EXCEPT
INTEGRATED SUSTAINABILITY

› SID QUICK GUIDE

Symbiosis in Development

v10.6

creating the foundations for a sustainable society

CONTENTS

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1. INTRODUCTION

› Except's office in Utrecht

This document is a short introduction to Symbiosis in Development (SiD), Except's framework to tackle complex sustainability issues on system-level.

Except is a research, strategy, and design agency that is at the frontline of sustainable development. With SiD, Except introduces an overarching framework that integrates energy, nature, culture and individual people into innovative solutions for resilient, equitable, and self sufficient companies, cities, and industry.

SiD contains a holistic process that allows different disciplines to work together and evaluate sustainability spectrum-wide. This leads to new insights in possibilities to create solutions that are more sufficient and that are able to last longer.

SiD guides individuals and interdisciplinary groups in incorporating problems beyond material and energy usage, extending to include social, ecological, economic, and political matters. If we ever hope to achieve sustainability, we must optimize for all of these competing areas at the same time – and this is what SiD does.

In this document, the basic principles of SiD are explained. Note that this is just a short introduction, and not in any way a full documentation of SiD. For a complete understanding of SiD, visit resources on the website, or read the SiD book, which can be downloaded in digital form, or purchased in hardcover.

Sincerely,
Tom Bosschaert & Hester van Zuthem

2. WHY SID?

Despite huge efforts of many organizations to head towards sustainable goals, the futures we are crafting are starting to resemble the realities of dystopian nightmares and film noir settings. Clearly, even though the goal for a sustainable society is relatively simple, figuring out pathways on how to get there is far from it.

Many tools have cropped up in recent years that aim to help make more sustainable decisions, ranging from full scale supply chain analysis to simple labels. Most of these focus on one or just a few of the aspects of the challenge, for instance on only the environmental aspects of sustainability, and have mostly proposed solutions in the realm of eco-efficiency. The logic suggests that if we can succeed in making the perfect, eco-efficient objects, then we will have created a sustainable world.

If only this were so, our task would be relatively straightforward. We have discovered though, that the true nature of the problems we face in society is systemic, requiring an entirely different approach.

OBJECT-ORIENTED SUSTAINABILITY GOES WRONG

If we imagine our society as a complex creature with various bits and pieces, slowly changing over time. These bits and pieces are our everyday technologies – cars, planes, light bulbs, computers, as well as us, nature, and all other 'things'. These technological bits move people from place to place, facilitate communication, put food on our table, allow us to read after dark, clean the water we drink, and perform many other amazing and useful functions. We like to keep all of those, but without their negative impact. Currently, most environmental policies are focused on these 'negative' objects. In other words, they are centered around finding bits within the organism of our society that could be running a bit more efficiently, and making an effort to replace them with "better" versions.

We've seen many examples of this type of 'sustainable' solution. They are often developed with the best of intentions, but result in worse scenarios than if they had not been conceived at all. Examples are solutions that save energy and at the same time pollute the environment with toxins, or eco-friendly devices that are produced under dismal human conditions. We see examples of 'green' solutions that are relocating the impact from one area to another, from one time frame to the next, and from one generation to the ones that will follow. As we see now, these are due to what we call an 'object-oriented' approach.

The system as a whole, its purpose, direction and impact, will not change if we just switch out bits and pieces. Our system will not change if we continue looking at and behaving in the same way we did when creating the problems we're in. It isn't the bits that need upgrading. It is the configuration of the overall system that is wrong. The foundations of our society. The awareness of what and where we are. The way we interact, exchange, understand, look, and strive. We need to begin functioning differently within our societies, changing the patterns of our behavior, and reducing our impact by orders of magnitude, not just by tiny increments.

SYSTEM EFFECTS AND ITS DIFFICULTIES

> ***"The greatest shortcoming of the human race is our inability to understand the exponential function."***
>
> › Albert A. Bartlett, physicist

The exponential growth of our civilization is not due to any single person, technology or event. It is something that emerges from the complex interconnections that make up our world. This is what we call a 'system effect'. System effects are the patterns that are shaping our society. While some system effects provide us with countless benefits, such as the ability to improve living conditions for vast numbers of people within decades, increased life spans and boundless forms of art and culture, they also take their toll.

Our challenge therefore is to create insight into these system effects, and harness the best of what our era has to offer to improve the worst. We can take this exponential growth and maximize its potential for problem solving while reducing the resources it takes to supply our civilization with what it needs. We can ride the big wave to get out of the stormy ocean.

TIME FOR A NEW SYSTEM-THINKING METHOD

Except Integrated Sustainability was founded in 1999 to address the fundamentals of society's issues. SiD soon surfaced as a requirement to be able to start working on this, after working for several years using traditional methods such as LCA, PPP and Cradle2Cradle, which returned dissatisfying results. We wanted to make a single overarching framework that ties all the aspects of sustainability together, and that establishes a language to use in inter-disciplinary teamwork. A framework that brings structure and insight to the otherwise confusing realm of systems analysis, that prevents redundant work between teams, and to elevate the discussion about sustainability to a new level.

We see a world where we form a symbiotic relationship with the foundations we rely on. We want SiD to help us find how we can strengthen our environment by using it; systems that are enjoyable and beneficial at the same time. We want to figure out how we can work towards profitable companies that are a benefit to society. A world where there's plenty of resources that are available in abundance, and no reason to wage war over them. When first applying this systems approach in 2000 in a small desert town of Australia, we saw its huge capacity for change. Since then, we've expanded it more and more, and improved it along the way.

We hope you'll find SiD useful in this challenge, and that you can help to make it better, so we can all grow towards this hope together, and make it a reality.

3. SYMBIOSIS IN DEVELOPMENT

Symbiosis in Development (SiD) is a framework to tackle complex sustainability issues, from idea and vision, via analysis and route mapping, down to execution. It provides insight into how, when and where interventions in complex systems can be implemented to make the system at hand more sustainable.

WHY SID?

One of the main difficulties of designing truly sustainable solutions is the complexity of scope and domain that need to be taken into account. Projects often focus on one or a few subject areas, such as energy, waste, or materials. It is rare for a project to be developed aiming for sustainability in a truly integrated sense, mostly because it's difficult and confusing to do so. SiD provides a framework to make this manageable and clear. It doesn't make the task any simpler, but it does make it much easier.

In the SiD approach, we investigate all factors involved in a problem-situation and, more importantly, their internal relationships. By identifying these various aspects and visualizing them in so-called 'system-maps', starting points for innovation become apparent.

> ***"The significant problems we face cannot be solved at the same level of thinking we were at when we created them"***
>
> › Einstein, 1946

This system-thinking approach provides us with an alternative view on our world. Uncovering the underlying structures of a system provides insights into both *what* is happening, and also *why* it is happening that way, taking into account the dynamism of our society. Restructuring the system with these insights can solve these problems and prevent them from coming back, addressing the root cause of a problem, rather than fighting the symptoms.

SiD actually combines two distinct system-thinking ways; bottom up systems thinking (Donatella Meadows), which is useful to start analyzing a problem and for closing resource loops, and top-down system-thinking (complexity theory) that allows us to see larger organic patterns in society and find ways to create resilient dynamic societal systems.

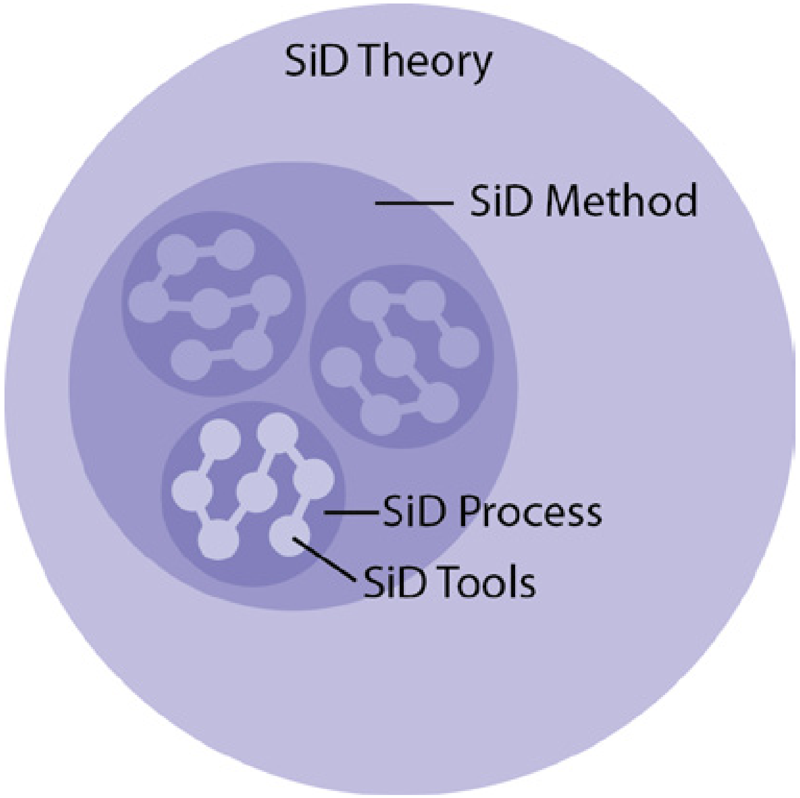
Because these challenges touch so many areas of society SiD promotes combining the insight and experience from multiple disciplines, including science, engineering, design, and the humanities. Together solutions can be developed across disciplinary borders and address all sustainability related areas.

WHAT IS SID USED FOR?

SiD can be applied to every field and type of project which touches on the creation of a sustainable way of life for humanity, whether that be the development of policy, software, cities, strategy, products, theory or other fields of practice. SiD can be used for example by business owners to develop new strategies or products, by governments to investigate international, national or local policies, by scientists to assess environmental impacts, or by schools to teach about sustainability.

"We developed SiD out of necessity After seeing many so-called 'sustainable' solutions eventually make things worse by shifting damage from one kind of impact to another, we felt it was important to create an entirely new approach."

› Tom Bosschaert



› The four components of SiD

SiD will not tell you what to do, or what is right and wrong, but it'll allow you to make a solid framework to figure out those questions yourself in any given situation, and get the job done faster.

FOUR COMPONENTS

SiD consists of four core components: the underlying theory, the applied method, the resulting processes and a set of applicable tools. In the next chapters, each component is explained in more detail.

The SiD Theory lays the foundation for its operation, ethics and reasoned approach. It includes SiD's sustainability definition and deals with approaching problems on a system-level.

The SiD Method consists of a five-step approach, including system level goal-setting, analysis, optimization, synthesis and evaluation.

The SiD Process details how the method is unfolded in time, to allow efficient implementation of different SiD tools. It clarifies how different disciplines come together to work on a problem collectively, including stakeholders and potential third parties.

The SiD Tools are a collection of new and existing tools that can be used in various stages of the SiD process. In fact, a SiD process consists of stringing together several SiD tools.

4. SID THEORY

The Symbiosis in Development theory is the core set of understanding that underpins all of SiD's method, process and tools. It allows us to understand what complex systems are, what sustainability really means, and how to use this understanding in order to move forward. The SiD theory establishes a common language between all participants in the process, so that we can clearly communicate about what we'd like to achieve and how to go about this.

SID SUSTAINABILITY DEFINITION

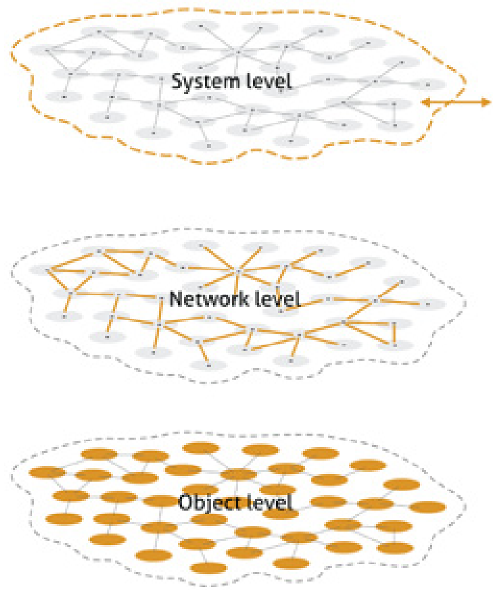
The basis of the SiD theory is the SiD sustainability definition. The need for a new definition of sustainability became apparent in the early days of our development work, since other prevalent definitions did not actually seem to define what sustainability is, how it should be made operable or tested against to find sustainable solutions.

> ***"Sustainability is a state of a complex, dynamic system. In this state, a system can continue to flourish resliently, in harmony, without requiring inputs from outside its system boundaries.***
>
> ***Applied to our civilization, this state is consistent with societies powered by renewable energy and closed loop material systems, living in thriving ecosystems, on a bio-diverse planet, with healthy and happy individuals living in just, tolerant, and diverse culture, supported by open and transparent economies."***

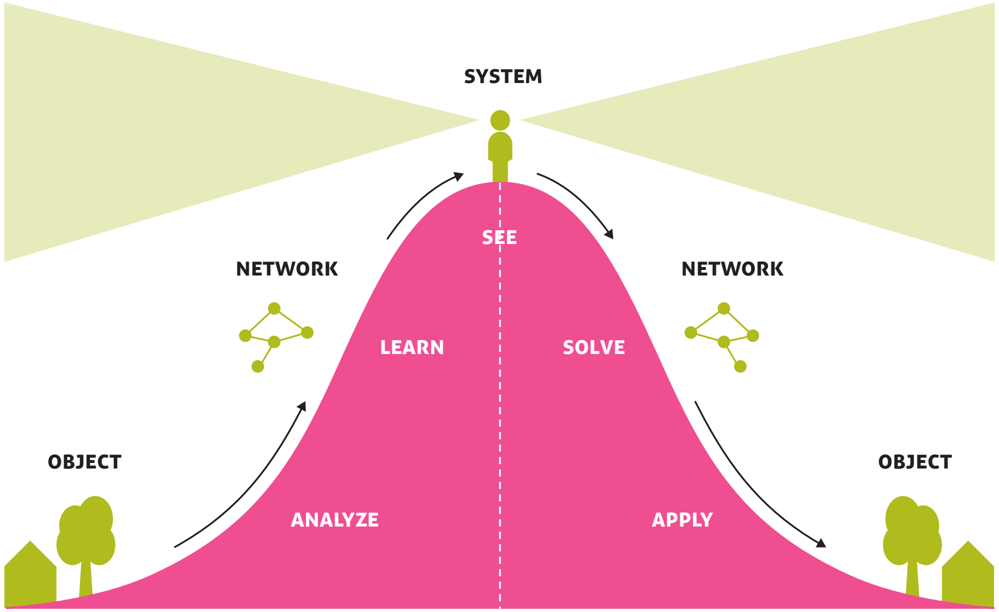
THREE LEVELS OF SYSTEM IMPACT

Extrapolating the definition, we understand that Systems can be seen on different levels. These levels range from objects (physical assets, such as cars, trees, people, etc), and connections (economic, cultural, biological relations, etc) to the system as a whole. SiD therefore recognizes at minimum three levels of impact: the object-level, the network-level, and the system-level.

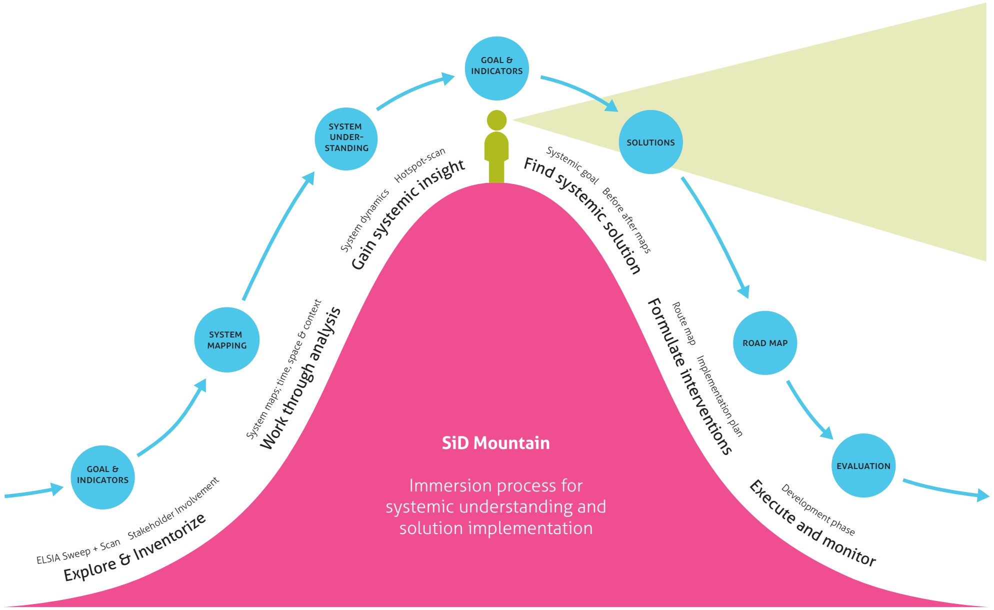
We define a system by its boundaries, which are an artificial construct that helps us make sense of it all without being overwhelmed by the complexity of it all. Where to draw a system boundary depends on the purpose of the question at hand, and greatly defines the speed and depth of a project. A larger system boundary makes the project more complex to study, but results in more degrees of freedom to find the best solutions. Small system boundaries are simple and fast, but often lack the solutions to make significant change and misses opportunities. See the SiD book for in-depth discussion on system boundary setting.

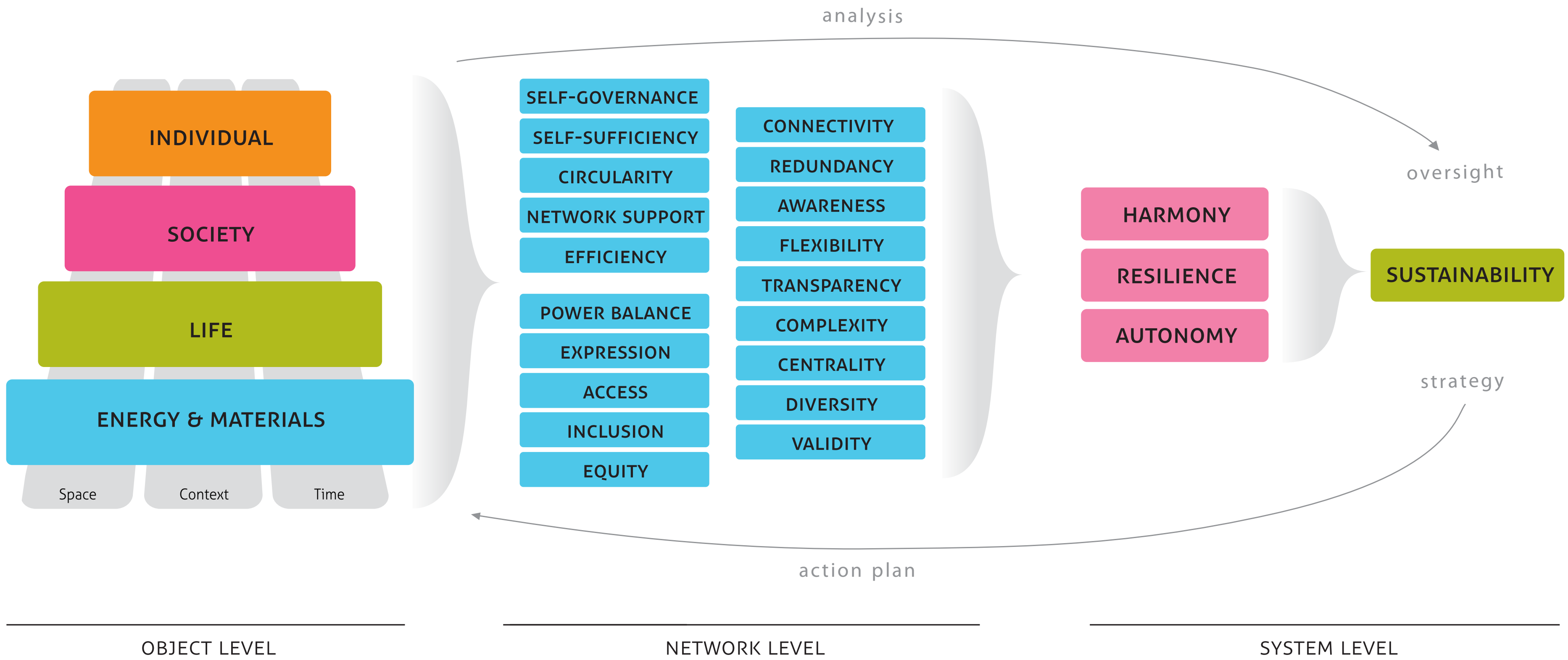


› Three systemic levels of impact

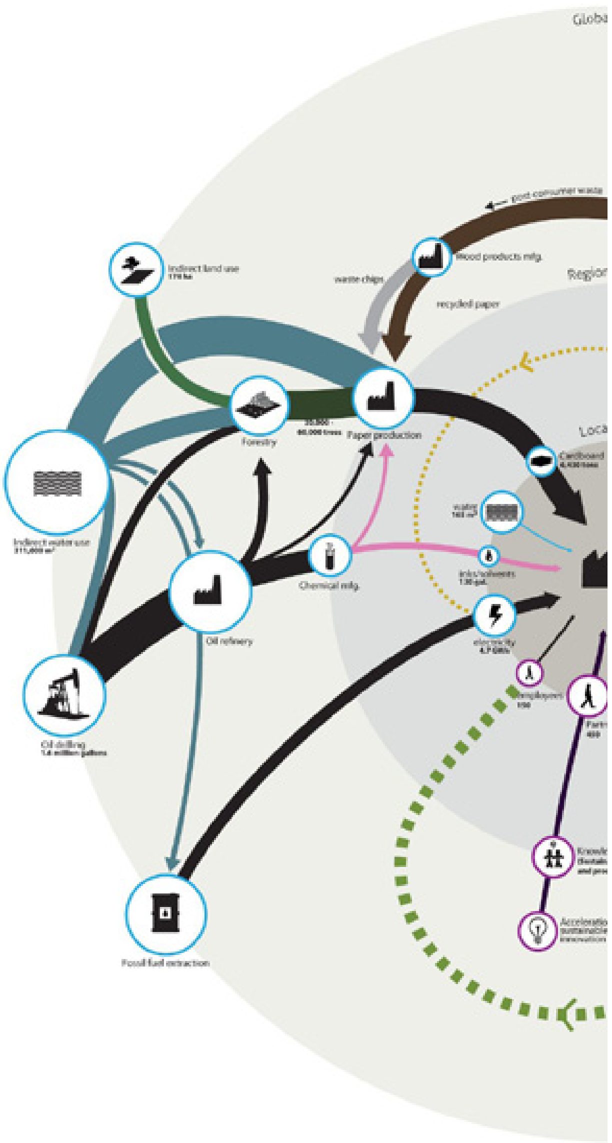


When we talk about the impacts of these three levels, we refer to a first, direct (or object) level, a second, indirect (or network) level, and a third level, which we call the system-level. You start mapping a system on the object level, progress through the network level and finish mapping at the systems level. When finding solutions and optimizing, you start at the system-level as this is several orders of magnitude more impactful than network or object level interventions.





This diagram shows a simplified outlay of the object, network and system levels. More detailed diagrams follow.



SYSTEM THINKING

Systems thinking is an approach that zooms out to find ways to make sense of how everything interrelates, learning from its patterns and dynamics. We need to analyze systems as a whole to derive meaningful conclusions from them. We've identified three steps to do so:

- Analyze through dimensions Time, Space & Context
- Analyze through scales within these dimensions
- Analyze in the full spectrum

Time, Space, & Context

Systems exist in the full realm of our reality. They grow in time, occupy space, and are connected to other systems in a variety of contextual relations. That's why we analyze systems in the Time, Space and Context dimensions for a full understanding of the system.

Three scales

Thinking in scales means that Time, Space and Context are evaluated on different scales, from small to big, above, below, and beyond your subject. This allows the inclusion of effects that may not be apparent at first, and opens up creative solution trajectories. Below some examples of scales listed per dimension:

- Space: local, national, global
- Time: past, present, future
- Context: object, network, system

FULL SPECTRUM ANALYSIS

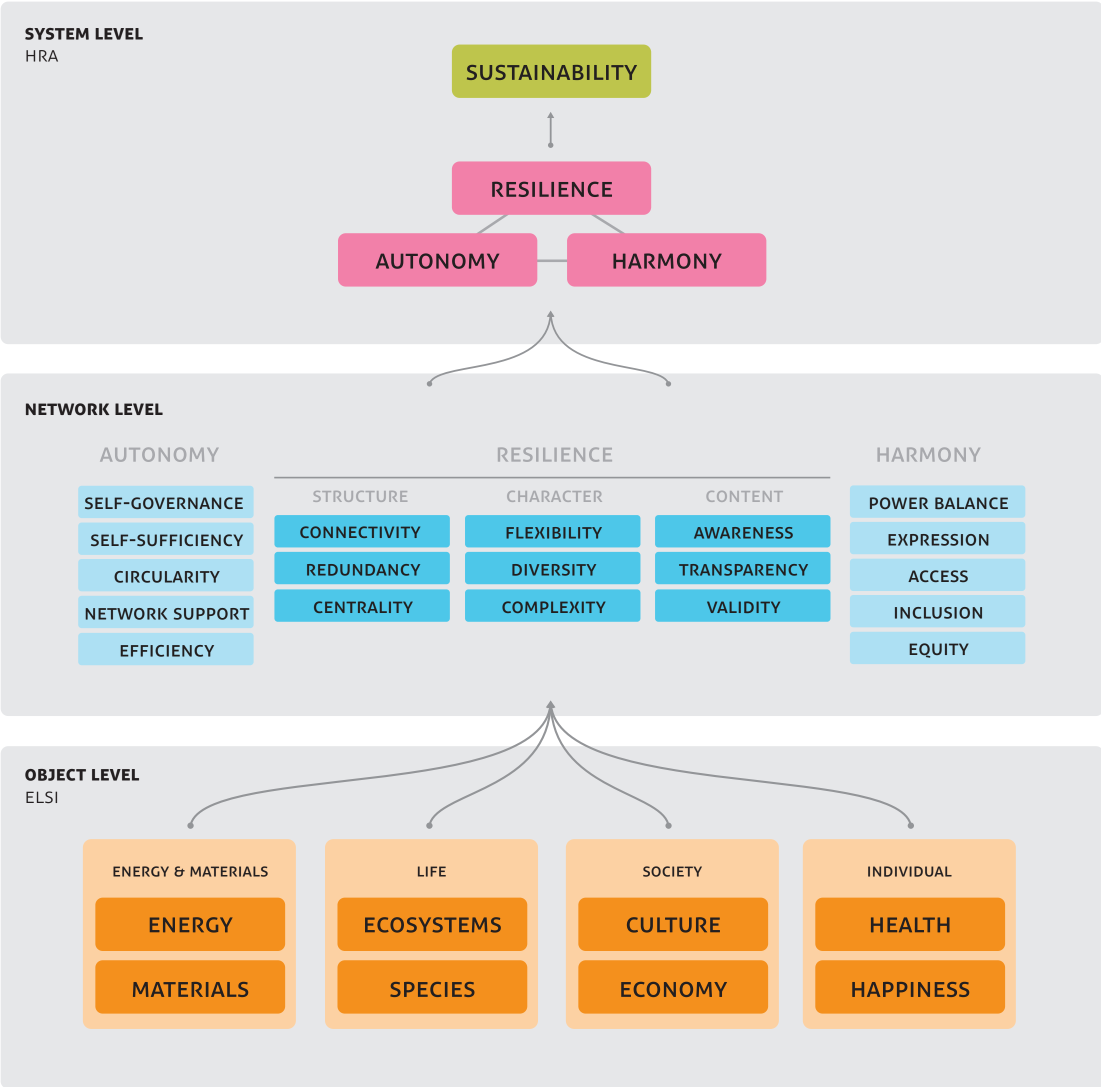
With the 'full spectrum' we mean to take into account all layers of society that influence one another, across the range, and not leave any important bits out. To do this, we've developed indicator sets for the three different system levels: Object, Network and System. Together they provide this complete full-spectrum overview. On the next page we'll show all these indicators, but first a word about 'indicators' in general.

Using indicators

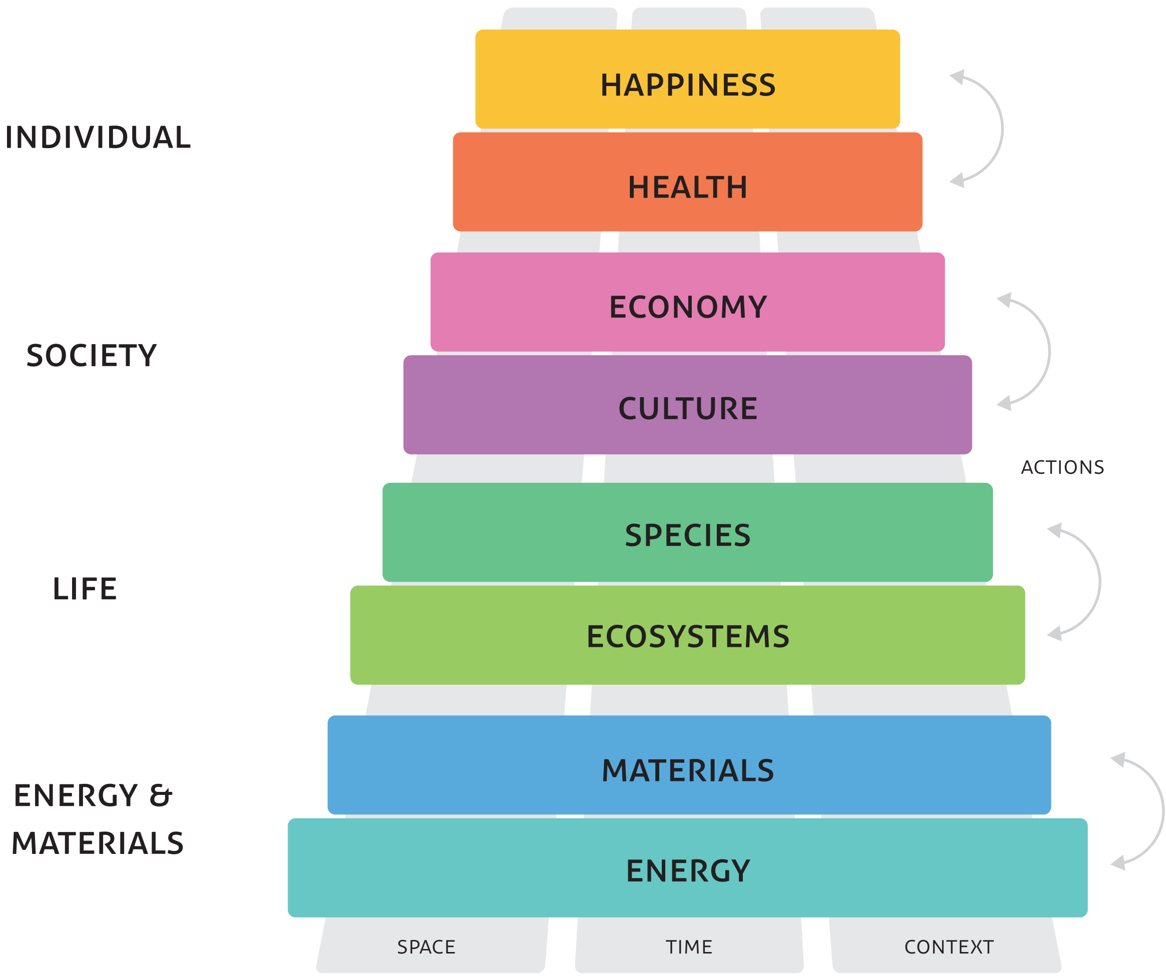
On each level of the system we use indicators to find out its performance. Indicators are used to specifically measure a certain aspect of one thing in relation to something else. There are good and bad indicators, and picking the right ones is important to be able to measure performance well. For example, measuring your pulse (heart rate vs. time) is a good indicator of the state of your heart. Measuring the size of your heart doesn't tell you all that much, and is a bad indicator of the state of your heart. It is possible for object properties (color, size, shape) to be indicators, but usually they are misleading: it's about an object's performance that counts, which is usually a relationship between the object and something else. This requires a frame, boundary or relation to make it a meaningful and therefore useful indicator.

The figure on the next page illustrates the SiD indicator hierarchy, showing all three levels. As the cyclical arrows suggest, the process of inventorising and implementing is an iterative process.

SID INDICATOR HIERARCHY



The SiD indicator hierarchy describes the relationship between the object, network and system levels, their parameters and indicators, and how one goes about working with these layers in a project.



› Object-level indicators (ELSI)

OBJECT-LEVEL INDICATORS (ELSI)

The ELSI system categorizes the full spectrum of physical aspects of our world, and tells us something about their causal relationships.

To ensure we take into account all physical aspects of a system, we use ELSI, short for Energy, Life, Society, and the Individual. This categorization can be used for management and policy issues as well as design problems, and replaces the less complete and effective "People Planet, Profit' adage (and its variants). ELSI4 is the four component version, and ELSI8 the expanded, eight component one (see diagram on the right). ELSI4 is divided in (with ELSI8 behind):

- Energy & materials (energy & materials)
- Life (species & ecosystems)
- Society (economy & culture)
- Individual (health & happiness)

The categories of ELSI are functionally nested within each other: all materials are made from energy, and all ecosystems are made of materials. The economy is a subset of culture, just as each individual is always a part of society, and so on. Alterations in the lower layers (Energy or Life) automatically affect the upper layers of Society and Individual. Influences the other way around, however, are less immediate, although they do give rise to the intent of large changes in behavior.

ELSI is like a harmonica. It can be compressed down to four categories, or expanded for complex projects to be a home to for hundreds of indicators. It is therefore an indicator framework rather than an indicator set in itself.

NETWORK PARAMETERS

The network level parameters help to unravel the complexities of the system level indicators, reveal complex system interac- tions, test and explore them, and find the object level drivers of these behaviors. This, in turn, gives concrete handles on finding the best inter- vention points to improve system dynamics.

Each network indicator can be used to evaluate the object and inter-object relationships, in time and space. They are used mostly in a qualitative sense, but if need be, can be used to construct quantitative simulation models using agent based simulation or other techniques.

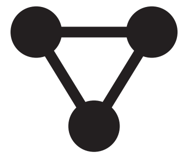
The standardized network parameters in SiD are split into the Resilience, Autonomy, and Harmony system indicators (elaborated upon in the following section). The Resilience set is called CRAFTDCCV, the Autonomy set SSCNE, and those dealing with Harmony are called PEAIE. Their names are acronyms, taking the first letter of each of their parameters.

AUTONOMY	RESILIENCE			HARMONY
	STRUCTURE	CHARACTER	CONTENT	
SELF-GOVERNANCE				POWER BALANCE
SELF-SUFFICIENCY	CONNECTIVITY	FLEXIBILITY	AWARENESS	EXPRESSION
CIRCULARITY	REDUNDANCY	DIVERSITY	TRANSPARENCY	ACCESS
NETWORK SUPPORT	CENTRALITY	COMPLEXITY	VALIDITY	INCLUSION
EFFICIENCY				EQUITY

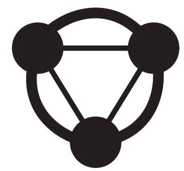
THE RESILIENCE SET: CRAFTDCCV

The set CRAFTDCCV stands for Connectivity, Redundancy, Awareness, Flexibility, Transparency, Complexity, Centrality, Diversity, and Validity. The resilience set is the most powerful of the three sets in understanding system dynamics.

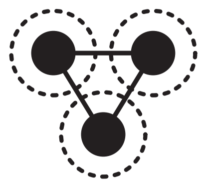
Connectivity is the amount of connections each agent has with other agents in the system. Connec- tivity increases positive system response, usually at financial cost.



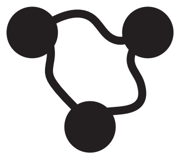
Redundancy is the level of doubling-up of agents and connec- tions in a system, which allow a certain level of failure before vital systems and loops break down.



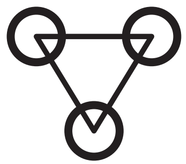
Awareness is the level of knowledge and perspective the agents within a system have of their own system and those they are related to.



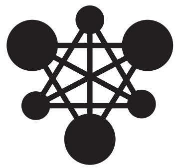
Flexibility is the ability for a system to (quickly) reroute important connections of resources, information and value.



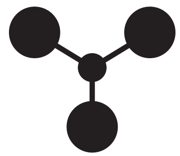
Transparency is the ability of agents within a system to see the actions of other agents, and participate in their planning. This allows agents to adapt their strategies to those of others and optimize their mutual balance within the system.



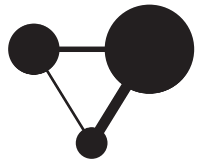
Complexity says something about the intricacy of the network, affecting both efficiency, speed, and expected behaviour. You can measure it by combining the amount of nodes, the amount of connections and the network's diversity.



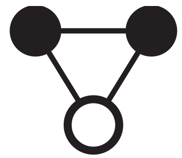
Centrality is a measure of structure of a complex network, which says something about to which extent the network is structured in a centralized or decentralized pattern.



Diversity is the level at which agents and relations within the system differ from one another. In virtually all cases, a higher diversity increases all system indicators, resilience, autonomy and harmony. This can usually only happen in conjunction with increased flexibility.



Validity is the truthfulness of information transmitted in a network as reflected on the objective observations of all of the nodes in the system. Also, it reflects on the relevance of the inquiry and the tools used. Measuring this parameter will expose a social component that may well be a pivotal indicator of the health of a society.



Note:

Although an attempt to be a fairly complete set and cross referenced to many other network evaluation tools, CRAFTCCDV is not the end-all and be-all of network indicators. In certain circumstances, other network indicators may prove to be valuable. You may even think of some yourself (if you do, let us know!).

Examples of other network indicators are:

- Similarity
- Fragility
- Volatility

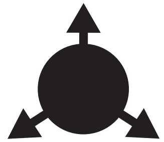
THE AUTONOMY SET: SSCNE

SSCNE are the five main network parameters that inform the Autonomy system indicator. Taking into account these five parameters gives you a good grasp of the aspects that influence the self-reliance of the system, such as resource self sufficiency, as well as the support it can provide for this to neighboring systems.

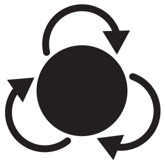
The SSCNE set builds on the following parameters:

Self-Governance is the measure to which the constituents of a system can govern themselves.

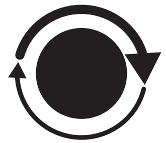
Network Support is the system's ability to support neighboring systems in case of calamity.



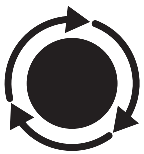
Self-Sufficiency is the measure to which the system can fulfill its own basic needs and beyond.



Efficiency is the amount of agents and assets contributing positively to the system in relation to their cost.



Circularity is the measure to which resources in the system are, and can be re-used in a closed loop.

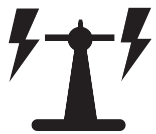


THE HARMONY SET: PEAIE

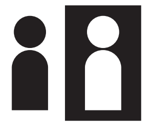
PEAIE are the five main network parameters that inform Harmony. These allow to investigate tinternal tension of a system, or its internal equilibrium. These are the balance between peace and war, orderly and disorderly society, and pressure towards revolution and rioting. These are the hardest to quantify of the three sets, and the most influenced by social science.

The PEAIE set consists of the following:

Power Balance refers to who controls what happens, and influences decision making. It also includes distribution of assets, and who controls resources and wealth.

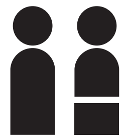


Inclusion is about to what extent people and all other life are considered valuable in relation to each other. It includes civil and political rights, economic, social and cultural rights, gender and race equality.

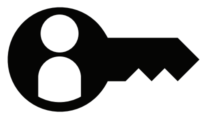


Expression refers to who can talk, who is heard, and what can be said openly? This includes freedom of expression and/or repression of perspective or opinion, commitment to transparency, and voluntary free flow of information.

Equity deals with the degree to which specific needs are equitably met.



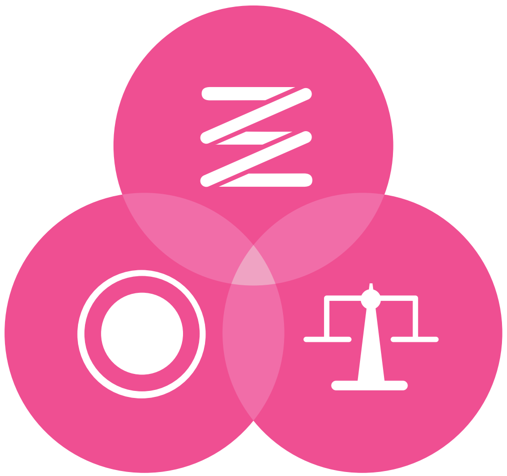
Access has to do with who can access important information, resources, education, etc, and to what extent?



SYSTEM INDICATORS (RAH)

System indicators tell us something about the performance of the system as a whole, and are the highest order of evaluation that you can perform on a system. The system indicators together define a system's 'sustainability', and include the performance of all the network and object indicators 'below' them. System indicators are most influenced by system dynamics of all the indicators, and when leveraged on subsystems, they affect both higher and lower levels.

As a standard, and derived from the SiD sustainability definition, we use HRA, short for Harmony, Autonomy and Resilience. The three system indicators are 'fed' by the network as well as the object indicators below, and also respond directly to one another.



Resilience

Definition:
Resilience is a system's capacity to withstand (unexpected) disturbances and its ability to return to a healthy state after suffering a blow (not necessarily the same state as before).

Resilience is not to be confused with toughness or strength. For example, for purposes of personal self-defence, techniques which rely on agility and flexibility such as Aikido are more effective than those which rely on pure strength, such as body-building. The same goes for systems: agile, flexible and adaptive systems are more likely to be able to return to a sustainable state than monolithic and tough systems.

Lessons from Resilience:
The concept of resilience as a goal for society is a lesson that will provide insight in many circumstances in life. After all, resilience is key for ensuring continuity in the long run. By focusing on resilience, one comes to insight that goals such as Growth and Profit lead down fragile pathways which, in the end, serve none. Placing Resilience at the topmost level of decision making leads to profound improvements in system performance for all stakeholders, creates clarity where there previously was none, and in the end should be considered a goal in and of itself.

Behavior:
Resilience is a complex system indicator, just like the other system indictors, and is influenced by a wide variety of network and object parameters, which change depending on the circumstance. Resilience is highly susceptible to systems dynamics, often more so than Autonomy and Harmony.

Autonomy

Definition
Autonomy, or self-reliance, is the level of independence of the system from other systems on any level, including material resources, decision making, trade balances, etc.

All systems are dependent on others to some level, which is not necessarily a bad thing, and it's rarely worthwhile to maximize autonomy. However, for vital resource flows, network functions and system behavior reaching a high level of autonomy increases sustainability of the system.

Lessons from Autonomy
Autonomy is very reliant on the physical world around us, resource availability and the unequal distribution of resources on our planet. By investigating autonomy, we will automatically discover local strengths and context specific solutions to universal demands, which leads us to closed resource loops and cycles, reducing waste and increasing the recognition of value that lies within everything around us.

What we learn from Autonomy is the necessity to discern between critical resources and those of want or luxury. For critical resources, such as food, shelter, clean water, and power, we best keep them close, decentralized, and adapted to our local conditions. Doing so will increase resilience and the ability for these needs to be provided in a context sensitive manner minimizing externalizations such as pollution and injustice. For luxury items, or those that are non-critical or rarely used, we may pool resources on larger scales to make their provision more efficient, as well as closing resource cycles on a global scale.

Behavior
Autonomy is the system parameter most directly influenced by the object parameters. Resource cycles affect an area or system greatly on its ability to be autonomous. Decision making structures are another important factor in autonomy, and the balance of interchange between neighboring systems.

Per resource, the scale of a balanced autonomy is different. For instance, it's perfectly feasible for small villages to capture and clean their own water, and valuable to do so. It increases their resilience. However, the same does not apply to a car factory. Not every village needs their own, even though they do need cars (it could use a garage though). Autonomy needs to be balanced. This can be done by by determining the criticality of the resource as well as its frequency of use and its cost of provision. Usually it's best to err on the side of autonomy for highly critical resources.

The same goes for policy decisions. Some types of decisions are best done on a centralized level such as the European Union or the United Nations, for decisions that are universal and are okay to be very slow to change. These are likely to be few, but critical, such as the universal declaration of human rights. Local laws and conditions are usually best to decentralize as much as possible to increase speed and decrease overhead.

Harmony

Definition
Harmony, or social justice, is all about fairness: fairness to each other, to future generations as well as all other living things. Harmony touches on the fundamentals of human interaction, and can be difficult to evaluate. Areas of study such as ethics may help, such as deontology or consequentialism.

Lessons from Harmony
It is not a great secret that humanity has been able to be unimaginably cruel, more so than any other species, both to itself and to other creatures that inhabit this planet. What this should teach us is that we can better be safe than sorry. At the same time, we've sacrificed an enormous amount of personal freedoms under the flag of safety, which teaches us that we can only go so far in protecting a group at the cost of the individual, and that in the end, we all have a responsibility to act in accordance with our morals. Keeping this balance, helping people to be aware in order to make the right decisions, and finding equitable mechanisms to steer clear of the atrocities that continue to plague both man and animal is a primary cause for any system hoping to be sustainable. After all, one can have a resilient, autonomous system built on the back of slaves, only serving to propagate suffering of many to benefit few.

Behavior
Harmony is primarily fed by the top layers of ELSI, such as cultural rules, laws, economic balances, and the health and happiness of those that are inhabiting the system. Mixed in that are network parameters that help the system to increase its harmony, but do not necessarily cause it to be harmonious, such as awareness, transparency, and validity. Increasing these network parameters through law or policy will likely lead to increased harmony in the long run.

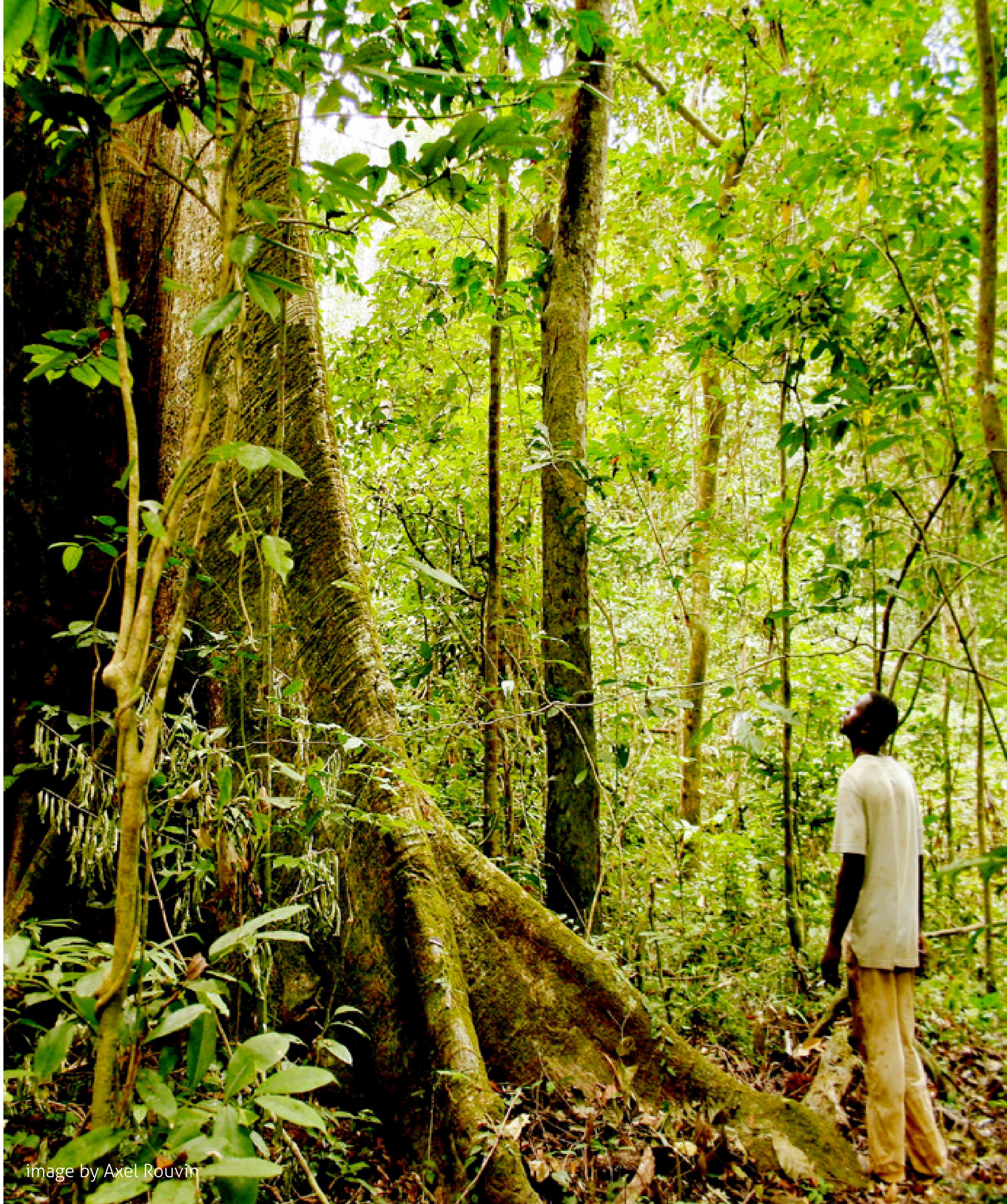


image by Axel Rouvin

THE 12 RULES OF COMPLEX SYSTEMS

As a handy reference list, remember these 12 properties of complex systems:

1. Complex systems are **numerous** (uncountable) in their components in which all components influence each other. They exhibit non-linear behavior emergent from their interactions beyond each component's mechanical (linear) behavior.
2. Complex systems can be **understood but not predicted**. Any action upon them may have unpredictable (side-)effects. Don't make decisions based on prediction; instead, prepare for resilience, adaptability, flexibility and so forth.
3. Complex systems **grow like organisms**, and, like them, perish. No complex system is meant to exist for eternity. Understand and accept the natural cycle of things, and aim for self-reproductivity and longevity rather than eternality.
4. Complex systems **require an increasing number of resources per added unit of complexity**. This means there are always limits to their growth. Systems respond differently at different scales, but may exhibit similar patterns at different scales.
5. Complex systems **change rapidly in revolution-like jumps, as well as in slow evolutionary progression**, and both together. These events can be triggered by anything. Patterns in details are just as important as large-scale variables.
6. Complex systems **do not necessarily behave the same way given the same conditions**, nor is historical behavior always an indication of future behavior.
7. Complex systems are **always dynamic, never sit still, and are never entirely in balance,** even if they seem to be.
8. Complex systems are not aware or alive per se, but **may exhibit survival or seemingly cognitive behavior**. It makes sense to mentally construct a complex system as a biological entity with a character to increase your understanding of its dynamics.
9. Complex systems **require incubation periods for changes to be registered**, processed, and acted upon. Be patient. Measure in the full spectrum for any changes lest you miss a rebound effect or changed state somewhere.
10. Complex systems, at the moment, **can best be understood by human brains**, as they're also organic complex systems. Immersing oneself in a complex system and fully interacting with it is the best way to learn its behavior. In other words, try to get out from behind your desk and connect.
11. Complex systems **interact beyond their chosen system boundary,** which needs to be taken into account at all times. Maximize the beneficial properties of these externalizations and minimize the system's dependency on them for increased sustainability.
12. Complex systems **always offer hidden dynamic processes** that can have beneficial as well as destructive effects. Find these patterns to boost capacity for change and prevent harmful externalities.

SYSTEM DYNAMICS

Systems are dynamic, respond to influences from the outside and inside, and exhibit behavior whose causes cannot be reduced to single objects or connections. The cause and effects of these system behaviors cannot easily be distinguished, but they can exhibit patterns that allow one to understand and work with systems effectively.

These patterns are often 'emergent', meaning they arise out of their mutual interaction and not due to any particular object or connection alone. The complex emerging behavior of systems is called systems dynamics, or system traps. Below, we listed common system dynamics that may help to recognize these and other patterns in complex systems.

- ***Big changes happen quickly***
  Complex systems have the habit of, once triggered to change, to change very quickly. Behind these apparent incomprehensible drastic changes, there is tendency of every dynamic system to stabilize itself in an equilibrium or attractor state.

- ***Scale dependencies***
  A general rule for complex systems is that their behaviour is linked to their scale and composition. A change in scale by an order of magnitude will cause systems to behave very differently.

- ***Rebound effect***
  The rebound effect is a universal systemic behaviour that occurs when a marginal change has been made to the system. It may be triggered through unfortunate delays in feedback that worsen the performance of a system, psychological effects, economic mechanisms or others.

- ***Exponential effects***
  An exponential effect occurs when one parameter in a system influences various other parameters in the system, which in turn, multiply causing the system to respond with an exponential change in another area.

- ***Law of diminishing marginal returns***
  This law, most know from economics, is a general rule that applies to all systems. The rule states that for each single unit of production that is increased, the return of that unit is slightly less than the one preceding it. This causes growing systems to hit a ceiling of efficiency at some point, after which it actually starts to drop, until the system collapses under the weight of its own overhead.

- ***80-20 Rule***
  This rule of thumb, also called the Pareto Principle, states that roughly 80% of the effects of systems are caused by 20% of their causes. This is not a law, but it's applicable to many situations in virtually all systems, on all sorts of levels, be they natural, societal, or economic.

- ***Historical momentum***
  A large system that has been operating for a long time often becomes rigid in its patterns, even if those are non-physical and could change on the fly. This 'historical momentum' is a primary target to overcome when aiming for societal transition effects.

- ***Tragedy of the Commons***
  Tragedy of the Commons is the depletion of a common resources shared by a group of people, even though each member of the group was aware this depletion worked against their personal and shared long term interest.

We've listed some common system patterns, properties, and behaviors you may find easily in the wild, and that may help you recognize these and other patterns in complex systems yourself. This is not an exhaustive set, just as any psychological handbook will be incomplete as to the number of behaviors people may exhibit for what reason, so will any list of system behaviors be incomplete.

The systems patterns mentioned aside are some of the fundamental understandings we need to absorb to move forward into this century. And they are but few examples of the myriad of system dynamics we can see around us.

A HAPPY COLONY OF ALIENS IN SPACE

The objective of sustainability is, put shortly, for mankind to continue to survive on this planet. Preferably, flourishing and happy, but that requires survival in the first place, and lack of critical hardship in the second. What does it take for us to survive like this? In order to figure this out, and get a feeling for its base principles, it helps to use the following thought experiment. Imagine an alien colony floating around in space. What does it take for it to survive? Imagining this clarifies some of the base theoretical principles of SiD, which is helpful to have in mind before diving deeper into the theory chapter. So let's have a look.

Preventing collapse

In order to understand how our alien colony floating around in space can continue to survive, it helps to think about its reverse, preventing it from collapse. This, since societal collapse has been well defined and studied. Collapse doesn't have to be complete annihilation, it is more often the degradation of a civilization to a more primitive state. In either case, collapse goes hand in hand with death and destruction of all kinds of values we hold dearly, such as cultural sophistication, economic value, and human rights. We don't want that, and therefore we want to prevent it. Here we have our alien colony. Floating in space. They are lovely aliens, they merely hope to survive and flourish. Let's look at what they'll need to achieve this, and not collapse.

The colony needs Autonomy

To begin with, the colony will need their basics in order. All life needs some input of resources. They may need to consume sustenance to stay alive, which they need to make. They may also need heat to keep warm in space. Basically, they'll need some material resources, perhaps including things like medicine to stay, in the most basic form, alive. In order to stay that way, they need to have an indefinite supply of these resources that will keep the colony alive, and an infrastructure of extraction, production, and distribution. This may include recycling everything to reduce reliance on outside sources, and so on. In SiD, these requirements are covered under the word 'autonomy'. Autonomy is about the colony's self-sufficiency, and making the decisions to remain that way. Okay, Autonomy covers the basic needs. What else do they need to survive?

The colony needs Harmony

In order to survive further, the colony should maintain some level of peace. It's all fine and well to have enough food and medicine and shelter, but if there's so much tension that they keep killing each other, well, that will threaten their existence. Things that may cause them to be upset with another can include how resources are shared, power structures, participation, and so on. All things related to this are called 'Harmony' in SiD, which point to the need for the management of internal tensions of the colony.

The colony needs Resilience

With autonomy and harmony in place, they're doing pretty well floating around. But then there's outside influences. They're floating in space, so at any time, a meteor or whatever unidentified thing can cross their path. They can be floating by a moon, and its shadow takes away the light of a star needed to survive. Or whatever you can think of can happen floating in space. In order to deal with this and survive, they need some properties. For example, they need to be able to detect things coming their way, like our eyes help do. Also, they need to be aware about what the meaning is of what they are seeing (awareness). And, if they understand that some giant space rock is hurdling their way, they need the capacity to get out of its way (flexibility).

In the event of being struck anyway, it would help if there isn't just one alien, but many, so that at least some will survive (redundancy). There's a bunch of these aspects that help the colony to survive unexpected and sudden changes in their environment. These we call 'Resilience' in SiD. All the aspects such as awareness and flexibility come back in SiD's sets of network parameters that drive Resilience, and help to figure that out.

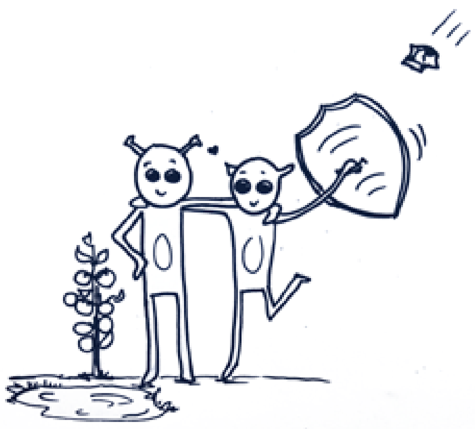
So, in order for a colony to not collapse, they need to be autonomous, in harmony, and resilient. If they have these properties, they can survive. If they manage to get them up to a certain level of comfort, they also set the preconditions for them to flourish and be happy, if they want.

The colony needs healthy system dynamics

These three aspects, autonomy, harmony and resilience, form the foundation of a sustainable society. If all three of them are in the 'green' then the colony has a good chance to survive. But, it's never that simple. These three aspects influence one another. For example, increasing the colony's resource intake, and thus their autonomy, may make them heavier. This then reduces their agility of movement, which reduces their resilience. There's hardly ever an ideal move, there's always a trade-of, within certain contextual circumstances. Some of these interactions can get rather complex, much more than a simple trade-off. Some may develop slowly over time, or are so subtle on an individual's basis that we can't see their massive effects on a grand scale, like climate change. We call the patterns in these interactions 'system dynamics', or 'system behaviors'. These are critical to keep in mind when trying to make the alien colony survive. For example, the relation between autonomy and resilience changes when the colony grows: it cannot grow indefinitely using the same structure. As it gets bigger, resilience is reduced if autonomy isn't changed in structure by decentralizing infrastructures, and so on.

It would be great if the alien colony has a detection system to find these shifts in resilience. Unfortunately, we humans don't really have an example they could follow. As a human civilization, we're pretty good at understanding that we need to secure water, food, power, and some other resources to survive; the autonomy part. We mostly understand the importance of the harmony part but we're not particularly good at arranging that (yet, I hope). The resilience part is where we still struggle the most, which eludes us often. And that also causes us to miss important system dynamics between all of them. We do not really have the 'eyes' to see them, or even the awareness of their existence. We make many decisions that make us less resilient in the long run for short term autonomy or harmony gain. As our society grows, we see increasingly self-reinforcing system behaviors that threaten our survival through it. This will make us sitting ducks in space, like an alien colony in space unable to move, eating up finite resources until it perishes.

For example, we are only recently aware of one of the most important system dynamics that we face, one that all of our societies are governed by, both the alien colony and us. The one system dynamic to rule them all: the law of diminishing marginal returns. We have no detection system, metrics, or governance in place to deal with this on a societal level yet. Large companies that are heavily subject to this are often not even aware it exists. For anyone wishing to survive in the long run, the alien colony as well as us, we best start looking at these things. Below I explain a little about the importance of the law of diminishing marginal returns, as an example of how critical the understanding is of these systemic behaviors. Further in the Theory chapter we discuss others as well.



Diminishing Marginal Returns

Joseph Tainter (1949-) is an anthropological scholar and historian, and one of the world's most interesting experts on societal dynamics. Tainter was fascinated by one central question: why did old civilizations cease to exist, even sophisticated ones? He wasn't happy with the usual answers, for example that the Mayans collapsed because of a famine, and the Roman Empire because they were overrun by Barbarian tribes. He figured the Mayans had dealt with famine before, and the Romans dealt with Barbarians before, so he wondered what was it that made them collapse this time around? What made their societies so fragile that they couldn't overcome that adversity? So, he studied a lot of old civilizations, including Mayans, Chacoan, and the Romans, using network and complexity theory, and he found a pattern. He wrote a magnificent book about it called the Collapse of Complex Societies (1988). In this book, he shows that societies become 'brittle' over time due to the law of decreasing marginal returns, an over-arching system dynamic. We get further into system dynamics further in the theory chapter, but to summarize here's a short simplified overview.

As a society grows and develops, it increasingly needs more of everything. A developed society has a larger footprint per capita than a more simple society, and this is an irreversible process (until collapse). More of everything means not just more energy and food, but also less tangible things such as capacity to handle trade transactions, cultural diversity, and management overhead. This means resources, including time, need to come in increasingly large supply to satisfy the needs of a society. And there are always limits to resources. Once the resources become scarce, it puts pressure on everything, making the system 'brittle'. If not a new, more concentrated form of the scarce resource is found, the system becomes critical. At that point, pretty much anything can set off the process of collapse. Collapse can then be slow and gradual, like with the Roman Empire, or with a sudden shock. As mentioned, collapse doesn't mean a total eradication per se, but certainly a decrease in complexity, and with it, a reduced capacity for support for many people, meaning death and suffering.
So, applied to our colony of aliens, it means that when it grows, it will need to fundamentally change its operations, infrastructures, and even base resource usage patterns to prevent becoming brittle and collapse. Even out in space, where there is infinite room to grow, there are limits to growth, and a necessity to tune systems to their changing dynamics over time. So, besides being autonomous in having food, energy and materials, and besides not killing each other, the colony needs to be aware of and adapt to changing system dynamics to remain resilient, and survive whatever the future throws at them.

Learning from aliens and collapse

Looking at our world, we can see the cracks in the system of our increasingly brittle society appearing. One can even deduct large societal movements such as the Arab Spring or the rise of nationalism in the western world as early systemic warning signs. We also have some hopeful unique properties that may help us in the long run. Our society is unique in comparison to older civilizations in that we are globally connected. For the first time in history, we have a world economy and resource system that can help to balance resource needs. This can keep a certain part of society from collapsing on its own. The downside of this is that this puts harmony under pressure. There's already a fair share of issue with migration, and countries stealing each other's resources such as oil, land, food, and water.
We also have unprecedented technological advances, that

may allow us to tap into more concentrated or abundantly available resources, such as renewable energy and nuclear fusion. This may help us beat the curve until we finally figured out that we need to globally curb our own growth, or figure out ways to deal with the growth cracks until we do.

But, besides battling the symptoms, even better still is for us to learn, understand, and apply the solutions that systemic insight brings us. We can develop some eyes and awareness of them, and develop ways to ride the wave of change out of the danger zone. Like the alien colony setting up control rooms to check for system dynamics in their colony. It's not hard to imagine some beautiful screens showing the development of their colony, some essential parameters to track, and a panel of wise aliens determining how to act on its dynamics.

There is no reason to think that our society does not comply to the law of diminishing marginal returns, and there is plenty of proof to indicate that we have become increasingly 'brittle'. But there are still many ways we can go forward. In that, it helps to allow ourselves to start looking at our society as an alien colony floating in space. What systems would we put in place to detect these system dynamics? Where in the system that has become brittle can we intervene to increase resilience? What measures can increase autonomy and resilience at once? How can we better embed harmony in the world? What part can we play in this? Questions I hope using SiD will help you answer.

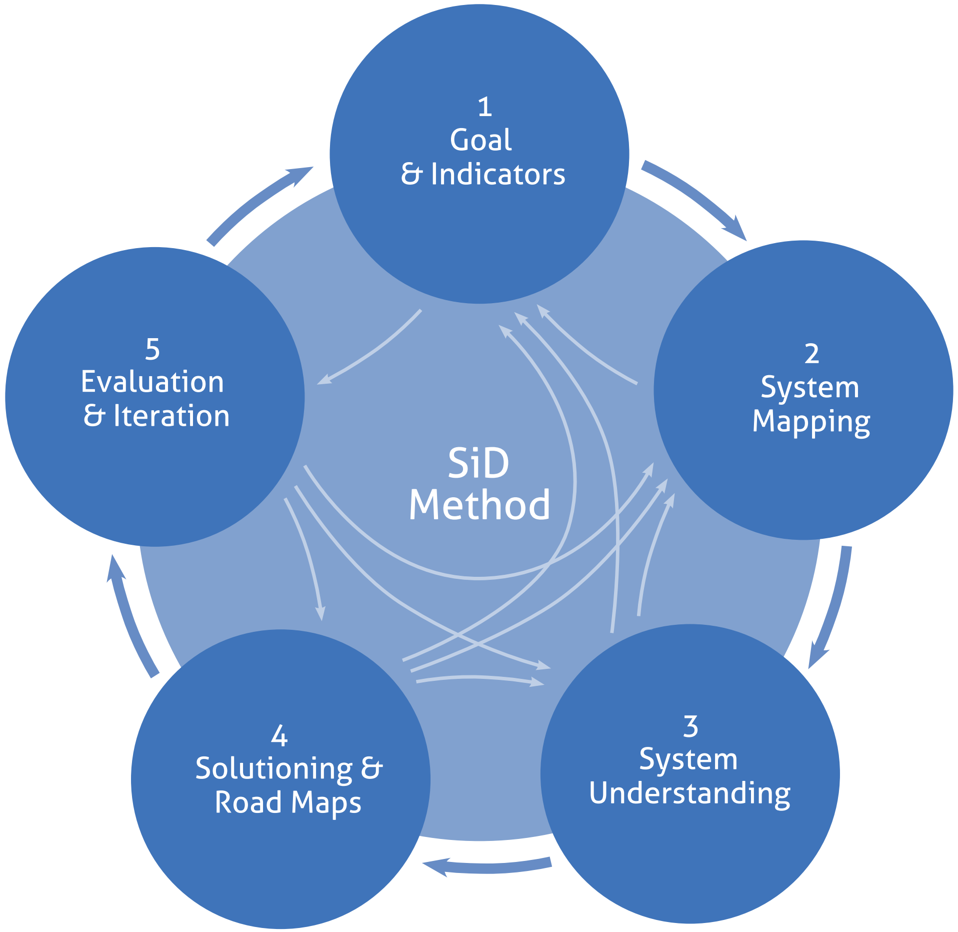
5. SID METHOD

The SiD method is a practical approach for finding pathways towards sustainable systems, by means of system mapping. Using the method leads to a clear insight in the current situation, an understanding of the system's dynamics, and an action plan to intervene in the examined system. The method describes an iterative process that can be started at any step, and can have different sequences. The amount of iterations is not known before hand, neither is the duration of each iteration.

The SiD method itself consists of five cyclical steps: setting goals (and determining appropriate measures of success), mapping the system, synthesizing knowledge to understand the system, mapping possible routes to optimize the system, and evaluating the results. Below, the steps are explained in more detail, but remember that the method can start at any stage.

Step 1. Goal setting & Visioning
In the first step we determine where we want to go with the project: our destination. We do this by following three steps:

- Set the goal for the project on a system level or develop a joint vision
- Define the system boundary
- Set the indicators to measure against, on an object level



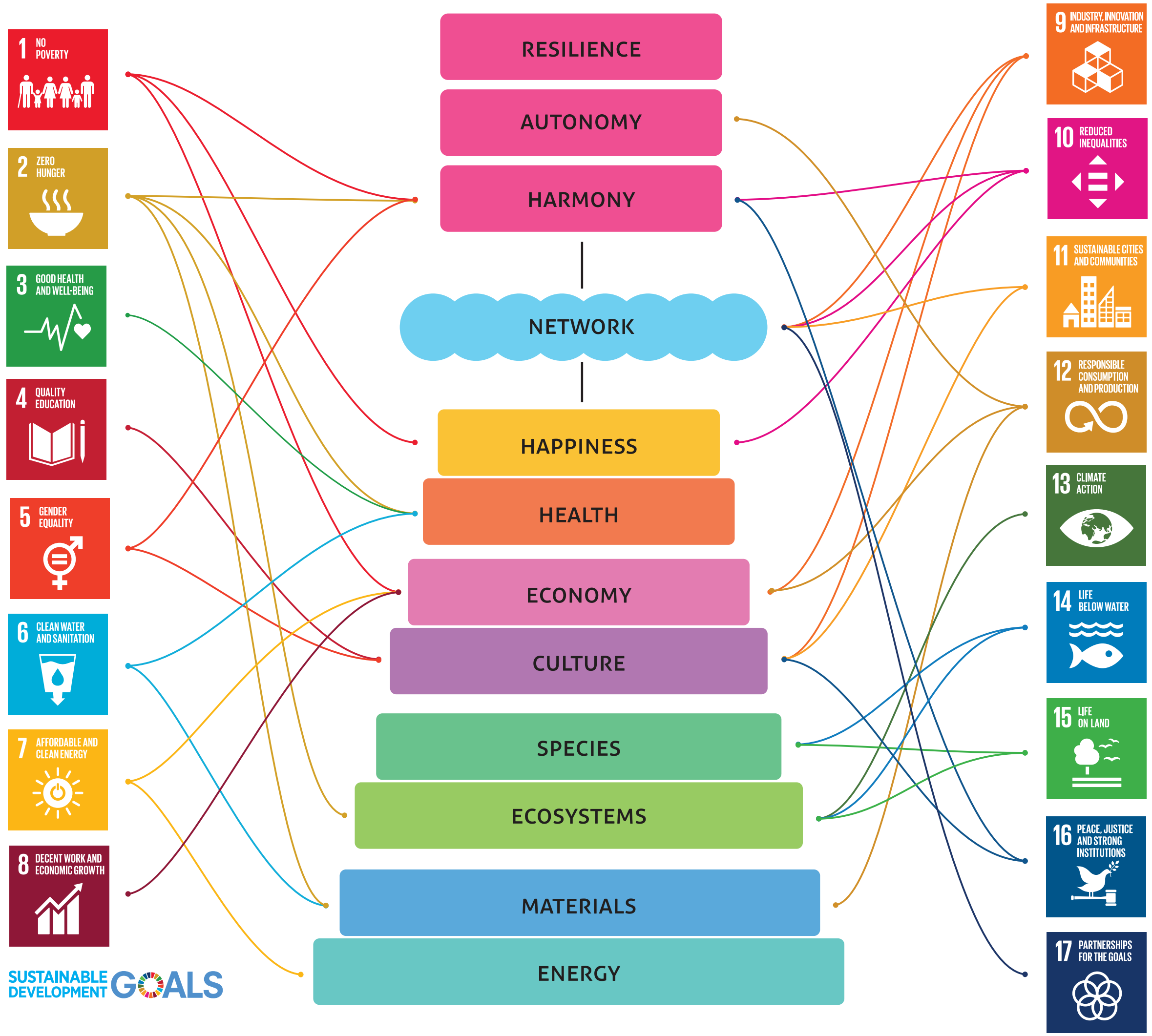
› The SiD method

Goal setting: the UN Sustainable Development Goals

The United Nations published its list of Sustainable Development Goals (SDGs) in 2015, as part of its 2030 agenda. When the SDGs were released, we were thrilled to see that they emphasize a holistic approach to sustainability with 17 global challenges to achieve a sustainable society.

The SDGs are particularly suitable a goal framework to guide a SiD development process. When using the UN SDG framework, for example when aiming for impacts in particular SDGs with a project, use SiD to explore what relations each goal has in the system that is under investigation. Once the objectives of a project are set, the SDGs can also turn useful to categorize indicators. The UN SDG goals are broad, so they usually have multiple areas of impact in the various levels of SiD.

On the right, you can see a diagram showing the main relations of each SDG goal onto the SiD SNO stack.



› the SDGs can be used as a goal framework to guide a SiD development process.

Step 2. Mapping the system
System mapping is one of the fundamental properties of SiD and forms one of the main steps in the SiD method. It's a key approach to understanding a system and working to improve it. It basically consists of charting the objects and network within a system boundary to establish what the system actually looks like in space, how it behaves in time and what its structure is. Often, it is easiest to start mapping on the object-level, next the network-level and to end up with system maps.

Step 3. Understand the system
This step is about understanding and learning about the mapped system and priming solutions pathways. This is done by 'immersing' yourself in the system both solitary and as a team. This way you'll develop a 'feeling' for the system, which will lead to possible 'eureka' moments, and will prime all participants for the solution stage.

Step 4. Solutioning & Road maps
This is the stage in which solutions are refined for both immediate implementation and future development. This is usually done by creating a second set of system maps, with a long term ideal configuration in mind, and back-casting from this to figure out how to get there. These steps are recorded and placed in a road map which serves as an action plan for implementing the improvements.

A roadmap is the plan that will lead to implementation and success of the solution, and without it, you may not succeed. In many cases, the solution is the roadmap itself, for example, when performing a sustainability improvement trajectory with a company. For others, where stakeholders determine the success of a project, the roadmap is the central glue to the co-creation process that helps stake-holders align, agree with, and support the trajectory over time.

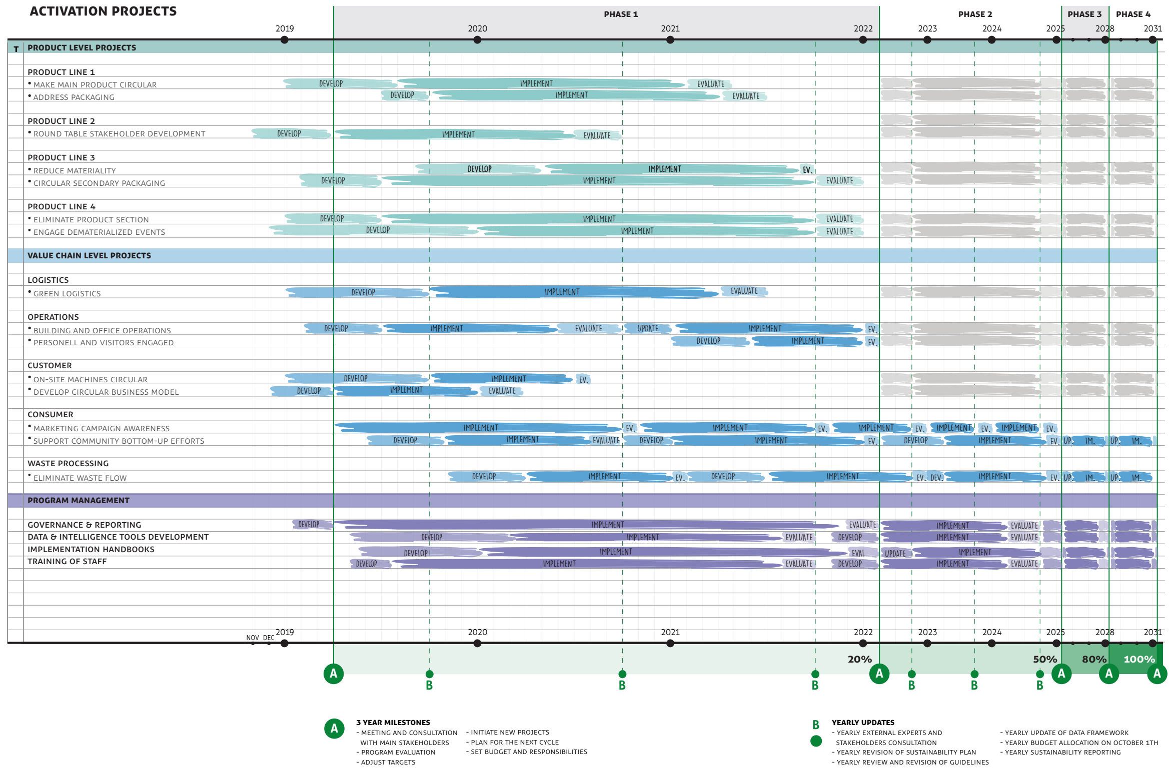
The roadmapping process consists of ten moments:

1. Draw the global timeline
2. Place the end-goal (set ambition level)
3. Review ambition of the goal in time
4. Map main solutions on the timeline
5. Cluster/arrange solutions in channels, e.g ELSI
6. Identify and solve missing steps
7. Identify transition phase for solution/channel
8. Identify responsible parties for solution/channel
9. Set milestones/reporting at intervals
10. Set an action plan, and evaluate

After this, the roadmap can be formalized, documented, shared, or whatever is appropriate in the process.

Step 5. Evaluate and Iterate
This step is reasonably straightforward: to evaluate the outcome of the process to the goals that were set, and prepare for a possible next iteration of the cycle.

As mentioned before, the steps of the method are cyclical and iterative: steps are often repeated as our understanding of the system under investigation grows and the focus or goal of the project shifting as a result. Certain steps may also be iterated by themselves. In short, there is not one finite or linear method to apply SiD to sustainability questions, but the described steps can serve as a mental framework to figure it out for each particular question at hand. The application of the general method is further refined by using it in a SiD process, in which the method is cycled through and can be planned accurately.



› Example of a roadmap

HOW TO MAKE SYSTEM MAPS

Okay, you're set on your first SiD project and you are now supposed to make these so called 'system maps'. However you've never made one, you may not even ever have seen one, and are completely lost in the woods. Do not fret, here's a handy guide. System maps are not hard, they are actually supposed to be easy. That's the whole point. Anyone can make them. They do require some exercise, but you'll get the hang of it soon enough. Okay, lets start.

What's a system map?

A system map is a way to organize data and information from the real world in a way that it reveals an underlying order or pattern which can help in determining the nature or behavior of a system, and helps in making decisions in how to improve the system. They are usually visual maps, but can also be lists or other ways of organizing information. System maps rarely come alone. To map a system, multiple perspectives and scales need to be taken into account, which usually means you end up with a set of interrelated maps.

What makes for a good system map?

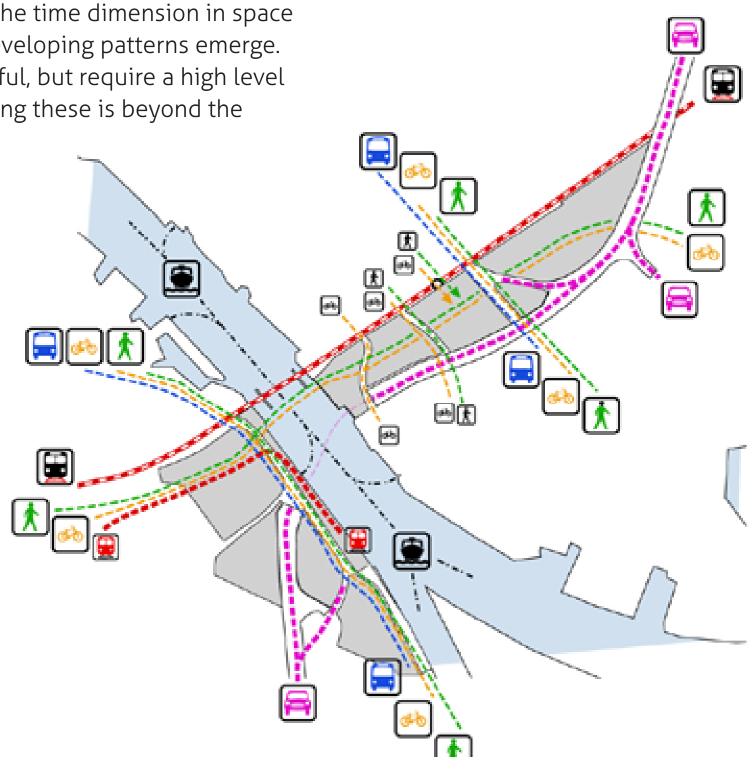
A good system map does the following:

- Reveals important connections or disconnections
- Is not so complex that it becomes unreadable
- Does not overly simplify reality to disqualify itself
- Can be easily augmented and adjusted
- Is appealing to the eye to make it easy to read
- Conforms to a larger organizing system so as to allow you to use multiple maps together to form a multi-perspective overview.

Making a good system map always takes a number of iterations. When you first start mapping something, you have no idea how the things you're mapping are related (or you may think you know but it turns out to be different). In the first few iterations, you'll work on a sketch level in order to figure out what you're up against. In later iterations you'll find the form and layout that works best for your purpose. Therefore, system mapping usually starts with sketches on paper. In some cases though, you'll be working with a computer model or illustration as a start.

Dynamic system maps

Using computer visualizations you can make dynamic system maps, or maps based on large data sets. With this approach, you can also embed the time dimension in space or context maps, and see the developing patterns emerge. These can be immensely powerful, but require a high level of technical expertise, and making these is beyond the scope of this guide.



STEPS TO MAKE A SYSTEM MAP

1. Determine subject and goal
First we need to know what we'll be mapping. Are we mapping a neighborhood, a person, an organization, or perhaps the influence of a certain action or policy decision? Also, we need to determine what the objective is for our mapping. Are we making maps in order to figure out a strategy to improve the system, or are we looking for a specific relationship or quality, or perhaps just using it to create general awareness?

These aspects will factor in when setting up the framework and making the content.

2. Make a mapping framework
You're usually going to be making multiple maps. For these to correlate to one another you need to set up a framework for your maps so they speak the same language. Even if you're just making a single map, you need some internal logic to have it make sense. SiD's structure makes this very easy for you, and suggests you make at least a time, space, and a context map. You may make multiple maps for each dimension for scale, if that's convenient. You need to determine what kind of map, and how you'll be representing the information. The following may help:

Space maps:
Space maps are a common mapping format we're all very used to, but don't be tricked into using a common mapping format without reflecting on it. Space can be mapped in many ways, it doesn't have to be geographical, or even regular.

Typical examples include a map of a neighborhood indicating all energy, material and waste sources to use as a starting point for creating a circular neighborhood system. Typical scales include building scale, neighborhood, city, region, country, world.

Time maps
Time maps we mostly know from graphs and time lines. Also with time maps you have more freedom than these types, but they can serve as a good starting point. Typical scales include diurnal (24 hours), weekly, monthly, yearly, decade, century.

Context maps
Context maps can be the most confusing map type, but at the same time the most powerful. Context maps do not have a fixed meaning for their axes, so they can show other kinds of relationships between the mapped elements. Simple examples include things like a shopping list, or a budget spreadsheet; they are not time or space maps either. More advanced and useful maps within the context of system mapping are causal loop maps, connectivity diagrams, and material and energy flow diagrams.

For the content, use a standard structure to gather information so that you can relate them to other maps. If you don't want to make your own system, just use ELSI8 as a starting point. Fill the categories with areas of interest for each of the 8 ELSI categories, gather data, and see if this works, and expand from there.

3. Populate the maps and adjust them
Gather the data you need and start populating your maps. It's best to start on sketch maps, and make quick iterations. In the beginning, do not try to be complete for everything, but work on all areas evenly. You'll see that you'll make more coherent and communicative maps this way.

As you're progressing during the mapping, you may find that a certain map type doesn't work. That's fine, great even. Adjust the framework for this to fit, and repeat the exercise until you've got the maps that do what you need them to do according to the goals and subject you set.

The exercise of mapping usually leads to insight into the system by the people doing the mapping. That's why we recommend that the decision makers in a SiD process and those doing the mapping are the same people, or at least have the decision makers present and involved. Write these insights down during the process, they're useful later.

4. Finalize maps
When you've gone through these cycles and are happy with the framework, map types and data, you can set to finalize all the maps to their end result. Involve others to perform some final evaluations and get some extra insights if you can.

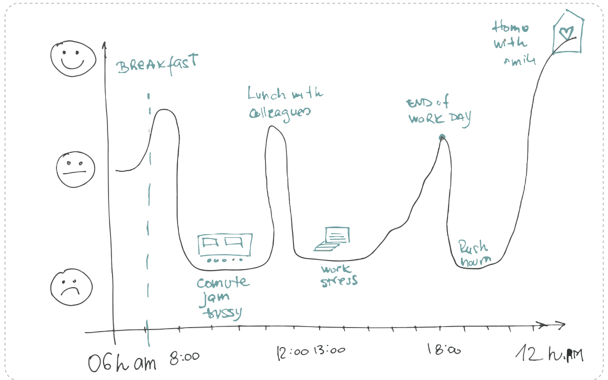
5. What next?
The maps should be revealing opportunities and patterns for the systems you're investigating. If they're not, something's not right, and you should check if you chose the right subject and goal, or perhaps get some help on how to represent the maps.

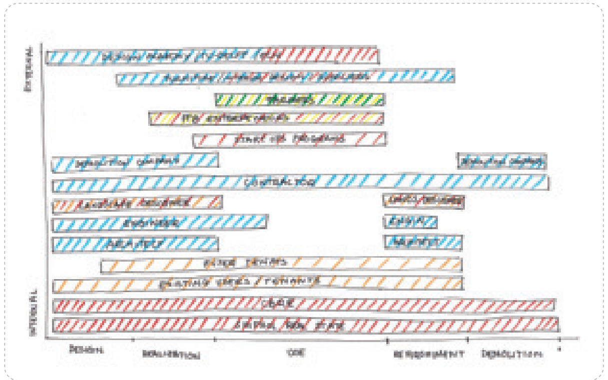
Once you're done, depending on your goal you may choose to make a second set of maps. Using the same framework, map the systems as you would like them to be, in order to be resilient, equitable and autonomous to the degrees necessary. You can use these future projections as a point for discussion, or as a way to find action pathways to improved performance of the system, be it a company, city, or policy.

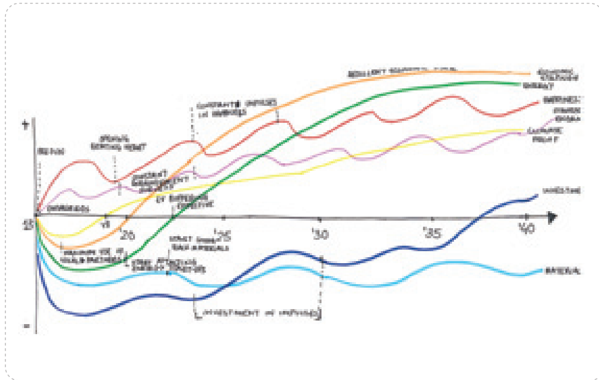
Some map examples follow after chapter 8.

SMALL | **MEDIUM** | **LARGE**

TIME



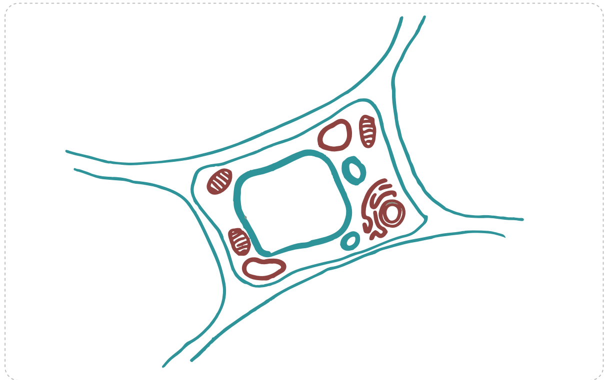


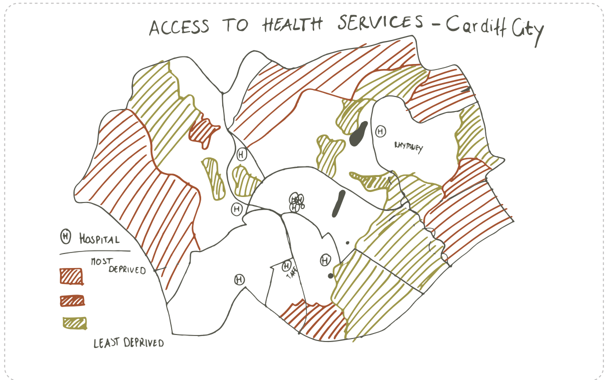


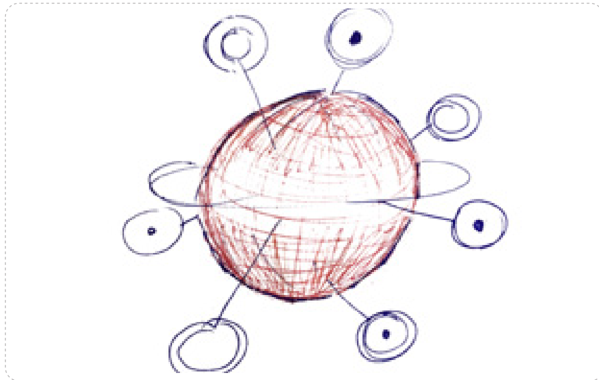
SPACE

Z

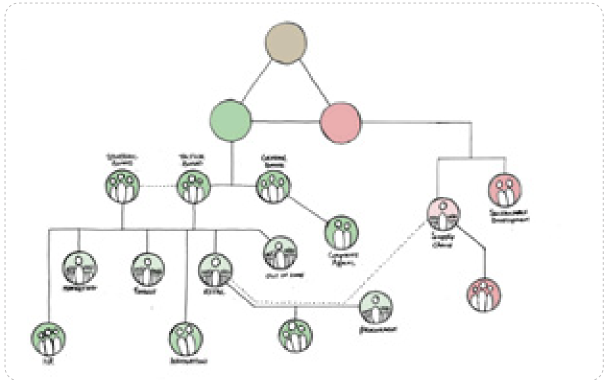
Y X

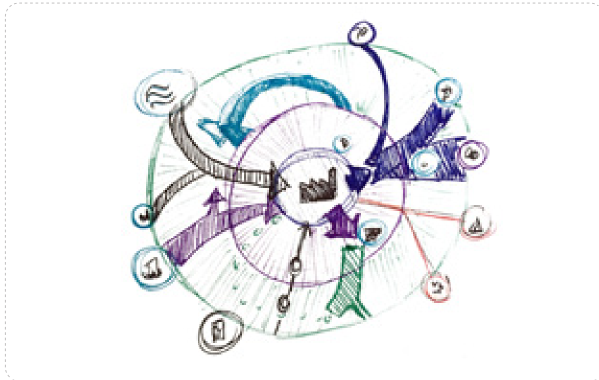






CONTEXT





› Examples of different types of system maps.

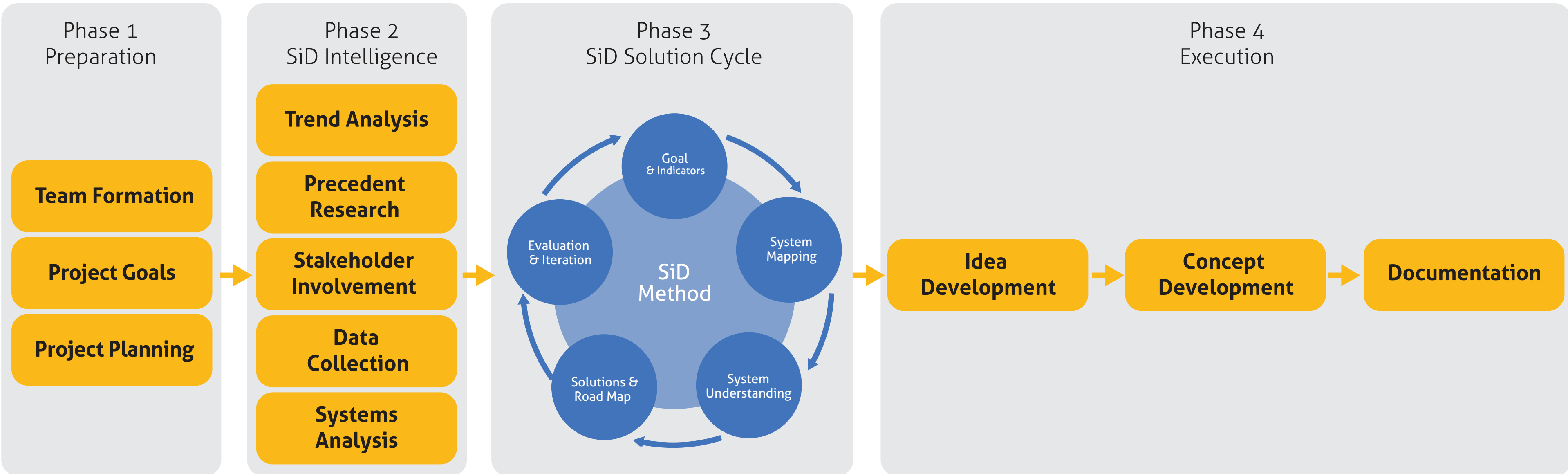
6. SID PROCESS

A process is the set of steps taken to achieve a certain end result. In the case of a SiD process, it is the steps taken to execute the SiD method. The SiD process is a modular structure that allows the project manager and its team to quickly layout a route to successfully execute a project. The design of the process therefore greatly influences the results of a project.

In each SiD process, one or more SiD method cycles are followed, which makes each project SiD process unique. Below, an example of a SiD process is displayed. This SiD process has parts where scientific analysis is performed, as well as creative group sessions.

Process design
SiD approaches process design in a modular, flexible fashion that builds on existing process design techniques. For most SiD projects the process is designed anew, because every project has its own peculiarities, and continuously tweaking the way we do things is essential for producing good results.

Assignment analysis
The first thing the project manager does is a quick analysis of what it is about, its timeframe, potential budget requirements, etc. By doing this, the project manager briefly explores the requirements of the project, so that a team can be formed, the right tools will be at the table when work starts, and the team members can be briefed on the project. In fact, this phase is an extremely quick SiD method cycle to get familiar with the task at hand and find your bearings. After this, a definitive process can be designed.



› An example of a SiD process

Team formation
The project team is the group of people that develop the project from start to finish. This does not include external experts, stakeholders, the client, or any partners that may be interacting with the project. The project team may include any of these parties, as long as they participate from beginning to end. Usually, the project team consist of 5-10 people.

At Except, a project team always includes the following 'mindsets': a scientific thinker, a creative thinker, a socio/ economic thinker, and a communicator. To us, mind-sets are more important than what degree people officially have.

Goal setting
Goal setting is the first content-step of a SiD process, and is an execution of the first step of the primary SiD method, as described in the previous chapter. Setting a goal at first should go rather quickly. As the process continues, the goal-setting step may repeat a few times to refine the set goal.

The primary system goal is usually rather broad (e.g. 'create a sustainable society'), so it is often beneficial to frame subgoals in a manner which give direction to the project.

Project preparation
To map a system, we need to go out and find the data we need, as well as make templates and other resources to make this happen. This phase is meant to determine what data to acquire, source the data, and process it in maps once acquired, to be able to map a system effectively.

Precedent research
The primary reason for the precedent research stage is to prevent reinventing the wheel. In this stage, all members of the core team go out and search available knowledge resources for existing solutions to the situation at hand, as well as record inspiring resources along the way. The results are recorded and organized in such a way that they can easily be referred to later, and may contribute to a database of solutions that are shared and reused as a starting point for other projects.

Stakeholder involvement
In every project, stakeholders are involved. Stakeholders include the people directly impacted by the SiD project, including any clients, customers of the client, users of the topic at hand, suppliers, lawmakers, regulating bodies, sector agencies, and so on. Including these parties in your development trajectory does two very important things: you will learn things you would never have come up with yourself, and you create consensus, which makes implementation and future collaboration with the stakeholders easier and more likely to succeed.

Systems Analysis
In the preparations phase, a systems analysis is performed to prepare materials to use in the SiD sessions. For example, pre-made time lines, area maps, and stakeholder maps are made to facilitate insight during the sessions. See next chapter on how to make system maps.

SiD sessions
The SiD sessions are the heart of projects in which a true innovation is sought for a complex problem. SiD sessions consist of 4 or 5 days of intense collaboration of the core team in a single room, preferably with the client. During these days, the core team cycles through the SiD method several times. They set goals, build system-maps, find solution pathways, and plan road maps towards actionable results. They dive deeply into the system, process it together, develop insight, and formulate innovative directions at the end.

Route Mapping
If the project at hand is one where a complex system needs to be improved over a longer period in time, rather than a singular project, a route mapping phase is important. Route mapping creates a plan of attack to realize a systemic change over time, which is sometimes over a period of decades. This can be done in the same SiD sessions or separately.

Verification and Modeling
The results of the SiD sessions are a bunch of ideas, system maps and a route map in which they are placed. These ideas will need to be checked on their validity, missing parts need to be added, closed loops investigated, and a solid plan drawn up. In this phase a selection is made for the most viable routes, and several modeling tools employed to test the scenarios for feasibility, possible unforeseen downfalls and so on.

Concept Development
After the modeling phase there are viable pathways to move forward, which will be developed into more detailed concepts, and documented. This may include design phases for physical development, the writing of concept reports for policy development, or making business plans and models. Depending on the subject, this phase looks very different.

Execution phase
Each project culminates in one or more execution phases. The road map is used as a guide to select which projects are executed first. One of the immediate execution phases is usually the communication of the current SiD process, via a book, website, presentation, or other medium.

› A multidisciplinary project team

The SiD process starts with the composition of a suitable team that examines the formulated assignment carefully, which includes stakeholders and the client (if there is one)as well as for instance policy makers and residents, in order to find overarching solutions that touch upon many different concerns.

Communication Structure & Strategy
A communication structure is a framework in which the team registers and stores information in order to be easily communicated. Setting a communication structure and/or strategy during the project can be a great help in the process. This can be done at the beginning of the project to smooth the project's reporting and publication during its course, as well as at the end to communicate the project's results to the right people, with the right message.

SID SESSIONS

The SiD sessions form the heart of the SiD process. The steps before the sessions are preparations for the sessions, and the steps after to activate the solution found. SiD sessions consist of 4 or 5 days of intense collaboration of the core team in a single room, preferably with representatives of the client and stakeholders present. In this room the team cycle through the method: from goal setting, through mapping, understanding, and solution phases. The result is elevated insight, systemic understanding, and clear action plans on moving forward.

Why a SiD session?
If you've come this far in this guide, you know that true sustainable development and innovation requires perspectives from multiple disciplines, and an immersion into the dynamics of the situation. That doesn't come easy in a regular office environment, so that's why a special environment and working method helps. Over time, the SiD sessions have grown to be the venue to create the ideal conditions for such a process.

As opposed to having a drawn out-process over several months of mapping, understanding, and solutioning, we found a more effective method. During the typical 5 days the core team spends together in a SiD session, they dive deeply into the system, process it together, develop insight, and formulate innovative directions at the end. At the end of this week the team is fully in tune with the specifics of the project, so much so that they will literally 'see' patterns emerging. In most cases, this one week is enough to formulate a strong route map that can then be fine tuned by individuals. In case it didn't work, or the problem is of a larger complexity to handle in a week, we do it again, iterating until an adequate solution presents itself.

Setting up a SiD session
SiD sessions are led by the SiD project manager, who determines the team, location, program, tools, and process.

The team consists of the core SiD team, led by the process manager, and with at least one scientific thinker, design thinker, and business thinker. The role of the process manager is facilitating and structuring, but not the decision maker. Added to this could be external experts, and client and stakeholder representation. Everyone joining should try to join for the full session, not just one or two days. Guest speakers are a possibility, but not recommended as they can break the bubble.

If the 8 is really the maximum amount of people, with 6 the ideal size. If there are more than 8 people, consider holding two smaller independent sessions and perform the 'systems understanding' phase together, and at the end of the week compare results. Another day is likely to be needed to process the results together.

The sessions are held in a single large room, with plenty of material to write and draw with, large sheets of paper and room to stick them up on the walls, fast internet, projector, screens, music device, whiteboards and flipovers, as well as plenty of fruit, water, tea, lunch stuff and other nourishment. Ideally, this room has access to the outside, and will not be disturbed during the entire sessions by any outsiders. A good SiD session room looks like a mess in half a day.

Present in the room should be the maps made during the pre-development phase, all the data, as well as the precedents that were found, hung up on the walls.

Attitude

A week long collaborative session can be either miraculous for all involved or a painful experience if the collaboration doesn't work well. This depends entirely on the motivation, attitude, and 'click' the team has with one another. A session works much better if it's done with people that have done it before, know each other's strengths and weaknesses, and are able to be open and constructive. This means that just trying a SiD session once with an untrained group will go better when repeated.

Some guidelines are:

- Follow the standard brainstorm rules (google them, print them out, stick them to the wall, and stick to them.)
- Anyone can do as they please. Need a break, want to go outside, need to clear your head for a while, want to play a game? Do so, and let others do it. But, when you're engaged, you're fully engaged.
- Be there. Don't be late, and don't leave early.
- Bring your own favorite tools and toys, like drawing equipment, games, music, even movies to watch during a break.
- Do not work on other projects in this week. Turn off your phone when you can.

Start

A week before the sessions happen, the project manager mails around a four page document with the program, the goal, context, the restrictions, and the research that's available. The sessions start with goal setting. While this has already been done in a previous phase, it's important to revisit the goal, how it's set up, any reservations, and whether it can be improved.

› A usual SiD session configuration, with maps on the walls, and a broad interdisciplinary team.

After this, the resource maps are investigated, getting to know the issue at hand. The project manager takes the team through a tour of the problem, and determines the agenda for the sessions. What follows next is highly dependent on the project, and can include system mapping, serious games, route mapping exercises, or design exercises. Depending on the project, the sessions look differently.

› This photo looks nice, but this team is too large to be effective. Much time is lost in communication, and a lack of group feeling hampers elevated understanding.

To go further into detail about collaborative group sessions is beyond the scope of this guide, and there are many valuable resources that help in achieving effective group work, but here are some general pointers:

- SiD sessions are more effective with group sizes between 6-10 than under or above this number. For larger groups, consider splitting them up in various sessions.
- Mapping the system together, with stakeholders present, is a very powerful way to get everyone to understand the problem better.
- Mix creative and analytical work, and focus on positive development rather than criticism (brainstorm rules).
- Make sure to mix work with 'reflection'. Include some leisure activities, like taking a walk in nature together, planning an evening with theatre and drinks, and make sure everyone feels comfortable and at ease. Stress is the biggest block of a SiD session. If a single person turns out to be unconstructive without foresight of improvement, consider removing them from the team.
- Ensure everyone is knowledgeable about the standard brainstorm rules. The most important one being that one should reserve negative criticism, and always try to be constructive. Saying 'no' to something may put the process to a dead stop. Instead, try to say 'what if we do it this way?' An alternative idea is always welcome.

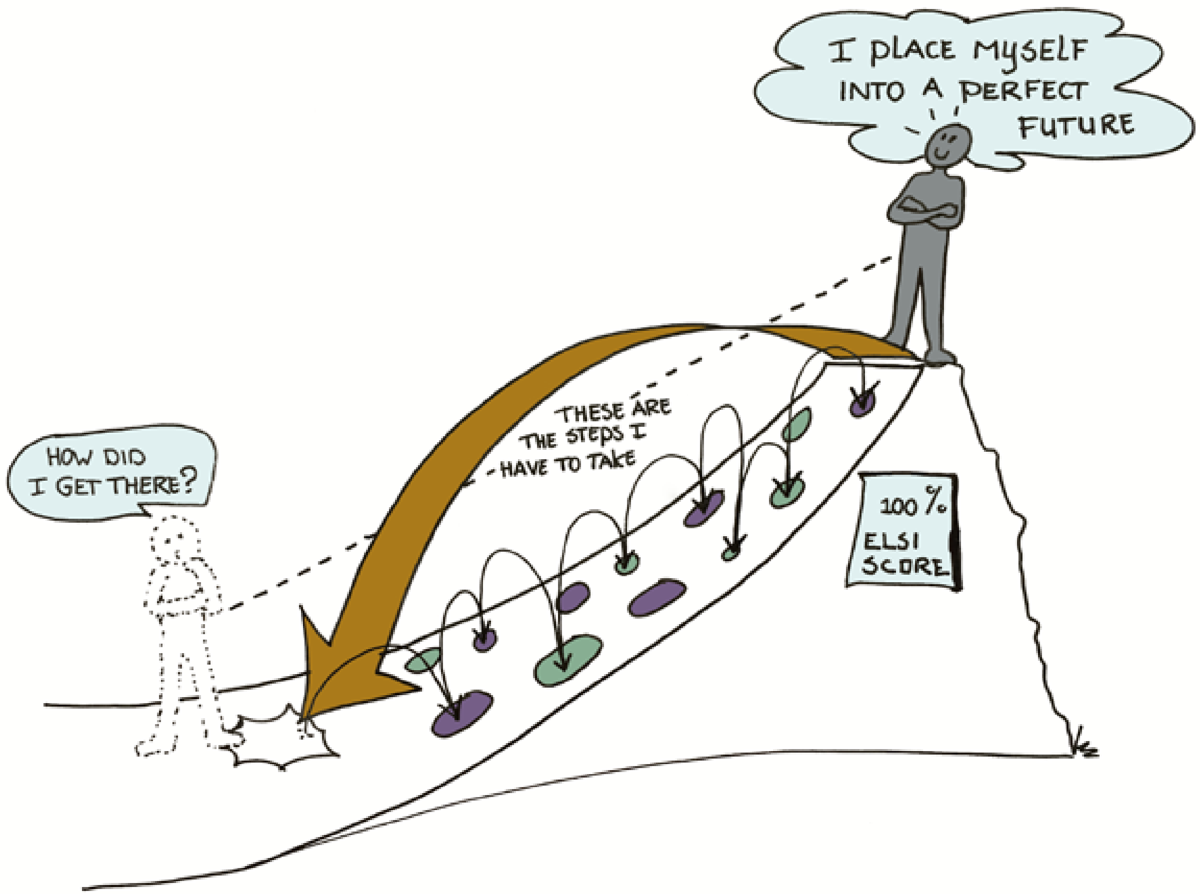
7. SID TOOLS

SiD contains a set of tools to use in the process to execute the various steps, perform evaluation, systems analysis and so on. In this quick guide we only include a list of the variety of tools as a reference, so you can get an idea of their range and diversity. We expand upon about one set of tools: how to make system maps, a vital component of the SiD approach, and how to organize a SiD session.

EXAMPLE TOOL LIST:

- SiD Sessions
- System Mapping
- SiD System optimization strategies
- Framework for Strategic Sustainable Development (FSSD)
- Principles of Green Engineering
- Principles of the Circular Economy
- Hannover Principles
- Biomimicry
- Spiral dynamics
- Maslow Hierarchy of Needs
- TRIAS Energetica
- Life Cycle Assessment (LCA)
- ARIES Ecosystem modeling
- TRUE system simulations
- SiD System mapping techniques
- Backcasting
- Stakeholder analysis methods
- Delphi Survey Method
- BREEAM / LEED / GPR Building assessment

You can read more in depth information about these, and more, tools in the SiD book.



› Backcasting is a technique used in visioning and strategy trajectories intended to produce steps to arrive at a desirable future.

8. APPENDIX: STAKEHOLDER MAP GUIDE

Involving stakeholders is a primary process step of SiD. To find out which stakeholder to involve how, start with making a stakeholder map.

A stakeholder map is a type of system-map that shows a visual representation of the relationships between various parties encircling a particular issue. Its purpose is to create at-a-glance insight into the network of relationships, allowing multi-disciplinary teams to create precise and effective intervention strategies in a limited time frame. The map also helps to communicate relationships surrounding a project to an uninitiated audience. Depending on its level of detail and structure, making a stakeholder map takes anywhere from one to several hours.

A stakeholder map can have many forms and sizes. During co-creation sessions maps are usually presented in a A0 or A1 poster format. We recommend drawing the map by hand at the start, as well as the final poster for the sessions. This saves time, is more flexible and allows all team members to participate in the creation process. After finalization, the map can be formalized.

The purpose of a map is not to be complete, which is impossible. The purpose is to create clarity and insight about the main patterns surrounding a project, as well as prioritize and strategize stakeholder involvement. In order not to get lost in the multitude of connections surrounding projects, the best approach to make a map is in an iterative fashion. This can be done by mapping a few primary stake-holders first, arrange them in a clear format, after which the map is refined in various stages, expanding relationships, etc. We recommend performing at least 3 iterations in a group process.

The best maps are those which provide immediate insight to groups of people. To do this, the map needs to be big, able to be read from afar, with big and clear letters and structure. Details and secondary relationships can be made smaller. Maps can be in various dimensions, for example, time, geographical, or relational (context). Sometimes, several maps are useful to present a strong pattern or insight. Sometimes, it's best to focus on one. There's no golden rule for this, use your own insight. However, we recommend always starting with a relationship/context map first.

SID STAKEHOLDER SYSTEM MAP PROCESS

A simple process outline to make a map is itemized below. The first iteration takes about an hour and a half, is executed with the entire group, and the iterations grow longer with increasing complexity. It helps to do at least the first iteration with the project group (3-5 people), and assign the refinement cycles to individuals that like to draw these kinds of maps to speed up the process. Because the result can be several maps, it can be arranged that each team member becomes responsible for a map-type. After 3 iterations (about half a day to a day) it's possible to end up with 3-5 maps.

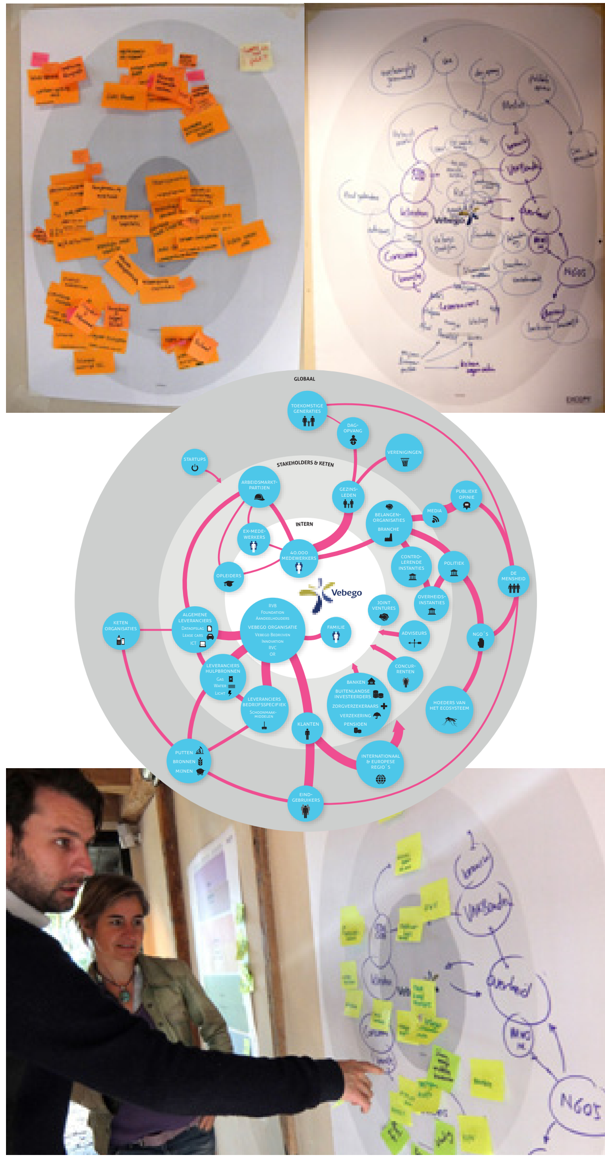
1 **Ask main problem-owner who the main stakeholders are (5 minutes)**
There's no easier way to figure out who's what by asking the main source. Of course, the source may be biased, but it's a good head start to just list the parties and their relationship to the project in the eyes of the problem owner. Adjustments can be made later.

2 **Short stakeholder brainstorm (10 minutes)**
Take a flip-over and write down all stakeholders that come to mind (brainstorm rules apply).

3 **Short stakeholder ELSI brainstorm (10 minutes)**
This is a repetition of the previous step, except now try to think of stakeholders that are in each SiD ELSI8 category. This helps 'fill out' the stakeholder pool. Take a flip-over board, write the ELSI8 categories on it as large squares, and place post-its with stakeholder names in them. (ELSI8 categories are, from top to bottom, Happiness, Health, Economy, Culture, Species, Ecosystems, Materials, Energy)

4 **Prioritize the stakeholders (10 minutes)**
Underline all stakeholders which are either the largest benefactor, problem owner, or influencer of the project's topic.

5 **Sketch and choose main map structure (10 minutes)**
There's many map structures that can be used, an the structure depends on the problem at hand. Sometimes a timeline useful, where stakeholders are mapped along the timeline of a process, history or development trajectory. Sometimes a geographical map is useful, where stakeholders near and far are mapped. In others, and most cases, a spiderweb context-relationship map is most useful. Sketch ideas about what maps are useful, discuss these and choose the ones to start with.



› A sketch context/relationship map in its first (post-it) iteration on the left, sketch phase on the right, and in its finalized form after design processing in the middle. Below shows the process of going from the first to the second step. While the designed map may look better on first sight, maps are best kept in the earlier stages until there's a formal communication requirement. This keeps them fluid. A carefully hand-drawn map can also be more compelling than a digitized one.

6 Build map structure (15 minutes)
Execute the map structure, also with (new) post-its on a central empty sheet. Often, it's best to start out with a context-relationship map. This type of map shows the relationship and priority between stakeholders. To start with this, take a new flipover sheet and write the name of the project's focus in the center. Write the primary stakeholders on a post-it and place them close to the center. Grouping these primary stakeholders where they are 'close' in relationship (EG government entities, private entities, businesses, individuals, benefactors vs sufferers, etc).

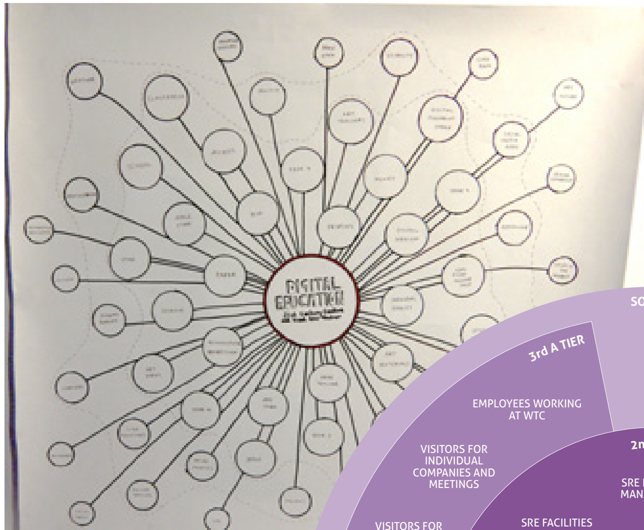
When starting with a timeline, write a long line on a landscape-oriented flip-over sheet. Identify what the scale of the map is (proces lenght, years, decades, 24 hours?), and fill the map from left to right.

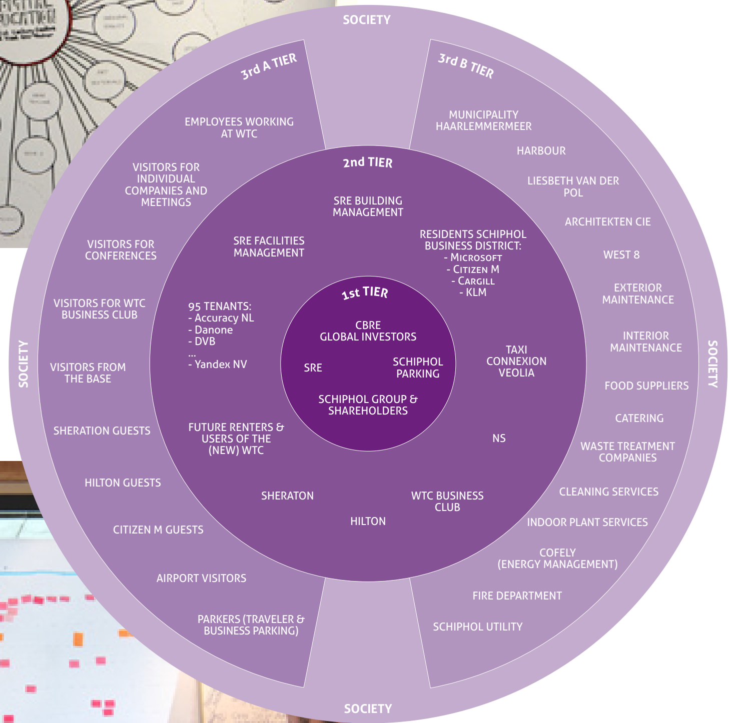
A geographical map starts with a sketch of the actual geography that's relevant. Also here think about scales. Is it just local, regional or even the world? Perhaps make several maps at several scales?

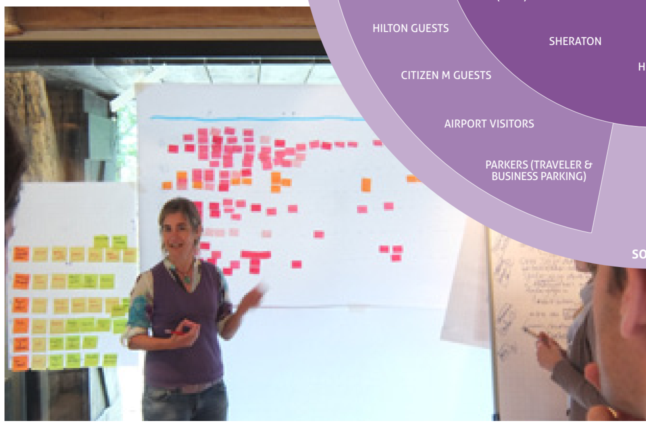
7 Refine map (30 minutes)
Add stakeholders that are related to each of these central stakeholders outward. For example, when investigating a supermarket, a primary stakeholder is a supermarket's supplier. A secondary stakeholder is the supplier of this supplier. Or their investors. Draw connections between primary and secondary stakeholders with lines.

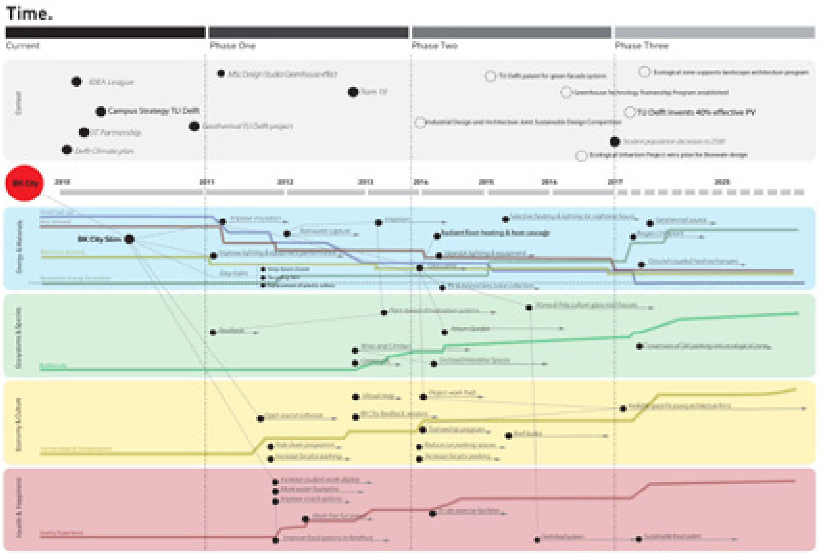
8 Iterate
Look at the resulting map. Is this a clear map? Is its structure revealing or creating clarity? If not, consider using a different map type. Or reclustering the primary stakeholders. Each iteration consists of the above steps. Some can be done very quickly (do we need more or a reevaluation of who the stakeholders are?), some may require a redrawing of the map.

Try to let your creativity loose and experiment. It's okay to make a rubbish map first. This means you've learned what doesn't work. In the end, a good systems map is revealing on its own. But, remember that the ost most important part of system mapping is the process itself, in which you and your team become the master of the subject.

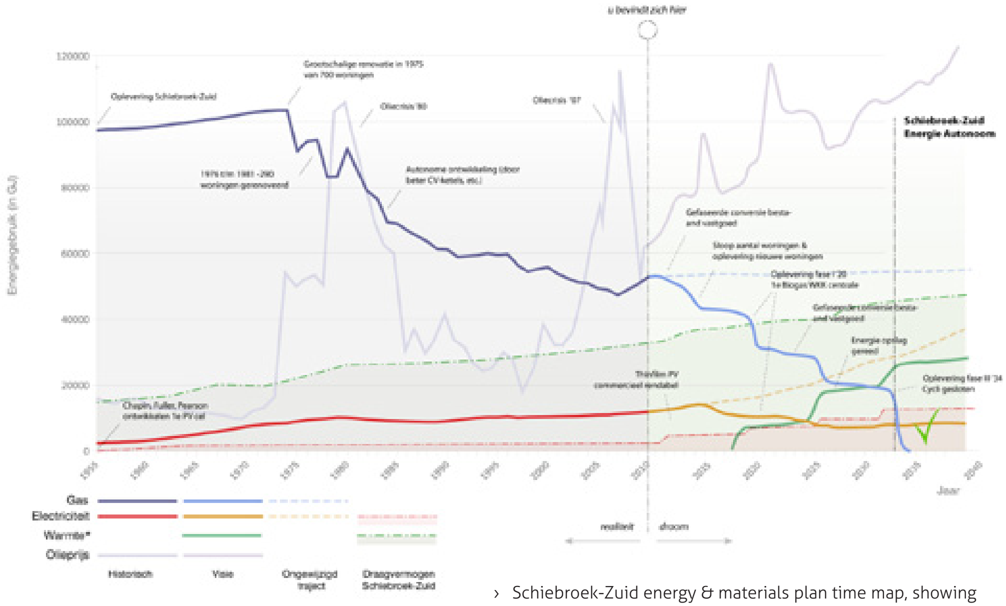




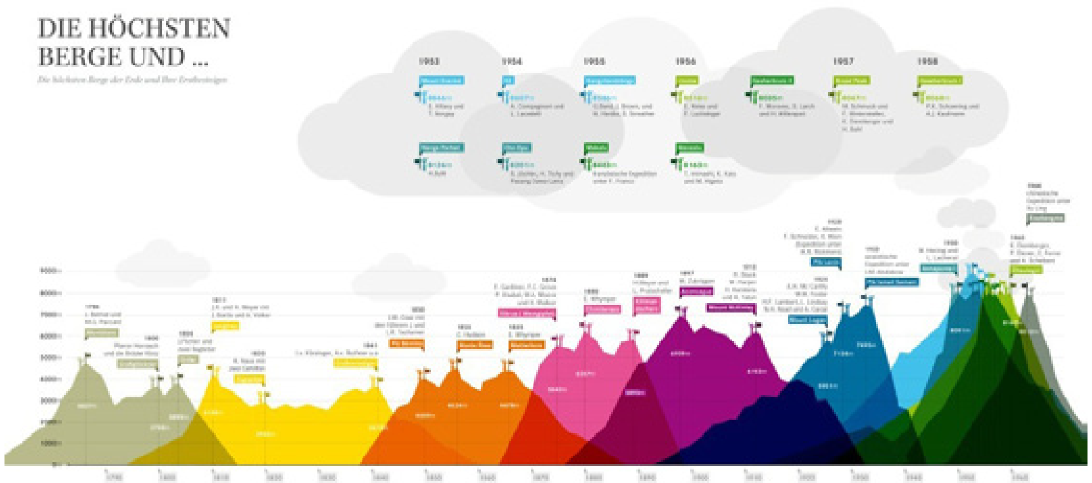




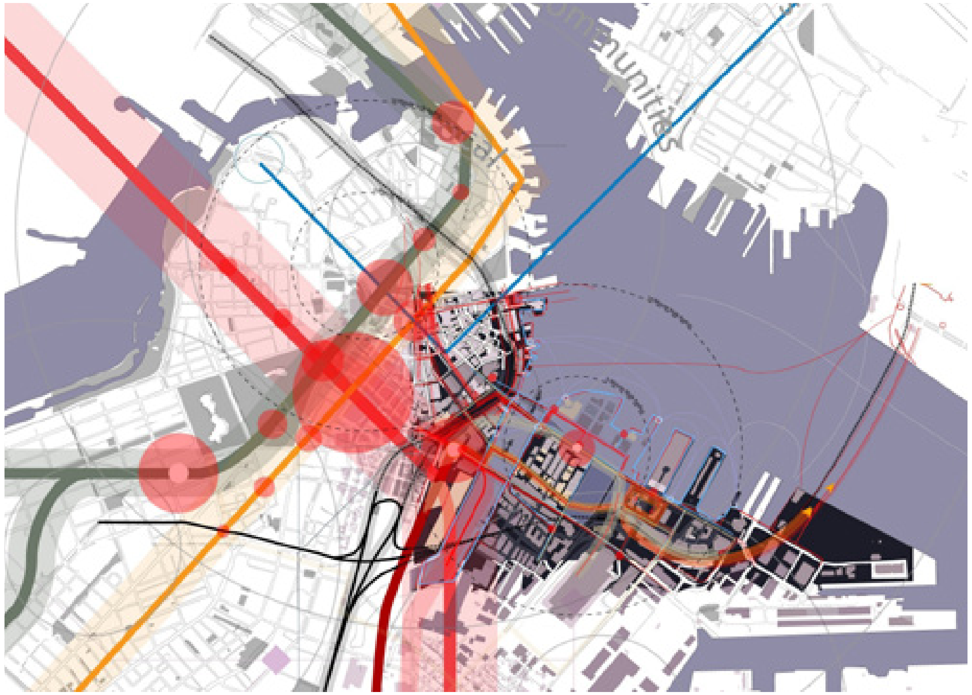
› TUDelft BKCity renovation time map, showing ELSI4 and context categories (Except)



› Schiebroek-Zuid energy & materials plan time map, showing both before and after situations. (Except)

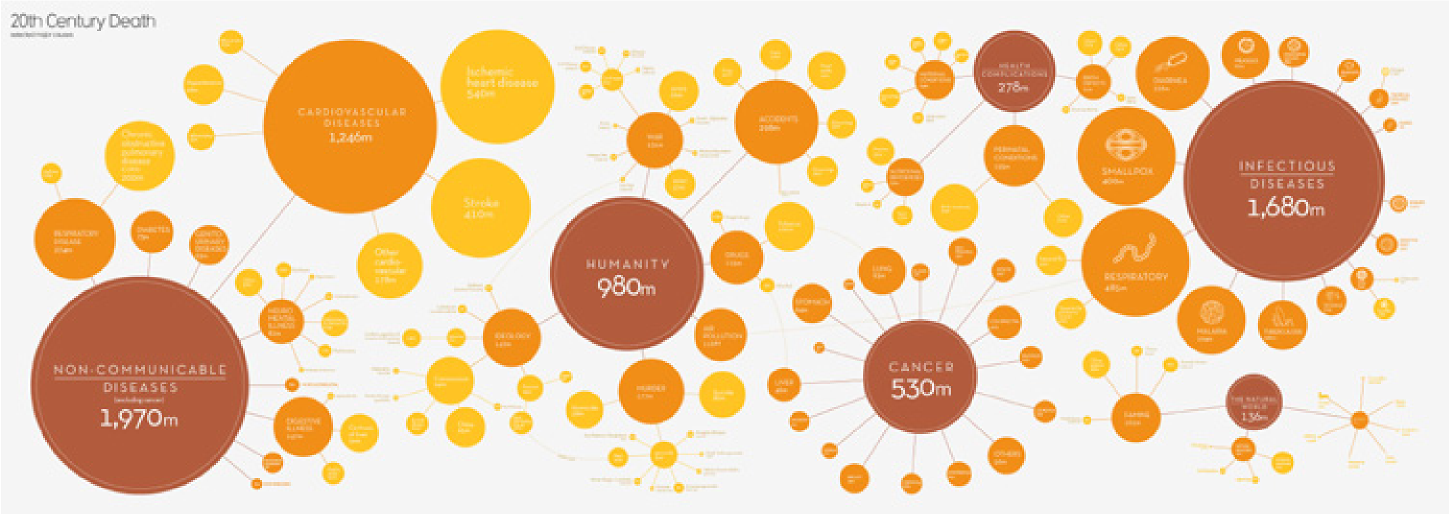


› Brockhaus Encyclopedia Infographics (Martin Oberhaeuser)

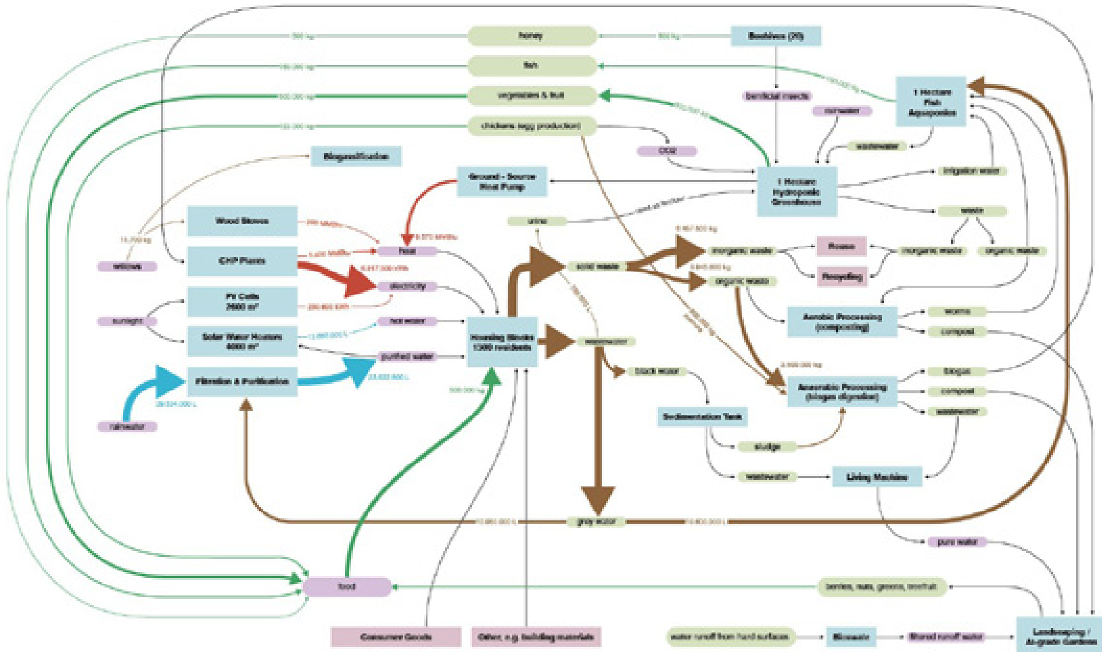


› Tranportation flows and intensities in Boston (Except)

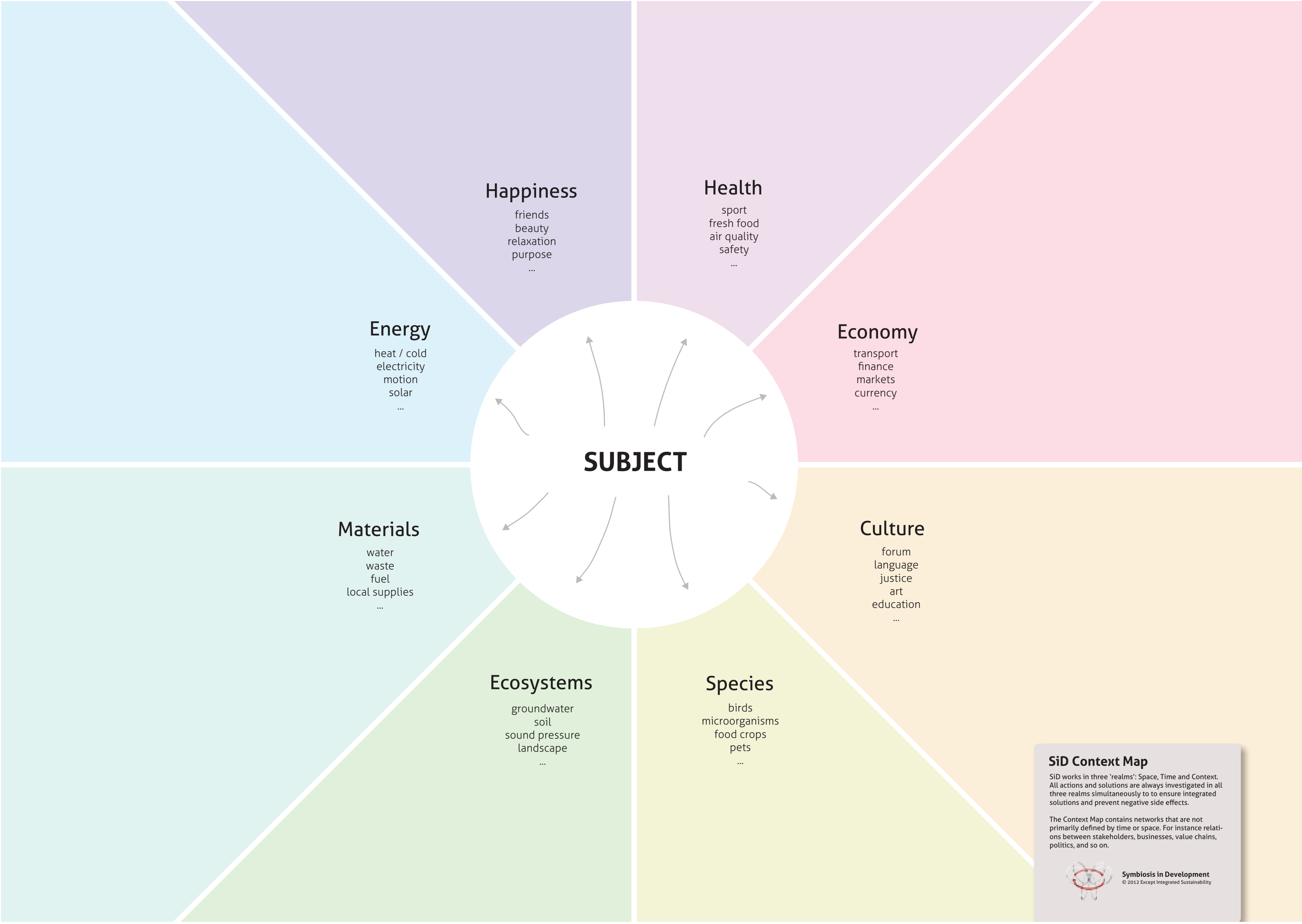
› Energy & Material in and output points for Schiebroek-Zuid (Except)



› Visualizing the major causes of death in the 20th Century (Informationisbeautiful.net)



› Energy & materials flow context map for the Schiebroek-Zuid renovation plan (Except)


Happiness
friends
beauty
relaxation
purpose
...
Health
sport
fresh food
air quality
safety
...
Energy
heat / cold
electricity
motion
solar
...
Economy
transport
finance
markets
currency
...
SUBJECT
Materials
water
waste
fuel
local supplies
...
Culture
forum
language
justice
art
education
...
Ecosystems
groundwater
soil
sound pressure
landscape
...
Species
birds
microorganisms
food crops
pets
...
SiD Context Map
SiD works in three 'realms': Space, Time and Context. All actions and solutions are always investigated in all three realms simultaneously to to ensure integrated solutions and prevent negative side effects.
The Context Map contains networks that are not primarily defined by time or space. For instance relations between stakeholders, businesses, value chains, politics, and so on.
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		AREA	CITY	COUNTRY	WORLD
friends beauty relaxation purpose ...	Happiness				
sport fresh food air quality relaxation ...	Health				
transport finance markets currency ...	Economy				
law language justice art ...	Culture				
birds microorganisms food crops pets ...	Species				
groundwater soil land use geography ...	Ecosystems				
water waste fuel local supplies ...	Materials				
heat / cold electricity motion solar ...	Energy				

SiD Space Map

SiD works in three 'realms': Space, Time and Context. All actions and solutions are always investigated in all three realms simultaneously to to ensure integrated solutions and prevent negative side effects.

We map the direct and indirect effects of chosen actions or objects from its local context down to its global effects. Effects that occur on one scale may have effect on aspects that operate on other scales.

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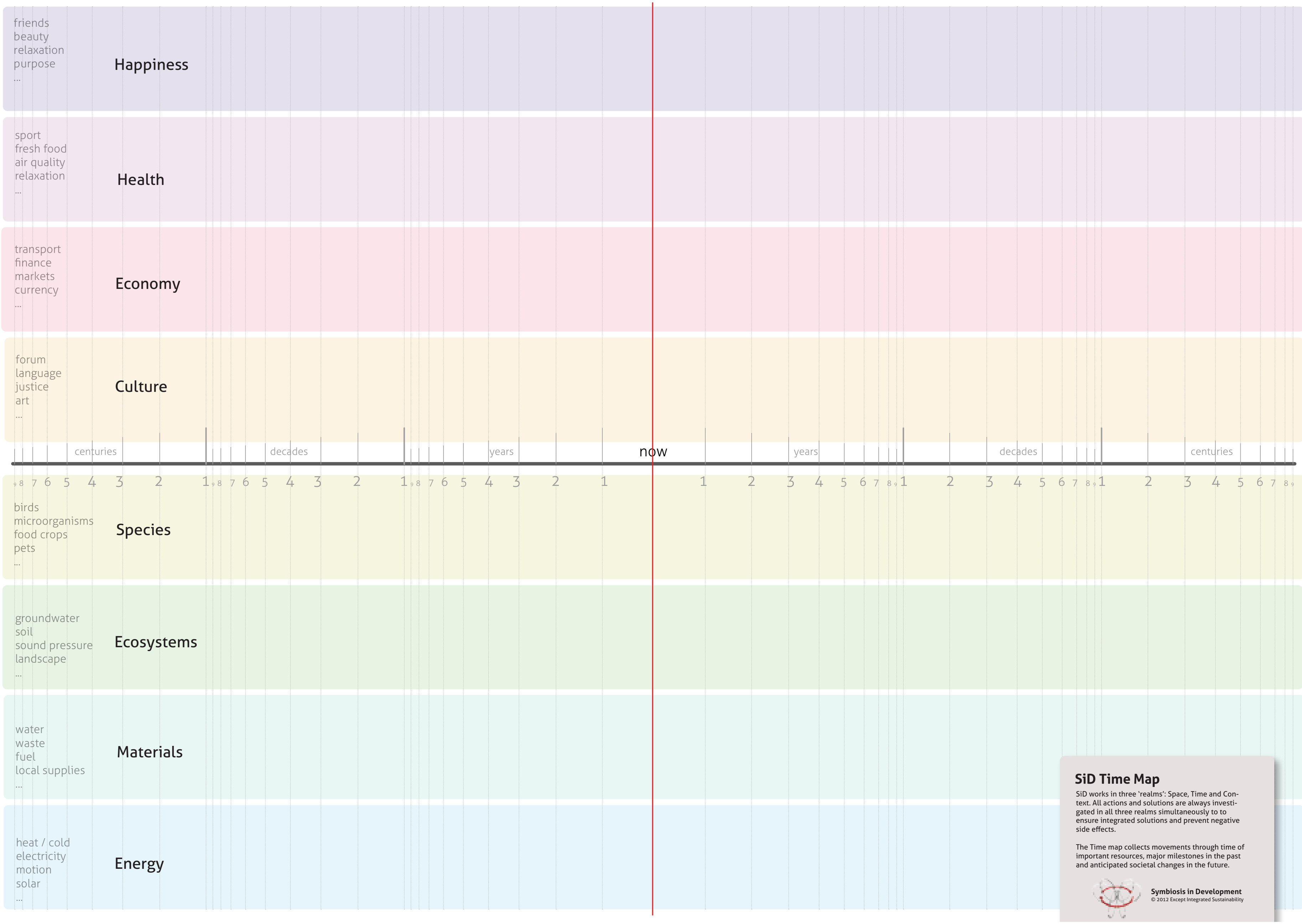

SiD Time Map

SiD works in three 'realms': Space, Time and Context. All actions and solutions are always investigated in all three realms simultaneously to to ensure integrated solutions and prevent negative side effects.

The Time map collects movements through time of important resources, major milestones in the past and anticipated societal changes in the future.

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9. LEARN MORE ABOUT SID

› Image of the markets at the Schiebroek-Zuid Urban Redevelopment, performed with SiD

We're in an ongoing process of using and refining SiD. We use SiD not only to develop projects but also to develop new or expand upon existing methodological tools.

In our experience it takes about one to two years of full time commitment to become fully versed in SiD. This is not due to the nature of SiD, but due to the complexity of sustainability itself, the breadth of the field and the amount of necessary background knowledge required to confidently work on sustainability issues.

Below, some suggestions for further learning:

- More information about the definition of sustainability can be found in the SiD Sustainability Definition article.
- More information about ELSI can be found in the Symbiosis in Development: ELSI article.
- If you want to learn more about the SiD method in practice, you can subscribe for one of our Trainings.
- Visit www.thinksid.org to buy a hardcopy or download the SiD Book.

COLOPHON

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"What's the use of a fine house if you don't have a tolerable planet to put it on?"

Henry David Thoreau