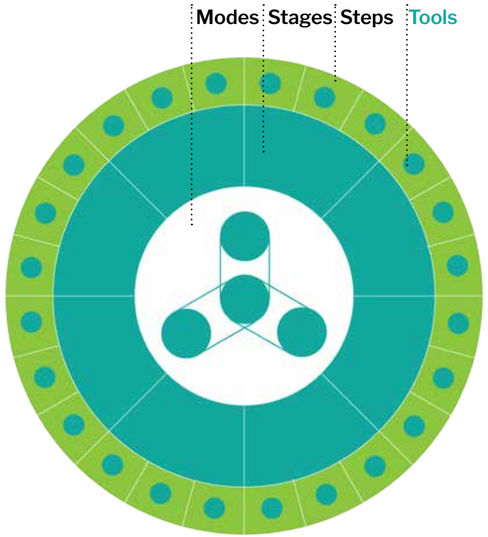
SCALE IMPACT

Advance and scale prototypes engaging leaders with commitment to action and transfer capabilities as needed.

Build on public will, connect with regulatory agenda, participate in the next steps, and define scalability models.

Build narratives to diverse set of audiences, and disseminate knowledge of both impact and processes.

TOOLS



This playbook offers several tools to support actors in the steps proposed by this methodology. Since the proposed methodology is iterative, they should be living actants providing guidance to all actors involved in the design practice.

These tools resulted from the integration of existing design and innovation methods with principles of ecology. Because they incorporate the eight lenses of innovation in their structure, the tools contribute for bridging the gap between ideological discourses and pragmatic actions in innovation processes for sustainable solutions. While not extensive, they provide new pathways for actors to systematically gather and organize information to take more holistic, integrative approaches in their decisions-making process. Yet, there are other tools being developed by colleagues that can be useful in overcoming some of the steps presented by this methodology.

Because this playbook is in progress, not all of the tools have reached the intended level of maturity to receive feedback. As such, the tools presented in this version are highlighted in black, and those in grey are still in early stage of development.

UNDERSTAND CONTEXT

Historical perspectives
Understand major decisions and narratives that shaped the context, and how innovation is currently contributing to the challenge.

Available resources
Identify resources in the context, including human and non-human actants, the constraints and the underutilized assets.

Flows of values
Map the values being exchanged between actants in the context, and their activities and experiences.

UNCOVER TENSIONS

Anatomy of Systems
Map and represent elements of the system considering the features, affordances, impacts and goals.

Ethnography of infrastructures
Map and represent the morphology, physiology, and anatomy of the infrastructures in the systems.

Interdependent relations
Sketch dynamic interactions among actants considering the variables in the systems, and main activities.

CHALLENGE PRACTICES

Patterns of disturbances
Surface patterns of degenerative dynamics shaping tensions, and validate assumptions with others.

New boundaries
Outline assets that should be maintained, leveraged, or regenerated. Validate with others.

Capabilities for change
Understand the distribution of capabilities among actors and explore limitations for interventions.

FRAME OPPORTUNITIES

Benefits of collaboration
Confront isolated modes of interventions and be strategic about team composition.

Common interests
Collaboratively agree on desirable impacts based on opportunities for collaboration.

Bright spots
Identify spaces with high demand for intervention given the assets and capabilities to be leveraged.

DEFINE PRINCIPLES

Alignment of expectations
Clearly state the expectations of the collaborations among actors, including roles and responsibilities.

Shared beliefs
Surface individual beliefs, and discuss among actors which ones should sustain the interactions among the collaborators.

Criteria for interventions
Collaboratively define principles to guide innovation processes, and make sure they are surfaced throughout the engagements.

EXPLORE ALTERNATIVES

Boundary ideation
Considering the set of criteria, build on existing initiatives, and explore how interventions can expand their impact through prototypes.

Paradoxical creation
Develop interventions that embrace existing paradoxes considering the principles previously defined.

Alternative future scenarios
Explore other laverages points considering uncertainties in the system.

MOBILIZE ACTIONS

Sketch Interventions
Sketch platforms for interventions and prototype new infrastructures to support their development. Refine, pivot, or iterate on previous versions.

Consequence systems
Identify indicators of fitness and explore potential consequences, including new activities, values and experiences.

Robustness of the system
Explore how interventions will contribute to and consider the overall robustness of the system.

SCALE IMPACT

Micro pilots
Advance and scale prototypes engaging leaders with commitment to action and transfer capabilities as needed.

Continuous interactions
Build on public will, connect with regulatory agenda, participate in the next steps, and define scalability models.

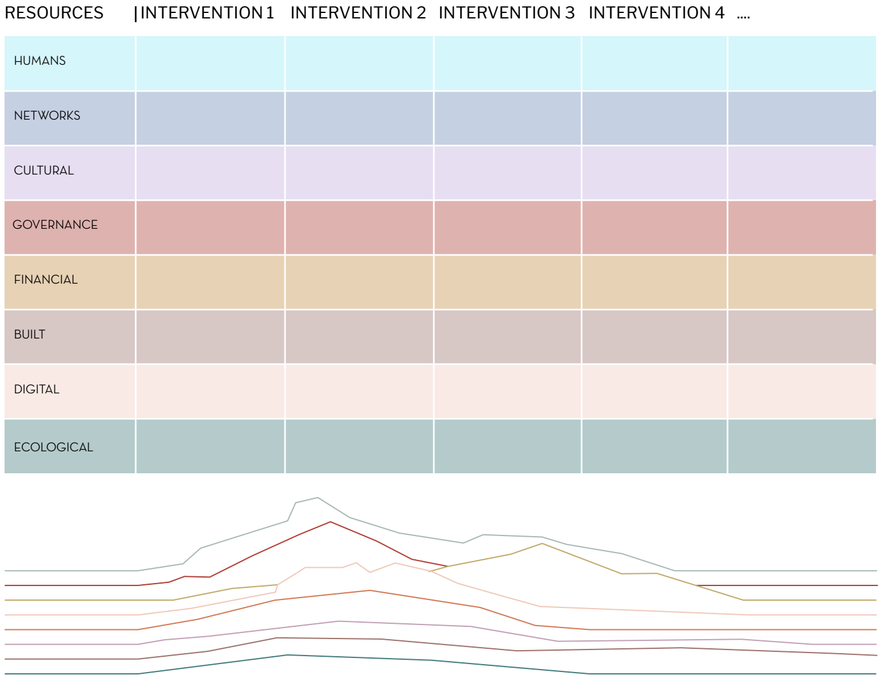
Storytelling
Build narratives to diverse set of audiences, and disseminate knowledge of both impact and processes.

Understand context

Historical perspectives

UNDERSTAND MAJOR DECISIONS AND NARRATIVES THAT SHAPED THE CONTEXT, AND HOW INNOVATION IS CURRENTLY CONTRIBUTING TO THE CHALLENGE.

This tool supports actors to understand how decisions were made over time, and to critically analyze them considering the different prioritization in use of resources and assets. It is also useful to explore patterns of decisions that might inform where opportunities might exist. Actors should use the eight lenses of innovation framework to classify the use of different types of resources in key past interventions that shaped the situation of interest. First, actors should do research about the context to determine the time period to be captured in the representation. Then, map the data gathered according to the appropriate division of time, and the use of resourses from each intervention. Engage with other actors to expand the understanding of the historical context. Lastly, create a subjective scale to represent the use of resources overtime, and score each period considering the prioritization of one lens over the other. While this exercise is purely subjective, it is useful in the exploration of patterns, and in the comprehension of the overall historical impact in the dynamics of the system.



Subjective interpretation that might indicate patterns of use overtime. For example, historically the policy making processes (governance) has not valued democratic participation (culture).

based on the ERAs Map[1]

Understand context

Available resources

IDENTIFY RESOURCES IN THE CONTEXT, INCLUDING HUMAN AND NON-HUMAN ACTANTS, THE CONSTRAINTS AND THE UNDERUTILIZED ASSETS.

This tool is useful to guide actors in exploring available resources based on their intended goals to understand the system. It provides a structure to map the stocks and flows of multiple types of resources, while contributing to identifying new or additional ones necessary to improve the fitness of existing interactions. While the same resource might be classified as both a stock and flow, actors should note that the stock units refer to the resources in their static form, while the flows refers to the resources actively circulating within the system.

Although the exploration should not be limited by initial framings, it is useful to start with a roughly defined boundary around the complex challenge in the system at play. This includes actants shaping the dynamics of the system, as well as a geographic boundary to support the beginning of the mapping exercise. As new information is gathered, these boundaries might change.

List the known resources given actor's knowledge and experience about the situation of interest. Even though not extensive, the guiding questions on the next page should provide a holistic structure for classifying information and expanding perceptions about stocks and flows of available resources.

When seeking for information, it is fundamental that actors rely on ethnographic user studies to understand not only the stocks and flows of resources considering the macro level, but also how these elements are manifested in the micro daily lives of actors involved in the situation of interest. In order to do so, these questions will have to be situated and adapted to the context of exploration.

While mapping the flow of resources, actors should explore how existing assets are being underutilized given their potential to influence new flows of resources and promote change. By identifying them, potential insights about the system might emerge. Insight are actor's interpretations of reasonable patterns that emerge from the information gathered. Make sure actors capture them. Because in this stage insights should be understood as hypothesis, not facts, actors should validate their mapping wtth others involved in the situation of interest, and iterate on the database.

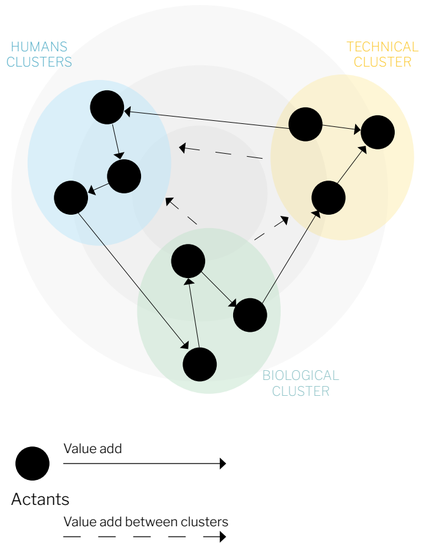
HUMAN		NETWORKS		CULTURAL		GOVERNANCE	
Knowledge	**Wellbeing**	**Professional**	**Personal**	**Local**	**Global**	**Regulations**	**Norms**
What are the institutional structures for knowledge creation and dissemination?	What are the institutions maintaining the capacity of individuals to perform?	What is the portfolio of organizations? What are the values being exchanged?	What are the structures promoting community engagement?	What are the traditions and cultural heritage? What are values and beliefs sustaining them?	What are global elements and practices that have been incorporated in the situation?	What are the policies influencing decisions?	What is the power structure?
How and where are the engagements within these structures happening?	How are is the capacity of individuals to perform?	How and where are partnerships and collaborations being formed?	How and where are the events and activities supporting for social gathering happening?	How and where are the (ordinary) practices and manifestations of the values and beliefs?	How and where are individuals and organizations being exposed to new global practices?	How and where are they being enforced?	How and where are decisions being made?
FINANCIAL		**BUILT**		**DIGITAL**		**ECOLOGICAL**	
Services	**Money**	**Infrastructure**	**Products and Services**	**Infrastructure**	**Data**	**Fauna and Flora**	**Life support systems**
What are the structures allowing for credits and loans?	What is the institutional structure defining value?	What is the infrastructure available and its condition?	What are the portfolio of offerings supporting activities?	What are digital infrastructures available?	What are the mechanisms for data collection?	What is the composition of species?	What is the composition and functions of energy, blue and green infrastructures?
How and where are financial services being provided?	How and where money in flowing considering the incomes and expenditures?	How and where are infrastructures being used?	How and where products and services are being produced and consumed?	How and where are infrastructures being used?	How and where data is stored?	How are species growth rates affected by various activities?	How and where are nutrients and components being extracted and regenerated?

Flows of values

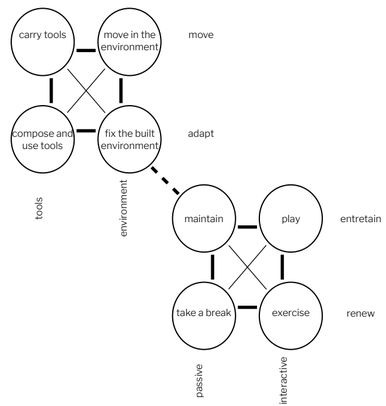
MAP THE VALUES BEING EXCHANGED BETWEEN ACTANTS IN THE CONTEXT, AND THEIR ACTIVITIES AND EXPERIENCES.

The flows of values should be sketches that represent where multiple types of values are being created, exchanged, or lost. Exploring options for interventions is often artificially constrained by assuming the engagements between actors are unchangeable. However, by identifying the human and non-human actants that are giving and receiving values, participants can expand collective dialogues around of what kinds of interventions are needed, how they can be structured, where and when they can be created, and ultimately who are the beneficiaries and the responsible for promoting the desired interventions. Values can be of any type: materials, nutrients, products, services, money, brand, or any other element that makes it worthwhile for each actant to be a participant in the web. Clustering the actants according to their nature (human, non-human technical, non-human biological) helps the comprehension of what values are circulating among and in between them. The matrix below supports actors to expland their definitions of value. The diagram on the right provides an example of how value flows might be represented. Circles in the background indicates proximity to the situation being analyzed.

	HUMANS	NETWORKS	CULTURAL	GOVERNANCE	FINANCIAL	BUILT	DIGITAL	ECOLOGICAL
WHAT ARE THE VALUES BEING EXCHANGED?								
WHAT ARE ACTIVITIES SUSTAINING THESE FLOWS?								



In addition to understanding how multiple values are being exchanged, it is important to understand what are the activities sustaining these flows. By doing so, new opportunities for innovation can be revealed. Use the innovation lenses to list activities sustaining the flows of multiple values. The activities could include those of some or all actors involved in the situation of interest. Then, cluster them based on similarities. Label each cluster, and draw lines between them based on dependency. Finding a broad definition for any cluster is a key part of the method. For example, “bringing people together,” “coordinating tasks”, “providing support,”. Rearrange the clusters for a diagrammatic representation considering the shortest line lengths and minimum line crossing, while indicating relationships and hierarchies. Are the activities supporting the goals?



based on the value webs and activity networks[11]

Uncover tensions

Anatomy of systems

MAP AND REPRESENT ELEMENTS OF THE SYSTEM CONSIDERING THE FEATURES, AFFORDANCES, IMPACTS AND GOALS.

Designers are known for their abilities to create interventions (products, services infrastructures and systems) with product-technology features capable of promoting new experiences among actors. While these interventions are often oriented towards impacting social systems, they embed new affordances into the socio-ecological context, and generate new interactions not only among humans, but also between humans and non-humans actors. Thus, it is important to situate the intervention considering the overall structure of the socio-ecological system.

This tool supports actors in understanding the interconnectivity between features, the interactions among actants afforded by them, the impacts these interactions generate, and the overall alignment between the features and the intended goals. Each zone should be read separetely given its own dimentions. While there is no single path for utilizing this tool, here is one suggestion:

Start by adding one goal in the center of the diagram. Identify few indicators of impacts supporting the achievement of the goal. Position them in the following circle and connect them to the goal. Identify features of the sytem supporting impacts, and position them in the outside circle. Then, connect the impacts with the features through the actionable properties these features embed into the the system. Apply the eight lenses of innovation to expand the representation of the system. Use color coding for separating the different levels and elements, and for tagging the different lenses. This will should surface how resources are flowing beteween the levels of the system. Validate your representation with others.

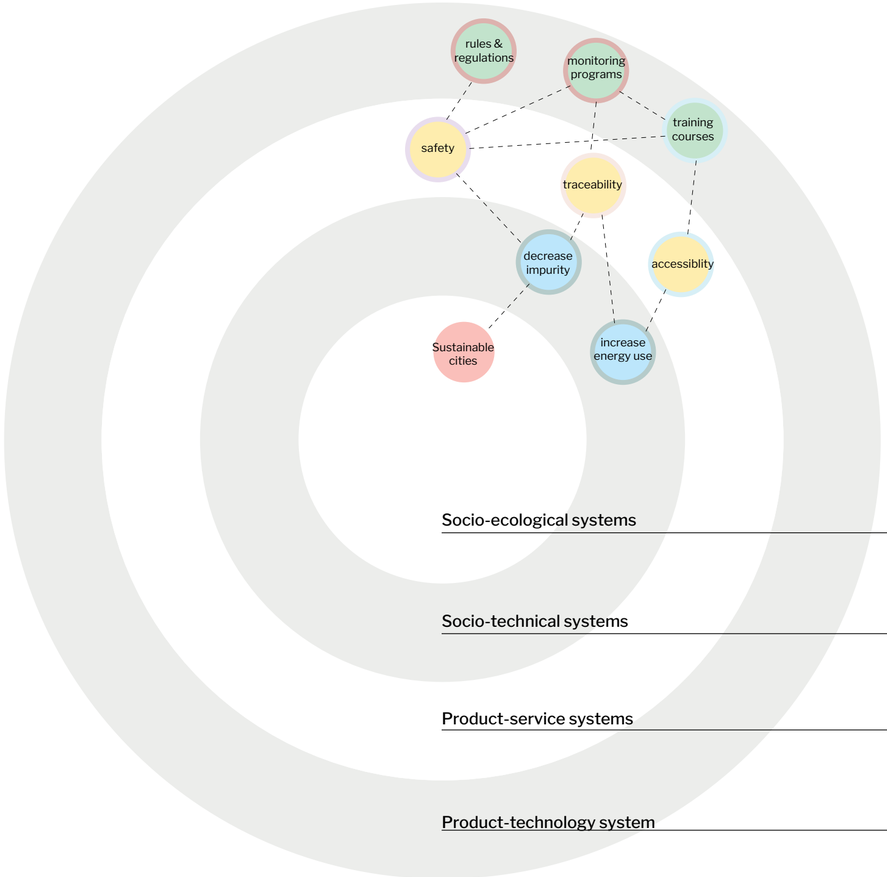
GOALS drives IMPACTS drives AFFORDANCES drives FEATURES

Desirable high level result based on actors' ambitions in designing the interventions and taking actions. (e.g. erradicate povertity, end hunger, responsible consumption).

Higher forces applied over existing ones that promote changes in the dynamics of the sytem. They can be intentional or not. (e.g. increase in education, environmental degradation).

Actionable properties embedded in products and infrastructures shaping interactions; actors in turn must possess the capabilities to perceive it and to use it (e.g. inclusion, diversity, traceability).

Attributes of products and infrastructures supporting devoted to specific functions and allowing specific actions among the actors involved (e.g. rules, sensors, signage).



ZONES IN THE DIAGRAM

Socio-ecological systems

refers to the aspirations to form cooperative and interdependent sustainable relationships with others actants.

Socio-technical systems

referes large-scale transformation in the way socio-technical functions are fulfilled. Elements in this level can function independently from others.

Product-service systems

referes to physical and organizational capacities that fulfill specific functions given their time, place, and actors involved. They cannot function in isolation.

Product-technology system

refers to human-made physical artifacts and digital technologies that influence and shape interactions among actors. They might fulfil one or more clearly distinguishable functions.

based on the multi-level model[12]

Uncover tensions

Ethnography of Infrastructures

MAP AND REPRESENT THE MORPHOLOGY, PHYSIOLOGY, AND ANATOMY OF THE INFRASTRUCTURES IN THE SYSTEMS.

The overall goal of this stage is to deconstruct the infrastructures supporting interactions among actants in the situation of interest. Because it is a context-based activity oriented by a particular focal point of interest, information gathered will be determined by unique circumstances, and influenced by the cultural perceptions of actors involved. This tool is useful for expanding the spectrum through which actors observe and interact with the infrastructures and their surroundings.

When deconstructing the infrastructures, actors should rely on the multiple levels forming socio-ecological systems given their own depth of detail according to their (A) morphology, (B) physiology, (C) anatomy, (D) behavior, (E) origin, (F) distribution, (G) stocks, and (H) affordances. Note that not all of the information from all the different levels are relevant to every design practice.

Once relevant information is gathered, the overall focus becomes to uncover the logics through which interactions are happening within and across the different of the levels, considering critical paths through which resources are flowing among them. In order to do so, actors might use the innovation lenses to expand their perceptions around the different typles of resources flowing among actants in the system. The proposed structure was developed based on fieldwork methods from biology, and theories of ecological compositions and analysis of landscape.

Although doing ethnography of infrastructures are human-led activities, and therefore will carry all of the aspects related to this conditions, including individual biases, this tool provides a structure for externalizing them, as well as establishing new dialogues about the dynamics in the system among different actants in the socio-ecological system of interest. Actors should substitute general information in the diagram for data gathered in their exploration of the situation of interest.

(A) MORPHOLOGY
The consideration of the size, shape, volume, texture, materiality, arrangements and composition of the elements in the system.

(B) PHYSIOLOGY
The function of the elements and their overall fitness in the system.

(C) ANATOMY
The analysis of the structure or parts that make up the elements in the systems and their living interactions.

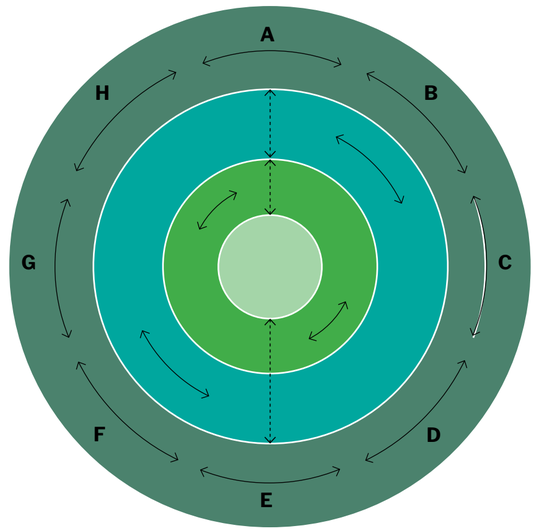
(D) BEHAVIOR
The analysis of the dynamics interactions between elements that results from the aggregate of autonomous actions or reactions in response to a particular situation.

(E) ORIGIN
The reason why elements existis, and what are the purposes they serve in the system, including roles, responsibility, and performances.

(F) DISTRIBUTION
The physical and non-physical presence of the elements in the daily lifes of actants in the system.

(G) STOCKS
The consideration of resources by their static resource units that support interactions among actants.

(H) AFFORDANCES
The actionable properties that the infrastructures are unlocking, and the processes that occurs in the systems because of their presences.



Socio	Ecological
Individuals	Genes
Communities	Species
Organizations	Ecosystems
Networks	Landscapes

based on the natural-based model[11]

Interdependent relations

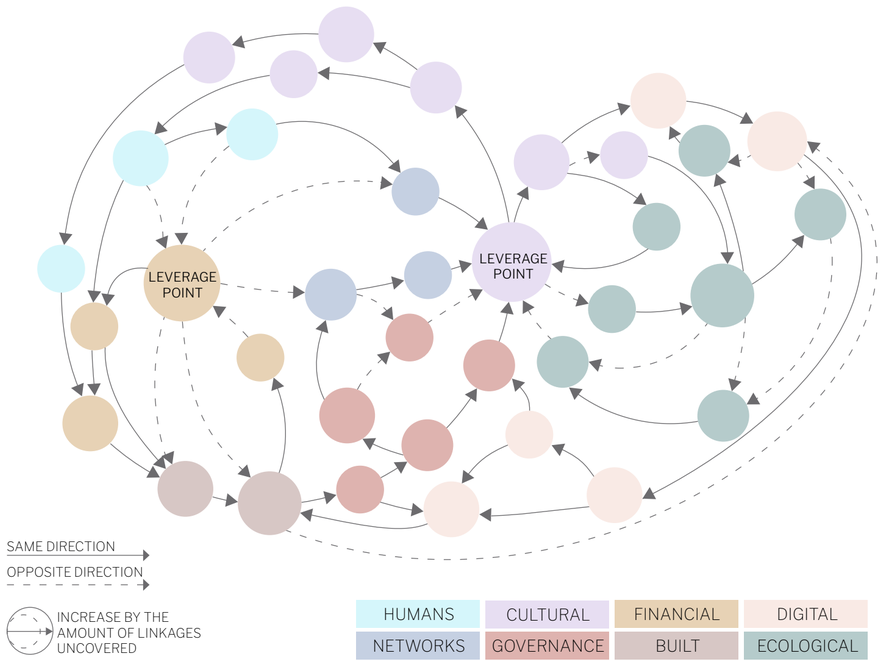
SKETCH DYNAMIC INTERACTIONS AMONG ACTANTS CONSIDERING THE VARIABLES IN THE SYSTEMS, AND MAIN ACTIVITIES.

This tool provides a high level visualization of the system considering the variables shaping its fitness. It supports actors to discover what are the points to be leveraged given the dynamic interactions among the actants, their causal relationships and their interdependency. It can also be useful for validating assumptions and expanding actors' perceptions about potential impacts, network effects, and consequences of their interventions.

Start by exploring the variations in the system caused between the two main actants in the system, and then expand your representation to other relationships. This should lead to discovering variables in the system: elements capable of increasing or decreasing over time. Make sure you don't represent static elements as they are not representative of the dynamics of the system. Use arrows to indicate the directions of the relationships between the variables. Use solid lines to represent relations trending in the same direction, and dashed lines in the opposite direction. Repeat this exercise considering other actants, and apply the eight lenses of innovation to expand the perceptions of the interdependent relations among them.

For example, in an educational system, actors might be teacher and students. If the goal of the system is to educate as much students as possible, then the variables might be qualification of the teacher (not the teacher), and the involvement of the student (not the student). The direction between the variables will depend on the situation of interest. By applying the built lens, one might include accessibly to the learning environment as another variable.

Sketching visualizations of interdependent relations can be messy. In order to have a clear diagrammatic representation and a better comprehension of the the flows of multiple resources in the system, use the eight lenses for clustering the variables, and aim for the shortest line lengths in the clusters and minimum line crossing within and across them. Also, consider representing hierarchies among the variables by correlating the size of their circles with the amount of relations they have in the system. The more arrows they have, the bigger their circle will be. By doing so, the points to be leveraged will be more easily surfaced, as they will be represented by the highest number of arrows.



Capabilities for change

UNDERSTAND THE DISTRIBUTION OF CAPABILITIES AMONG DIFFERENT ACTORS AND EXPLORE LIMITATIONS FOR INTERVENING IN THE SITUATION.

In order to generate positive impacts, it is important to recognize what are the capabilities actors have to use resources, and how assets are being utilized. Actors should start with self-reflections to consider their own capabilities, and then integrate the collective. Below is a suggestion of how each actor can explore its own capabilities given their use of resources and assets. On the right, a suggestion of how capabilities might be combined, and what they can inform.

First, consider positive changes each actor in the system have promoted, and reflect on the questions: why are they considered a positive change? What capabilities allowed them to be implemented? First list the capabilities, and then use the structure below to identify the multiple resources and assets used by each one of the actors. In this stage, actors should expand their perceptions about their agency in the system by correlating their use of resources and their capabilities. Lastly, actors should be able to understand how they interact with existing resources in the system, discover how their capabilities are influencing the flow of resources, and what limitations they might have in influencing these flows given their capabilities.

	HUMANS	NETWORKS	CULTURAL	GOVERNANCE	FINANCIAL	BUILT	DIGITAL	ECOLOGICAL
WHAT RESOURCES WERE USED?								
HOW THEY WERE USED?								
WHY THEY WERE USED?								
WHO BENEFITED FROM IT?								
CORRELATED CAPABILITIES								

For a better outcome of this step, it is recommended the use of physical artifacts to roughly represent the use and prioritarization of resources. Each actor should have one, similar artifact that is built accordingly with the context of its application. When combined, artifacts surface the overall use and prioritarization of resources according to the capabilities that each actor brings to intervene in the system.

Once individual representations are created, actors should combine their data and compare them considering their use of resources, utilization of assets, and their own capabilities. Actors should be able to answer the following questions:

1. What are the most and the least prominent resources being used and assets being utilized?

2. What capabilities to intervene in the system different actors bring, and what are the missing capabilities among those involved?

3. What is the overall interaction with the resources and assets in the system?

4. Are there other actors that should be involved?

On this example, actors used a pizza as an artifact for interaction. Each actor had one pizza. The colors of the slices represented the different types of resources, and the thickness represented their prioritization. Actors also used the artifact to explore multiple combinations. For example, they combined pizzas by types of resources, and by major resources being prioritized to understand their impact in the system as a collective.

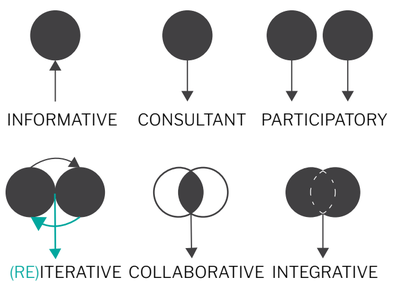
Benefits of collaboration

CONFRONT ISOLATED MODES OF INTERVENTIONS AND BE STRATEGIC ABOUT TEAM COMPOSITION.

As actors intervene in complex socio-ecological challenges, they often conclude that a collaborative approach to innovation practice is required to achieve sustainable solutions. The increasing popularity of participatory practices in innovation processes reflects the widely shared belief that collaboration offers the potential to generate interventions that could not be designed by isolated efforts. When developing strategies for collaboration, actors are either focused on the technical expertise needed to develop the desirable interventions, or on expanding the demographic composition of team to bring new social perspectives around the situation of interest. Either way, strategies have been focused on collaboration for problem solving, but not for problem definition. As a result, actors may experience unanticipated negative side-effects in the system, even when the team fulfills its technical requirements and expands its demographic representation. While both technical and demographic criteria are fundamental for informing collaboration focused on designing sustainable solutions, they should not be considered as the only determinant factors.

This tool provides actors with a structure for considering additional factors, other than demographics and technical expertise, when mapping the overall composition of their teams. It considers, for example, personal experiences as valuable contributions that actors directly or indirectly bring to solutions. Moreover, it understands that actors bring different lenses for the innovation process, might play different roles, and can bring different types of knowledge around the situation of interest. They are also likely to contribute to different sectors of society, and even operate within different levels of the social system. Each one of these criteria is relevant when defining the overall composition of the team. While no single structure cannot summarize the holistic contribution each individual can bring, this is helpful for articulating the overall composition of the team, for surfacing deficits and overlaps in advance, and for supporting strategic decisions about who should be involved, and why.

TYPES OF ENGAGEMENT



TEAM COMPOSITION

How many actors are involved?

What levels of the system are being represented?

ACTOR KNOWLEDGE

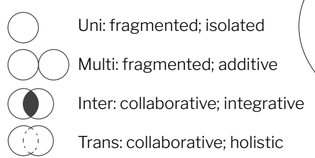
Tacit: know-how; experience

Explicit: formalized; codified

Embedded: locked; daily practices

Statistical: data driven.

TEAM DISCIPLINES

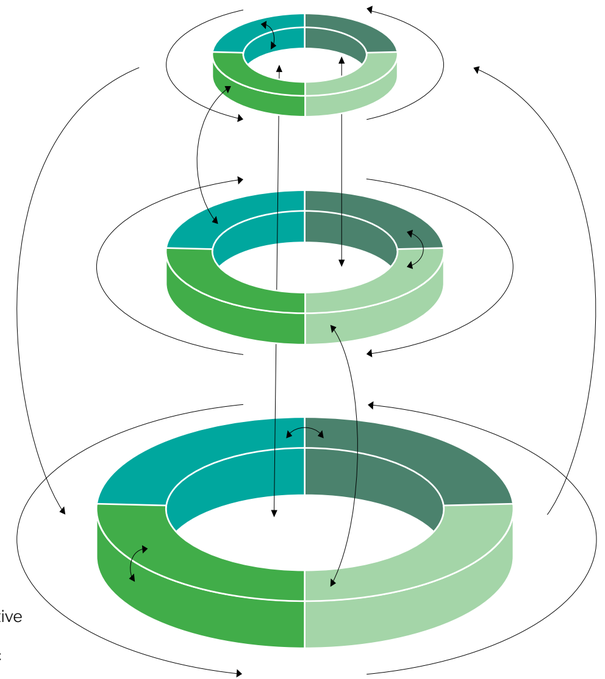


Uni: fragmented; isolated

Multi: fragmented; additive

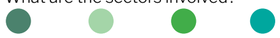
Inter: collaborative; integrative

Trans: collaborative; holistic



SECTOR'S REPRESENTATION

What are the sectors involved?



Public Academia Private NGO

KNOW-HOW

Strategic (MACRO)

Rational approach based on structures and functions in general laws: ecological (e.g. thermodynamics law), legal (e.g. regulations) or technical (e.g. models for optimization). It relates to systems dynamics.

Operational (MESO)

Integrative approach to fit functional and relational complexities. It relates to institutions, organizations and communities that reveal connections between micro-macro levels.

Tactical (MICRO)

Subjective approach within specific contexts, situations and circumstances. It relates to adaptations of natural phenomena, as well as culture and its diversity at the ground level.

Common interests

COLLABORATIVELY AGREE ON DESIRABLE IMPACTS BASED ON OPPORTUNITIES FOR COLLABORATION.

The exercise of challenge framing is an endeavor activity that requires commitment and openness among actors. Thus, getting a good sense of what the opportunities are for collaboration should take into account the expertise and experiences of the actors involved as a fundamental step to understand the potential of the impact. More integrative opportunities can be identified by applying the innovation lenses to support interactions of the challenge framers, given the desirable changes in a particular domain or area of interest.

This activity should start with individual reflections about what is the challenge to be confronted, and why. Actors should consider opportunities boundless in this early exploration, and write them all considering the proposed framework. Framing efforts should consider the criteria for engagement previously defined, and how actors plan to use the different types of resources considering their interests to intervene in the system. Although speculative, they should consider what might be the overall change in each type of resource given their challenge framing. In pairs, actors should share their points of view and speculations about resource use, and advance the conversation with the goal of integrating their individual perspectives into one statement.

At every opportunity, actors should be open to reflect and expand their perspective about their personal definition of challenges, and recognize the brain power and capabilities to deal with different resources as valuable assets for interventions. They should explore “what if” questions to frame challenges based on shared interest, and transform them into opportunities to build on their individual positions. Once they achieve an initial framing, actors might ask themselves: does this challenge require innovation? This process should be repeated to build on group consensus by expanding engagements exponentially (1-2-4...) until one final statement is achieved.

INITIAL REFLECTIONS:

These questions serve as initial reflections for individual activities, but also as a starting point for collective conversations.

What are the disturbances in the system?

What should be the goals of interventions?

What are the desirable changes or needs to be covered in the system?

What are impacts actors envision in the flows of resources?

Resources	should it increase decrease maintain
HUMANS	
NETWORKS	
CULTURAL	
GOVERNANCE	
FINANCIAL	
BUILT	
DIGITAL	
ECOLOGICAL	

EXPANDING:

Individually or in groups, actors might challenge their own perspective by asking themselves:

What if (the desirable change or need) became a path for achieving (the goal of the intervention)?

Then, they should expand their hypothesis, and speculate:

Who would benefit from it?

What are values would be added to and extracted from the system?

Are there big risks?

What might be barriers and drivers of change?

FRAMING:

Once actors have identified a challenge worth tackling, draft a question that clearly indicates the aspects to be addressed, the desirable change(s) in the system, the intended impact(s), and the overall goal(s). Below is a framework to structure your answer:

HOW MIGHT WE (verb + challenge to be addressed)
TO (verb + desirable change in the system)
SO WE CAN (verb + intended impact)
AND ACHIEVE (overall goal)?

Lastly, in addition to a final the table of intended impacts, it is important to consider:

What are other challenges related to this one?

Who were the partners framing this challenge?

What are potential and desirable partners to be involved?

Define principles

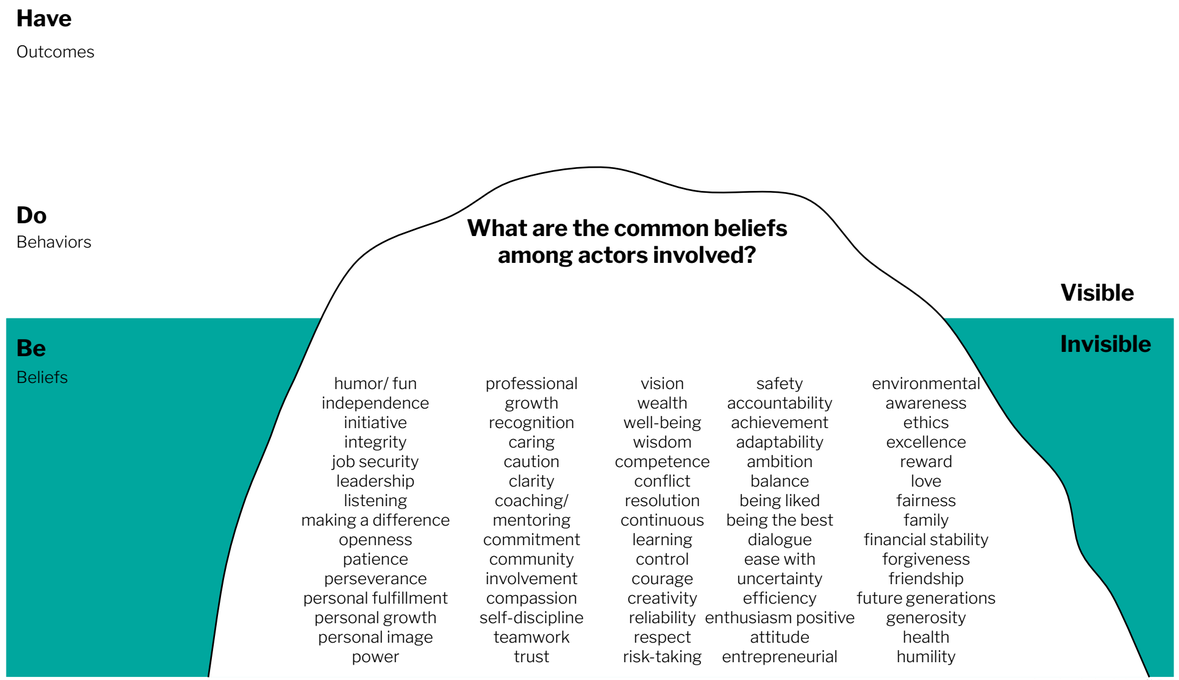
Shared beliefs

SURFACE INDIVIDUAL BELIEFS, AND DISCUSS AMONG ACTORS WHICH ONES SHOULD SUSTAIN THE INTERACTIONS AMONG THE COLLABORATORS.

As actors are increasingly involved in collaborative processes of making decisions, new processes of establishing agreements and reducing the friction between individual beliefs and collective expectations are required. When making choices, actors will search for signals about how to fit within a certain community, and adapt their behavior accordingly. If they cannot find a proper path to adapt, it is likely they will leave or be ejected. Thus, every collaboration exerts pressure on its actors to conform to its cultural norms. For the purpose of this exercise, culture will be considered as the standard beliefs and expectations of "how actors act." It involves messages that actors will share and receive about how individuals are expected to behave, given the collective goals, beliefs, routines, needs, or values.

Developing a conscious culture among actors collaborating is imperative for the achievement of their goals. In this exercise, actors might start by asking themselves: "What culture do they need in order to achieve the intended outcomes?" Collaborations agreements tend to be established considering tangible aspects (the effect), obscuring the importance of what remains hidden (the cause). When collaborating, actors usually focus on results (the having), and give little attention to the necessary process (the doing), and even less to the fundamental aspects underlying processes and providing the necessary capabilities for their functioning (the being). This exercise supports actors in developing consciousness about "the being" by surfacing the different beliefs that each individual brings to the collaboration, while providing guidance to establish alignment considering their differences.

Start by individual reflections on what are the core five behaviors the collaboration should adopt in order to achieve the desirable results? Actors might reference the list provided in this tool, and expand as necessary. Combine the stated beliefs from the different actors based on similarities, and name the clusters. While there might be similar words, it is important to check on the meaning and personal definitions about the terms because actors will bring their own interpretation about the situation, and the required behaviors to sustain the productivity of the collaboration. Then, create statements that represent the collective intentionality.



based on the be-do-have[11]

Define principles

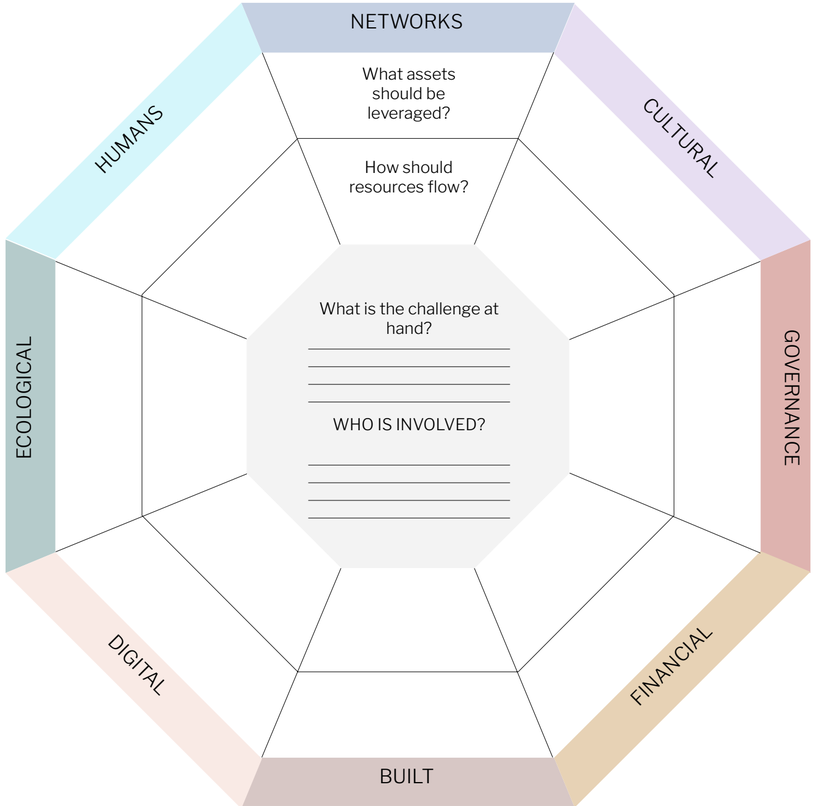
Criteria for interventions

COLLABORATIVELY DEFINE THE PRINCIPLES THAT WILL GUIDE INNOVATION PROCESSES, AND MAKE SURE THEY ARE SURFACED THROUGHOUT THE ENGAGEMENTS.

This tool supports actors to speculate about new boundaries of the system through criteria-based ideation processes. Criteria are principles intended to guide decisions during design processes to dictate how innovation should move forward. Traditionally, the development of criteria in design practices comes inform how the gap between current systems and the desirable state will be achieved. They emerge as a result from fragments of knowledge embedded in individual's mental model and capabilities that are sparked by the circumstances they believe are problematic. While a significant amount of effort has been dedicated to exploring how more meaningful criteria can emerge, particularly to meet the needs and wants of humans, little attention has been given to how individual's mental models and capabilities frame the vision and the direction of the intervention.

Considering each actor's capabilities to intervene in the system and the shared beliefs, reflect on critical criteria to guide the interventions given each one of the lenses. Each criterion should indicate the intentions about how particular resources should be used and assets should be leveraged in the system at play, especially in the long-term application. First, use the table below for sketching criteria as individual actors. Then combine with the other actors to compare and explore multiple combinations of criteria. Actors might start in understanding similarities, and finish by using the wheel on the right to agree on one criterion for each one of the lens that should be prototyped in future interventions.

	HUMANS	NETWORKS	CULTURAL	GOVERNANCE	FINANCIAL	BUILT	DIGITAL	ECOLOGICAL
How should resources flow?								
What assets should be leveraged?								



Explore alternatives

Ideation of boundaries

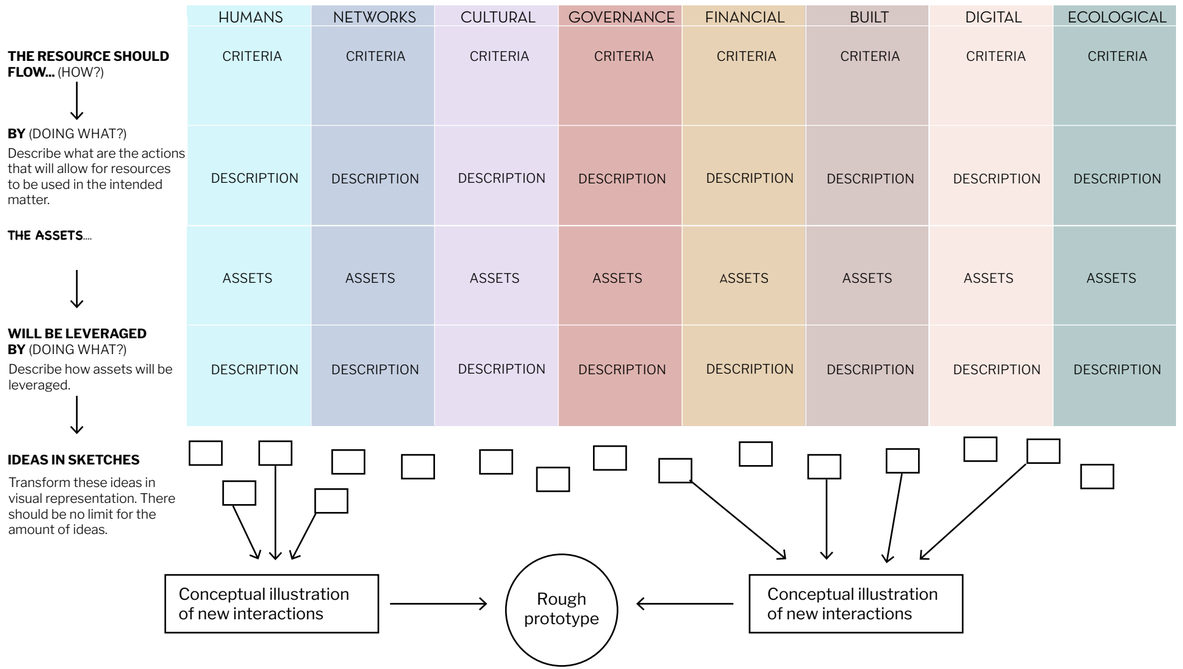
CONSIDERING THE SET OF CRITERIA, BUILD ON EXISTING INITIATIVES, AND EXPLORE HOW INTERVENTIONS CAN EXPAND THEIR IMPACT THROUGH PROTOTYPES.

First, actors should start with their set of criteria and identify those capable of expanding existing initiatives by expanding their impact. Actors should rely on the innovation board to incorporate previous decisions into their ideations. New ideas should emerge from the criteria given the provided structure. Designated sketchers should capture collective ideas with small descriptions, and validate them with the other actors. A sketch that seems unimportant in early stage may have more value later in the process when concepts are combined into solutions because they are manifestations of alternative futures developed based on the set of criteria.

Then, actors should combine multiple sketches into conceptual illustration by speculating new interactions among both the actants involved in the existing initiatives, and the new ones that might come into play. This step inform speculations about new boundaries to be formed in the system. Actors should make the series of illustrations showing how their imagined interactions are aligned with the set of criteria previously defined, and how they are supporting transitions in the system to achieve the overall goal.

Lastly, actors should quickly move into rough prototypes to represent how their intensions can be translated into concrete interventions. Rough prototypes are important in this early stage because they become boundary objects to establish discussions among future interactions, rather than focusing on the specifics of offering itself. By inviting other actors into the debate, prototypes also support generative discussions about consequence systems that would not have been obvious in the previous steps.

When engaging with others, actors have to make sure there is a narrative behind their prototypes capable of translating the how the complexity involved in the challenge is embedded into a concreate intervention, and how existing initiatives are being leveraged. Actors are encourage to use information in tools from early stages to situate their intentions, and understand how new boundaries might be formed in the system.



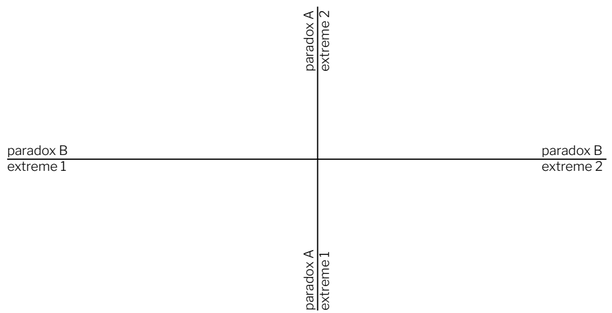
Explore alternatives

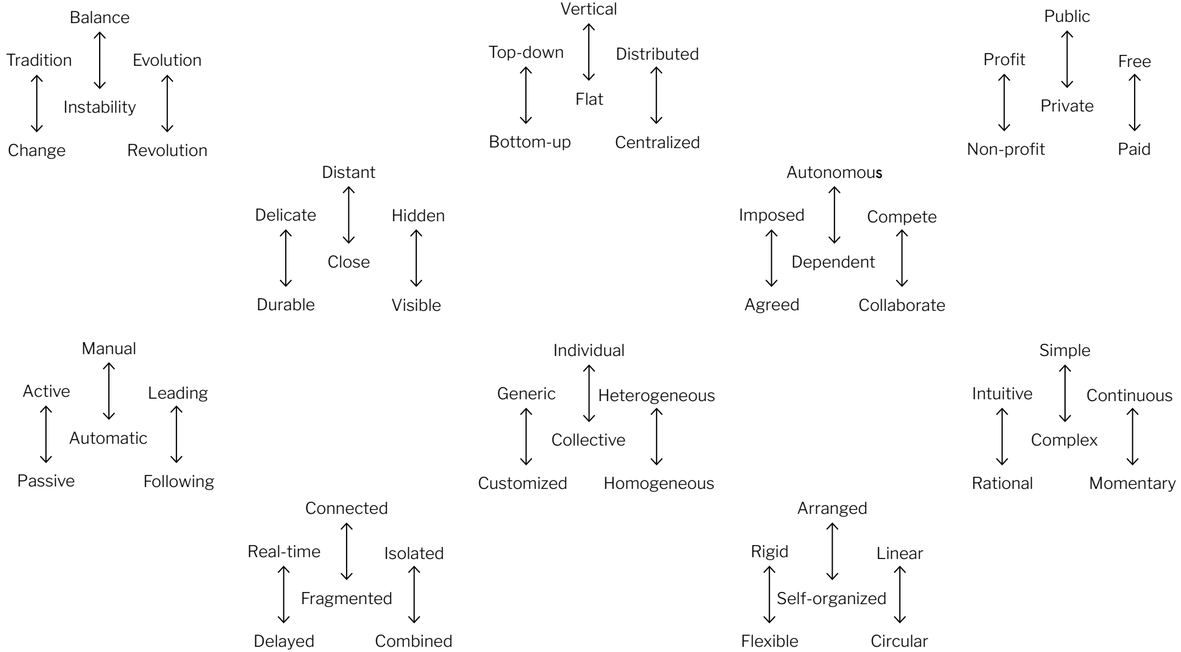
Paradoxical creation

DEVELOP INTERVENTIONS THAT EMBRACE EXISTING PARADOXES CONSIDERING THE PRINCIPLES PREVIOUSLY DEFINED.

A paradox is a statement that contradicts itself and might yet be true (or false at the same time). Socio-ecological complex challenges are characterized by their many inherent paradoxes, and the tensions they create. Sustainable solutions should incorporate interventions capable of addressing both sides of the paradoxes. This is called paradoxical thinking. Please use the suggested list as starting point to discover paradoxes within the socio-ecological challenge.

Start by selecting two paradoxes shaping tensions. Write the extremes of each paradox on the axes of the quadrant. Considering the principles of interventions previously established, look at each quadrant separately and ideate on interventions that address their extremes. Generate as many ideas as possible. Determine whether or not interventions exclude each other, and cluster them based on their similarities. Finally, explore how they connect and reinforce each other in an interconnected array of interventions. Repeat considering as much paradoxes as possible to speculate future scenarios that can be prototyped.





Based on Bau[15], adapted from Namahn's systemic design toolkit. Namahn developed a set paradoxical cards that can be found in their website.

Explore alternatives

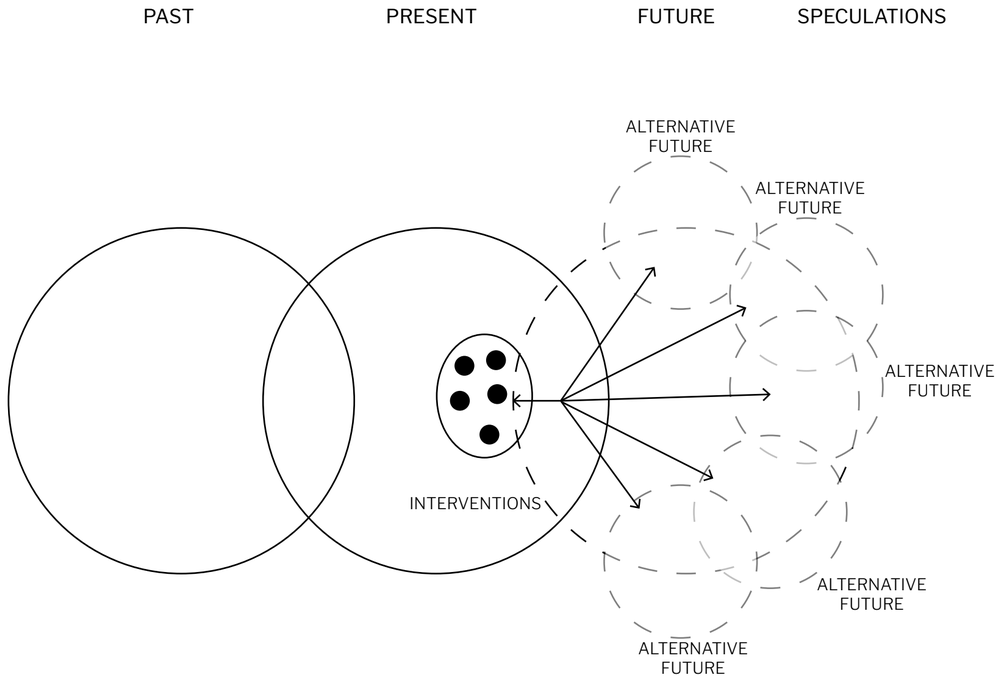
Alternative future scenario

EXPLORE OTHER LAVERAGE POINTS CONSIDERING UNCERTAINTIES IN THE SYSTEM.

When intervening in systems it is important to recognize complexity but also uncertainty. This means exploring the future in a non-linear way, including its resistance to change. What are aspects and functions in the system that can remain the same regardless of future system change?

Future-state scenarios enables actors to think about solutions that can handle multiple possible futures. New scenarios should be generated based on alternative leverage points that were not considered before given their expression of critical uncertainties. The goal is to expand on potential for impact, and develop narrations of alternative future visions that can ground interventions considering secondary effects in the system. The previous conceptual intervention should stay the same, but its manifestations and the new interactions should account for different situations. Based on new situations, actors should reflect on what other futures might be considered to achieve a more robust, sustainable solution? What might be new features and affordances to be incorporated into the intervention?

Actors should start by referencing their early representations of the system structure and system's dynamics to reach a common understanding about what situation in the system should guide new explorations. Then, actors should follow similar processes of the previous ideation. While alternative future scenarios might inform new tensions to be addressed, it is important that actors stay aligned with the criteria for interventions and the overall goals already established. Lastly, actors should create a storyline that represents what interactions would look like if the scenario becomes reality, including the previous explorations.



based on the Future-state scenario[1]

Mobilize actions

Sketch interventions

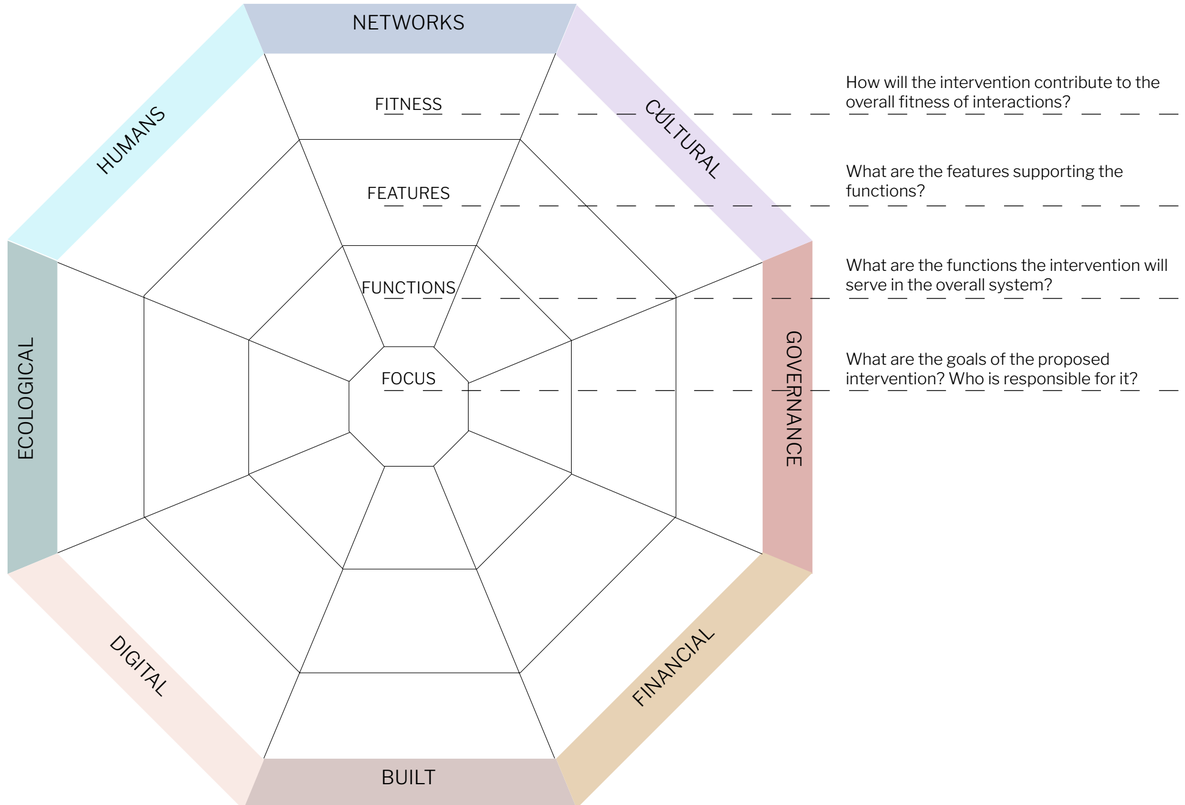
SKETCH PLATFORMS
FOR NTERVENTIONS
AND PROTOTYPE NEW
INFRASTRUCTURES
TO SUPPORT THEIR
DEVELOPMENT. REFINE, PIVOT,
OR ITERATE ON PREVIOUS
VERSIONS.

Because existing infrastructures were not established based on principles of sustainability, they are limited in supporting interventions for overcoming complex challenges in socio-ecological systems. Due to the adaptive nature of these challenges, it is important to sketch interventions before mobilizing significant amount of resources. Sketches should focus on new platforms capable of supporting new organizational models. They should allow for the interconnectivity of hard and soft infrastructures to leverage and integrate existing initiatives, while aligning new offerings with the broader goals.

Unlike isolated interventions, platforms should consider the flow of multiple values, and account for feedback systems based on the interactions among actants, and their emerging properties. Successful platforms ensure easy access, as well as feedback loops, traceability, and adaptability, with mechanisms for data collection and data management. As a strategy, platforms allow for self-organization and autonomy with actants contributing to the overall fitness. Strategies are more about long-term values than immediate gains.

For example, a Farmer's Market is a platform focused on increasing food access that supports multiple types of interactions. They provide inclusive educational programs, mechanisms for tracking data, access to local food, space for gatherings, and stations for waste management. Below, a set of principles for sketching platforms:

- have a core set of functions on which new interactions can emmerge. For example, educational programs, local business support, and food access.
- increase their fitness over time as they evolve and become more integrated into the socio-ecological system. Participation expands overtime, and the expansion becomes an important variable that actors value.
- allow for self-organization and autonomous interactions. Each one of the vendors have ownership of their space and products.
- be attractive to diverse set of actors. For example, providing different types of food, prepared, and are commonly found at Farmers Markets.



Consequence systems

IDENTIFY INDICATORS OF FITNESS AND EXPLORE POTENTIAL CONSEQUENCES, INCLUDING NEW ACTIVITIES, VALUES AND EXPERIENCES.

When designing sustainable solutions, actors should consider the potential impacts, outcomes and consequences of their interventions, even if they are not favorable to the intervention or within their immediate scope. Because socio-ecological systems are adaptive, there are certain unforeseeable consequences of interventions for which actors cannot reasonably be expected to accept responsibility (e.g. emerging properties). However, they cannot merely abdicate responsibility by limiting themselves to their own definitions of scope, or capabilities of intervention. This matrix provides a structure to explore potential negative consequences given the flow of multiple resources. Below, actors also find a structure for articulating these potential consequences within their own practices, and expand their ethical obligations as human actants in the socio-ecological system.

The representation below assumes that the ethical obligations of the actors in exploring these consequences and changing their interventions vary according to the risk associated with the outcome, which is a function of the consequence and probability of the event.

UNADDRESSED

Consequences are known but are not examined because of the predefined scope.

UNINTENDED

Consequences are known but with low enough probabilities that associated risks can be ignored.

UNEXPECTED

Consequences are known but with no anticipated risk because of zero probability of occurrence.

UNFORSEEN

Consequences are unknown but could reasonably have been foreseen if the necessary resources had been applied.

UNFORSEEABLE

Consequences could not have been reasonably identified.

RESOURCES	UNADDRESSED	UNINTENDED	UNEXPECTED	UNFORSEEN	UNFORSEEABLE	ACTIONS REQUIRED
HUMANS						
NETWORKS						
CULTURAL						
GOVERNANCE						
FINANCIAL						
BUILT						
DIGITAL						
ECOLOGICAL						
ASSUMPTIONS						
EVIDENCE/DATA						
ORTHODOXIES						

based on the taxonomy proposed by Stacey & Stacey[15]

Micro pilots

ADVANCE AND SCALE PROTOTYPES ENGAGING LEADERS WITH COMMITMENT TO ACTION AND TRANSFER CAPABILITIES AS NEEDED.

Once the proposed intervention has achieved a certain level of maturity, a micro pilot project should be implemented. Ready to be tested into a broader audience, the hypothesis should be introduced to a selected group of actors already engaged in the situation of interest. Because the goal is to develop a project that will provide more consistent feedbacks to assist actors in understanding consequence systems, as well as validating the proposed intervention given the desirable impacts, this stage is focused on continuous and practical exploration with the direct audience of interest. As such, there are activities focused on running simulations of future interactions, as well as activities focused on exploring how to embed interventions into daily lives of actors. This process guides the transition of a conceptual development to its practical appliance, and it should be done in a faster pace than its final proposal, and with a lower cost expectation.

In the micro pilot stage is important to work on changes that will validate and incorporate other points of view into the proposed intervention, as well as inform what does it take to embed new interactions into existing initiatives. It is likely that this stage will have its maturity when there is greater acceptance from the selected audience. But in order to be precise, the project needs to select a coherent evaluation method that will illuminate the benefits and risks of the candidate project proposed. It should focus the evaluation on the maturity of the actors involved, the capability of absorbance, and the overall impacts given the desirable goals. It also should count on the innovation lenses to support the creation of indicators capable of representing the impacts in the various types of resources.

With safe and precise information in hand, actors will be able to challenge the proposal and clarify the next steps for concrete intervention. Once micro pilots trigger actions, proponents will enter a transition period when responsibilities and capabilities are fully transferred to leaders in the situation of interest.

Preparing:

Utilizing previously develop representations of the anatomy of system, situate the project considering the intended interactions to sustain the new flows.

Based on the necessary conditions for the hyphotesis of the project to be true, actors should select a group of actors and a controled environment to pilot the intervention, and agree on a common agenda. All actors involved should know:

Hypothesis
What is the hypothesis of the pilot? What are the necessary conditions for the hypothesis to be true? What factors are informing key considerations in the project (including the resources and assets being utilized)?

Composition of the pilot
What are the intended changes to be addressed? What are the rules, roles, and responsibilities each actor will assume in the pilot?

Contribution to the situation
What points of the system will be leveraged? What actants will be considered, why and how? Where will the project take place? What are the intended new interactions? What is the adaptive capacity in the control environment?

Indicators of performance
What will be the indicators to inform the performance of the pilot?

Piloting:

Actors should be immersed in the situation of the pilot in order to better understand the impacts being promoted, and the dynamics shaping the absorption of the changes.

Key signals:
In addition to common field research practices, actors should be aware of potential emerging properties. They should be as conscious as possible to understand how the core activities of the project are capable of providing proper answers to their hypothesis. As such, they should also account for conter expectations given the interactions happening within the project. In addition to new interactions among actors, the pilot should be equiped with proper mechanisms to identify the impact among non-human actors, and incorporate them into their considerations about the project.

Significan observations:
State significant observations considering the relationships formed and the interactions that are happening. Actors should register when, where, why, how, and according to who those observations are to be consider significant. It is fundamental that actors account for their role (if any) in the interaction being documented. Thus, they have to register in detail what were their interactions with other actants as well.

Pivoting while piloting
As actors involved in the design practice will be immersed in the situation, they should be able to take actions and intervene considering new information, interactions and signals of behavior change in the system.

By the end of the pilot, data should be analyzed according to the intentionallities of the intervention, and next steps should be clearly identified among all actors involved in the project.

Scale impact

Continuous interactions

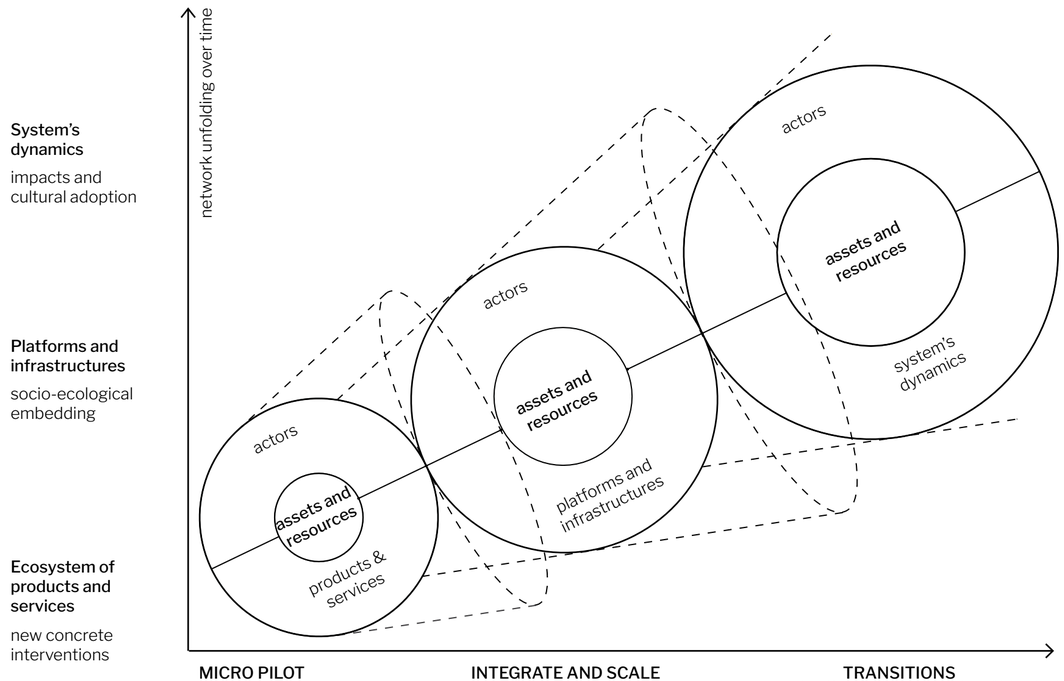
BUILD ON PUBLIC WILL, CONNECT WITH REGULATORY AGENDA, PARTICIPATE IN THE NEXT STEPS, AND DEFINE SCALABILITY MODELS.

Interventions by design in socio-ecological systems are considered to be adaptive transitional processes that required continuous engagement of actors in supporting the overall fitness of the system. The goal of this exercise is to unfold the interventions along the micro (products and services), meso (platforms and infrastructure) and macro (system's dynamics) levels, and to understand how actors can be involved over time. Actors should consider transitions given the desirable goals by distributing their design interventions in time and space, while exploring the interconnectivity of engagements within and across the different levels. Actors should also consider the bahvior change overtime, and use the indicators of fitness to inform new decisions. By doing so, actors by might be able to understand how transitions and new properties emerge within existing systems, and and include elements of feedback, self-learning and adaptation.

Start by identifying the new products and services within the proposed intervention that can be independently embeded in the current situation. In environments with some level of control, explore adaptations and resistance to change given the minimum version of the solutions (micro pilots). Actors need to ensure that the core functions of the intervention are explored as complete as possible in its reduced form. Define the actors that will be involved and the resources required to empower them.

Explore how flows of resources can be interconnected given the overall goal of the intervention and the indicators of fitness. Identify existing products and services that can be incorporated into new platforms and infrastructures. Engage with existing organizations and institutions that are willing to collaborate due to similar goals and beliefs.

Finally, actors should explore how elements are impacting the system's dynamics, and identify what are the required actions to maintain the robustness of the transition. Actors might consider engaging in policies, and regulations, as well as taking advantages of existing mechanisms such as lobbying, media coverage, and endorsement from celebrities.



adapted from Namahn's systemic design toolkit, based on the transition theories[17]

Scale impact

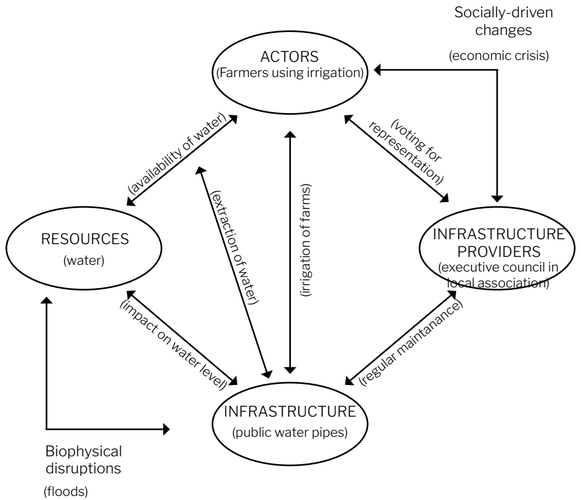
Robustness of the system

EXPLORE HOW INTERVENTIONS WILL CONTRIBUTE TO AND CONSIDER THE OVERALL ROBUSTNESS OF THE SYSTEM.

This framework provides a support to understand how robustness in socio-ecological systems might be considered given four entities: actors, resources, infrastructures, and infrastructure providers. Robustness focuses on identifying the cost-benefit and the trade-offs of interventions to explore how might desirable interactions be preserved given the transformations and new behaviors sparked by the interventions. A socio-ecological system is robust if the interactions among actants support its integrity, including the capacity to support a human population without causing a long-term ecological suffering. In a socio-ecological system, actors will rely on the multiple types of resources and existing infrastructures to interact with one another, and with other non-human actants. Infrastructure providers are intended to govern, monitor and manage the overall dynamics of the system. While the distinciton is important, there might be substantial overlaps between infrastructure providers and actors.

Overall, actors involved in the design process have to (1) clearly define what are the desirable system's interactions, and (2) conceptually understand if the collapse of one part of a socio-ecological system imply that the entire system loses its robustness. For example, when rivers collapse, but the urban social life continues to function due to the human's ability to adapt and use alternative resources, should an urban environment be considered a robust system? Should actors consider the trade-offs, and assume that the socio-ecological system should lose its robustness due to the prioritization of its social component?

In this tool, there are two types of disturbances to be considered in the overall robustness of the system: external and internal disturbances. External disturbance can include biophysical disruptions and socially-driven changes. Examples of biological disruptions are as floods, earthquakes, landslides, and climate change, and they are likely to have higher impact in multiple types of resources and in the infrastructures. Socially-driven changes are related to the increase of population, economic crisis, depressions or inflations, and major political changes, and have greater chances to impact the actors and the infrastructure providers. Internal disturbances refers to fast rearrangements of the ecological or social system induced by their subsystems and interactions among actors in specific situations.



As actors are bringing new interventions to the system they can substitute the general terms by the information about the situation they are involved, and advance on its robustness. Because interventions in socio-ecological systems are contextualized, the indicators of robustness are unique to each context. However, when designing for robust systems, actors might consider:

Are there clearly defined rights to use resource units given the situation at hand (e.g., irrigation system)?

Are there context-sensitive correlations that specify the amount of resource use (water) and the activities necessary to use it (e.g. labor, material management, irrigation, and/or money inputs)?

Are the actors utilizing resources and affected by harvesting and protection rules and regulations included in decision-making processes for creating and modifying these rules?

Are the governing bodies partially accountable to the actors in the socio-ecological system? Are they the user of the resources themselves?

Are the actors violating rules-in-use receiving graduated sanctions from other actors?

Do the actors have rapid access to low-cost, local arenas to resolve conflict among themselves?

Do users have the rights to devise their own institutions without being challenged by external governing bodies?

Are governance activities being organized and distributed across multiple levels within the socio-ecological system?

adapted from the robustness model[1]

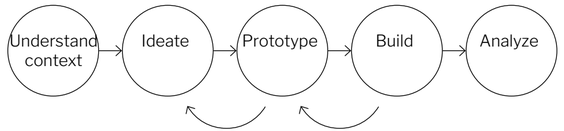
INTEGRATIVE APPROACH

Socio-ecological systems are defined by the perceptions of those who define it. As such, the framing of what is to be consider the problem, the solution, the innovation and the opportunity for intervention is subjective, and open to change as actors learn more about the system. The four spaces presented are intended to support actors by presenting a structure to situate new information about the situation they are engaged as they immerse themselves more deeply into it. The methodology and the tools are meant to guide interventions situated in the interplay of the problem space, the solution space, and the innotavtion space. Because the process is iterative, the boundaries of each space will continue to change as new actants and new interactions are uncovered. Moreover, the elements might move from one space to another according to the stage and mode of exploration.

The problem space refers to the various forces, entities and components shaping degenerative dynamics in the socio-ecological system at play. The solution space involves all the interventions aiming at solving the complex challenge, given all the possible interactions between all actants in the system. The innovation space refers to the entire range of forces, entities, and components that can influence and shape new dynamic interactions in socio-ecological systems. Lastly, the opportunity space involves all the potential new interventions capable of solving challenges given the capabilities of the actors involved in the design process, and the adaptive capacity of the actants shaping the socio-ecological complex challenge.

Simplistically, by mapping the multiple flows of resources and available assets in the problem space and situating possible interactions between all actants in the solution space, participants will be able to explore the innovation space, define the opportunity space, and create an array of interventions to be prototyped considering the points to be leveraged, given the constraints of resources, including knowledge, time, money, materials and nutrients, and adaptive capacity. Interventions should be technically facilitated and interconnected by new infrastructures capable of informing the impacts and emerging properties within the socio-ecological system at play. Without new infrastrcutures for connecting the interventions, it is likely that existing dynamics in the system will adapt, and absorb its impact through resilient properties. Throughout the process, the lenses should be used to amplify actor's perceptions of the dynamic interactions, and expand the opportunities for integrating systems. Ultimately this playbook offers an alternative to existing design practices, where iterations are part of specific phases, and the linearity is more present. in the overall process.

FROM



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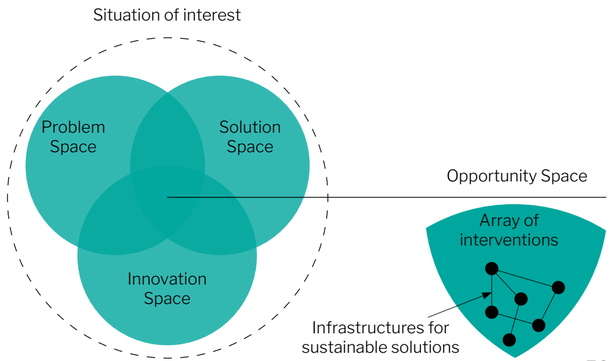

INNOVATION DASHBOARD

This innovation dashboard is a living tool that supports actors in understanding their decisions over-time, and their connectivity in a synthesized structure.

NAME OF THE PROJECT	GOAL	SITUATION OF INTERVENTION

TARGETS

WHAT IS THE OVERALL GOAL TO BE ACHIEVED?

WHAT ARE DESIRABLE IMPACTS?

PRINCIPLES

WHAT ARE THE CRITERIA GUIDING SUSTAINABLE SOLUTION?

	THE SOLUTION SHOULD	BY
HUMANS		
NETWORKS		
CULTURAL		
GOVERNANCE		
FINANCIAL		
BUILT		
DIGITAL		
ECOLOGICAL		

ACTORS INVOLVED	COLLABORATION BELIEFS

OUTPUTS OF INNOVATION

WHAT ARE THE POINTS TO BE LEVERAGED?	WHAT ARE THE INTERVENTIONS BEING PROPOSED?

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LENSES OF INNOVATION

Sustainable solutions for socio-ecological challenges - 1.0

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