

Stories in social-ecological knowledge co-creation

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1. SPACES Project

The Sustainable Poverty Alleviation from Coastal Ecosystem Services (SPACES) project began in 2013 and is coming to a close at the end of August 2017. The project is supported by the UK programme, Ecosystem Services for Poverty Alleviation (ESPA). A group of scientists from Stockholm Resilience Centre (SRC), Exeter University, Lancaster University, Cambridge University, Kenya Marine & Fisheries Research Institute (KMFRI), Kenya Forestry Research Institute (KEFRI), Wildlife Conservation Society (WCS), University of British Columbia (UBC), Northumbria University, University of East Anglia, and University Eduardo Mondlane (UEM) have joined together to study the relationship between the wellbeing of poor communities and coastal ecosystems. The project has focused on eight coastal communities in Kenya and Mozambique. The communities were chosen based on site characteristics, rural or urban/peri-urban, and the ecosystems that the communities have access to, coral reefs and/or mangroves. In Kenya (Figure S1), the four sites studied were Mombasa/Kongowea, Tsunza, Shimone/Wasini Island, and Vanga. In Mozambique (Figure S2), the four sites studied were Vamizi Island, Lalane, Maringanha, and Mizee.

Interdisciplinary research was conducted in all sites by combining both ecological and social science. The researchers investigated the state of the ecosystems by collecting mangrove and landings data, conducting underwater ecological surveys, and through Ecopath and Ecoism modeling. The team also looked at who benefits from the ecosystems through value chain analyses, an in-depth household survey, and through focus groups on access to ecosystem services. Additionally, team members

explored how ecosystem services support wellbeing through community profiling, ecosystem service to wellbeing focus groups, and interviews. Lastly, the team studied to the future of policy and interventions in the region through policy analyses, workshop 1 & 2, and community dialogues.

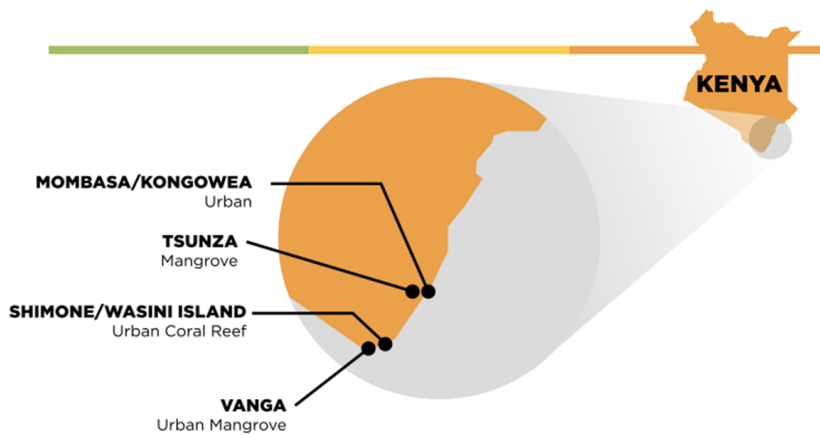


Figure S1: Map of the four sites in Kenya.

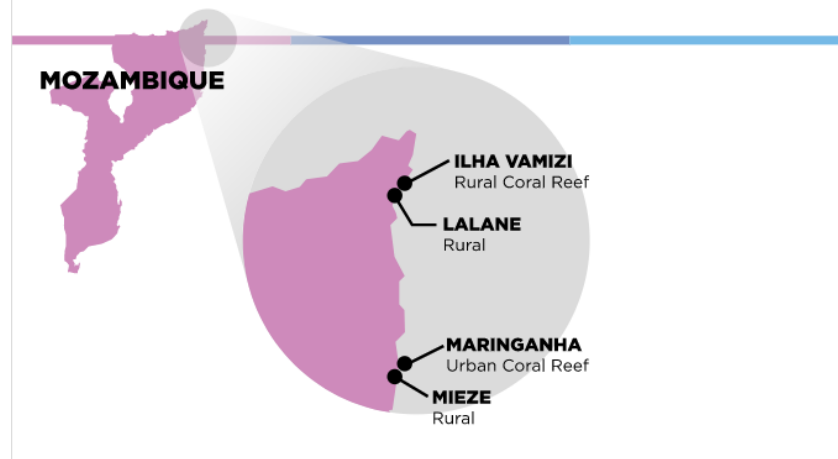


Figure S2: Map of the four sites in Mozambique.

2. SPACES participatory workshops

SPACES scientists developed an iterative participatory approach to enhance understanding of the coastal social-ecological systems in terms of feedback dynamics, tradeoffs and opportunities for sustainable poverty alleviation in coastal Kenya and Mozambique (SPACES 2017). Experts in the areas of poverty alleviation and sustainable resource management were brought together in a set of two participatory workshops aiming to engage stakeholders and collaboratively build systems diagrams and future scenarios to explore key dynamics of the social-ecological systems and how it might develop in the future.

The workshops used participatory modelling and scenario tools to investigate the question of: How can the coastal ecosystems of Mombasa, Kenya and Pemba, Mozambique and the benefits they provide support the well-being of the poor, now and in the future. By ‘well-being’ we mean having basic human needs met, and being able to pursue one’s goals, and enjoy a satisfactory quality of life. It is related to concepts of happiness as well as material wealth.

Workshop one “aimed to help a range of different stakeholders and experts to share knowledge and think together about the nature and development of poverty and environment” (KE_Report WS1

Report: 4). Prior to the workshop, the participants filled in a survey about challenges and solutions facing the communities. Then during the workshop, systems thinking was the method used to understand and make sense of the situation. Two tools were used to support systems thinking, systems diagrams and future scenarios. Following the workshop, exit interviews were conducted with all the participants.

Workshop 2 “aimed to: 1) Engage the stakeholders in the findings from the SPACES project. 2) Explore how human well-being and the ecosystem health might change in different future scenarios. 3) Identify interventions for poverty alleviation and sustainable ecosystem management and explore how they would work under different scenarios, and 4) Identify existing initiatives (“seeds”) that could change the course of the scenarios” (MZ_Full Report WS2: page 2). Pre- and post- interviews were also held with the participants to understand the learning that was taking place during the workshops. Figure S3 below shows the steps of each workshop and detailed descriptions of each method used follow.

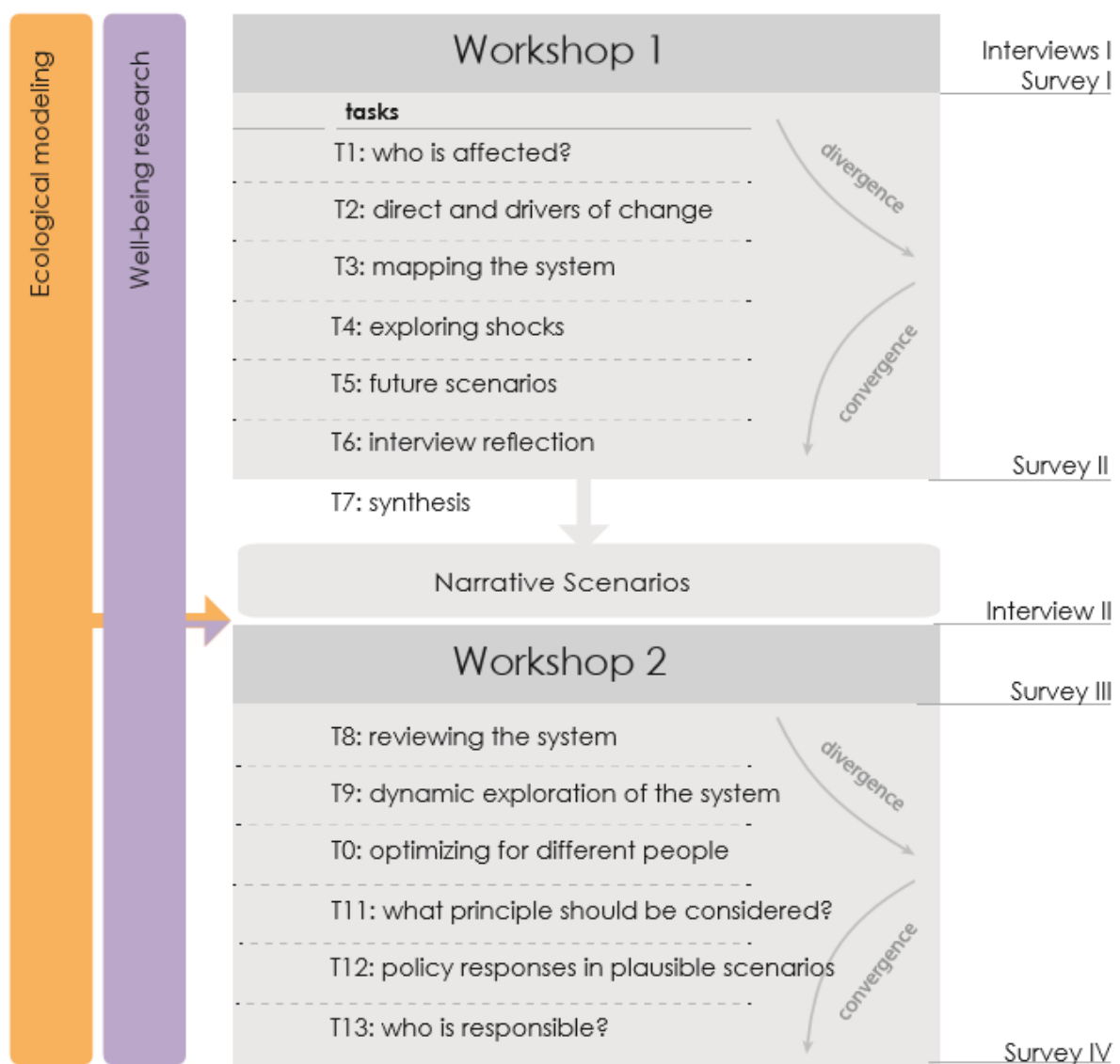


Figure S3: Chart of workshop 1 and workshop 2

2.1. System diagrams

System diagrams draws on the expert knowledge of the participants at the workshop to map out a model about key factors affecting the coastal communities. This was done through a series of steps (taken from the MZ_WS1 report):

Step 1: define the problem to be addressed

Step 2: define the boundaries of the system to be described

Step 3: identify the concepts that are part of the system

Step 4: group functionally similar concepts into clusters and name the clusters

Step 5: write a glossary to describe the meaning of the concept clusters

Step 6: link the concepts and identify the direction of interactions

Step 7: define the sign and strength of interactions

The first activity of the first workshop in both countries was conducted in groups of participants divided according to their knowledge association (community, policy-makers/government, development or conservation practitioners, scientists). Each of the 4 groups were invited to draw system diagrams with the key factors that affected the wellbeing along the coast (see Supplementary material for detailed methodology). The overall goal of this is to co-create a shared image of the main factors shaping poverty and the relations to ecosystems.

In Kenya all four groups had education in their diagrams of key factors. Governance and environmental protection also appeared in all diagrams. Interestingly, the historical and cultural issues that some participants discussed in the interviews did not feature prominently in the diagrams.

Similarly, security only appeared in 1 diagram. In Mozambique, a similar pattern was found:

Governance, participation and collaboration was present in all four groups as well as education and environmental protection. All of these were identified as key challenges.

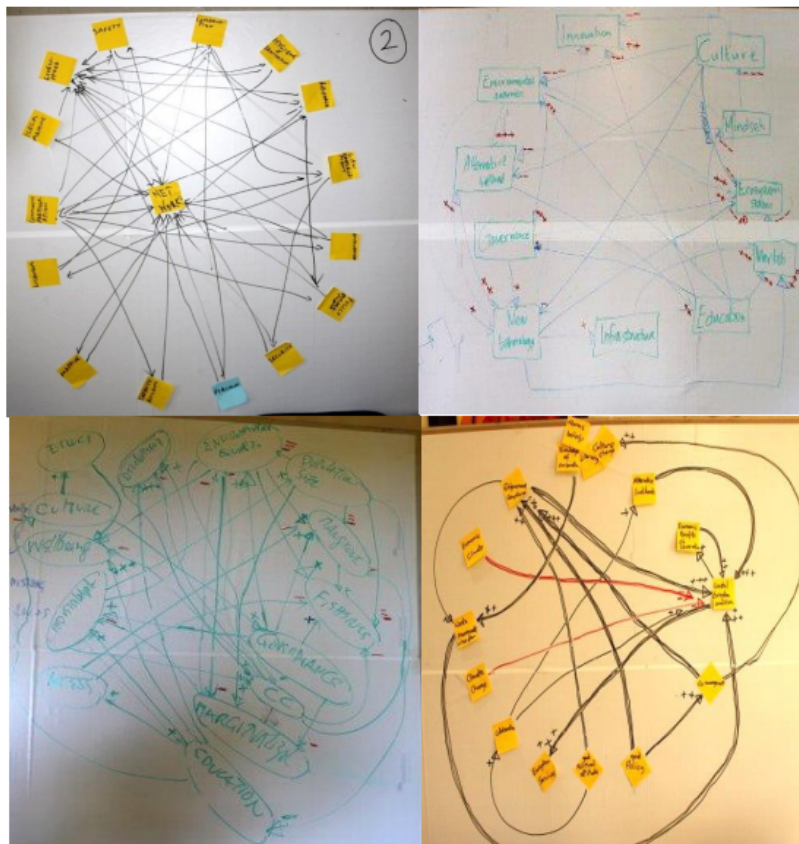


Figure S4: Pictures of the original system diagrams developed during the workshop1 in Kenya.

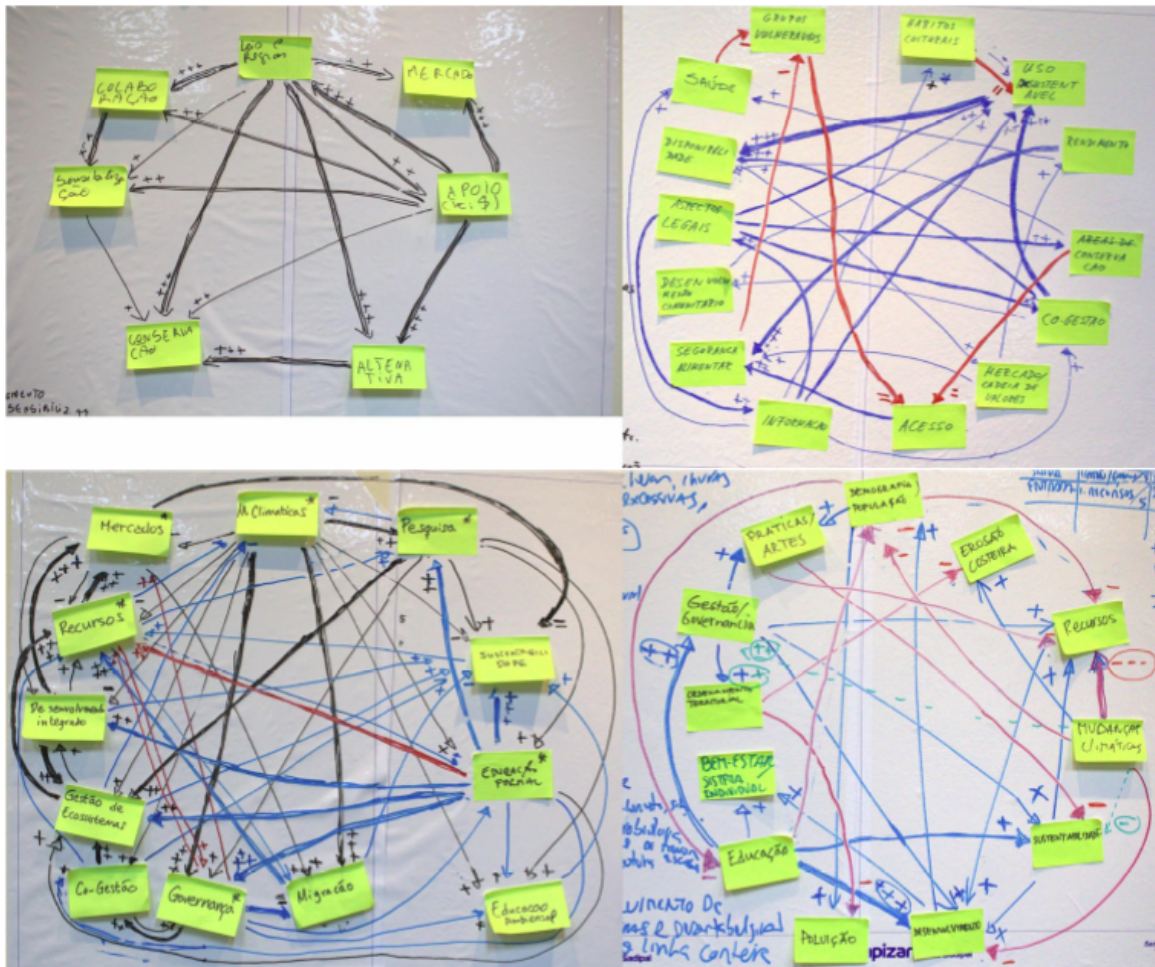


Figure S5: Pictures of the original system diagrams developed during the workshop1 in Mozambique.

2.2. Creating stories of the future and making use of the future

Moving on from the system diagrams, a reflection was invited around the key processes that may drive change in the coastal social-ecological system. Each participant then was invited to allocate a total of 2 votes amongst all the “driving forces” listed. From the list of most voted drivers (Table 3) two key drivers were selected through a plenary discussion. These two drivers represented interesting dynamics the group as a whole decided to explore in the scenarios. The two driving forces were laid out on a two axis where each quadrant represented one of the four possible combination between increase and decrease of each driving force. For example, the top right quadrant would be a scenario where both drivers would increase in intensity.

Participants sat in mixed groups to work with the combination of two key drivers. The task was to create a story of a plausible future. A total of four stories (one per group) were drafted in the first workshop. Then these stories were further developed with the consultation of a wider range of experts and finally they were illustrated by an artist and films of each narrative were produced.

Although some of these key drivers, like ‘governance’ or ‘education’ are recurrent themes in development work, we noticed that the timing and context of the workshop had some influence in saliency and perception of key drivers. In Kenya, the meeting occurred in a particular tense period where security was perceived as low – in the venue of the meeting had to be changed in order to accommodate international security recommendations. ‘Security’ appeared as a top driver of change.

In Mozambique ‘Gas and Oil’ were not chosen as a key driver, because according to participants “the exploitation of gas and oil is stable and will continue”. Interestingly, in the time between workshops (6 months) global prices of oil had declined considerably and “gas and oil” exploitation, now shadowed with uncertainty, became much more prominent during this second encounter.

Table S3. Most voted driving forces from each workshop

Drivers	Votes
Kenya	
Governance	10
Security	10
Education	6
Community Acceptance	4
Development	4
Climate change	3
Mozambique	
Governance	16
Education	8
Climate change	6
Fishing technology	6
Development Population	5
Gas and oil	5
	2

Figures 6-13 are photos of the scenarios created by the participants in Kenya and Mozambique.



Figure S6: The scenario created by Group 1 in Kenya with the title “Haiwezekani (impossible or Iraq)”



Figure S7: The scenario created by Group 2 in Kenya with the title “Coastal Ecosystems and Poverty levels in 2045 with high security and high community acceptance.”



Figure S8: The scenario created by Group 3 in Kenya with the title “From better to worse home.”

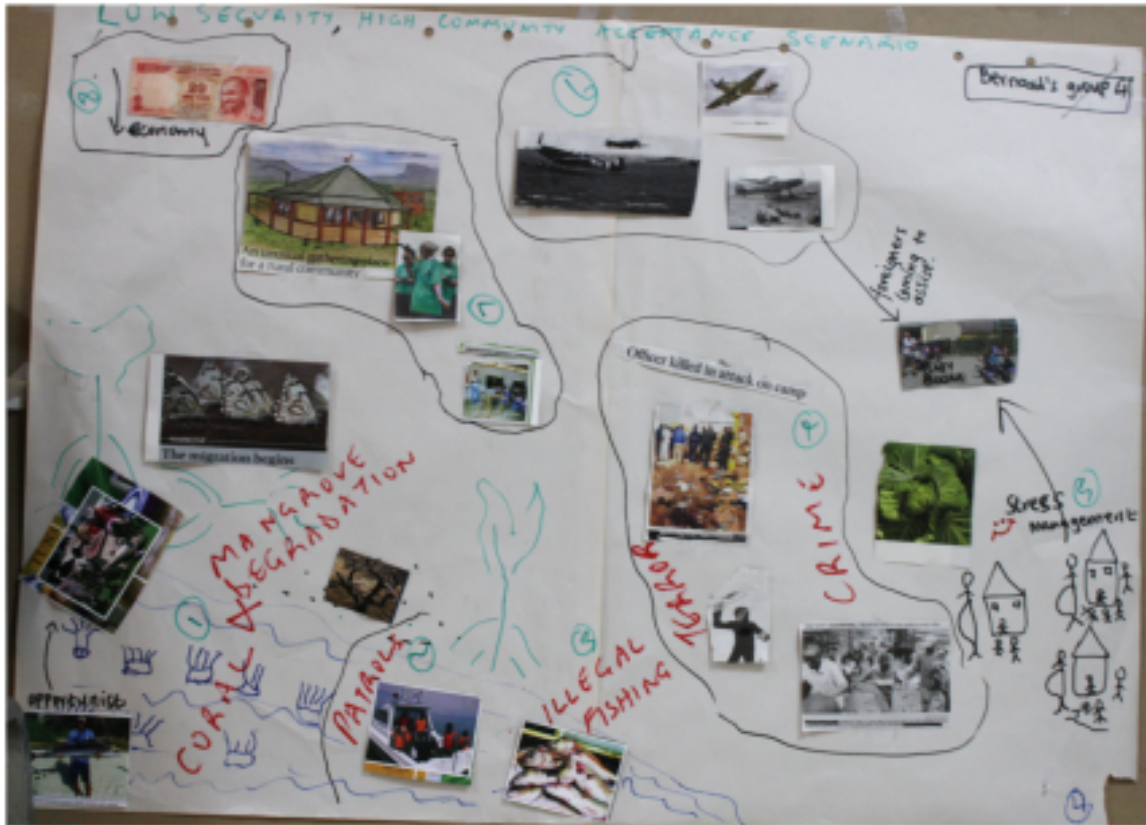


Figure S9: The scenario created by Group 4 in Kenya with the title “Low security, high community acceptance.”



Figure S10: The scenario created by Group 1 in Mozambique with the title “Fight against the power”

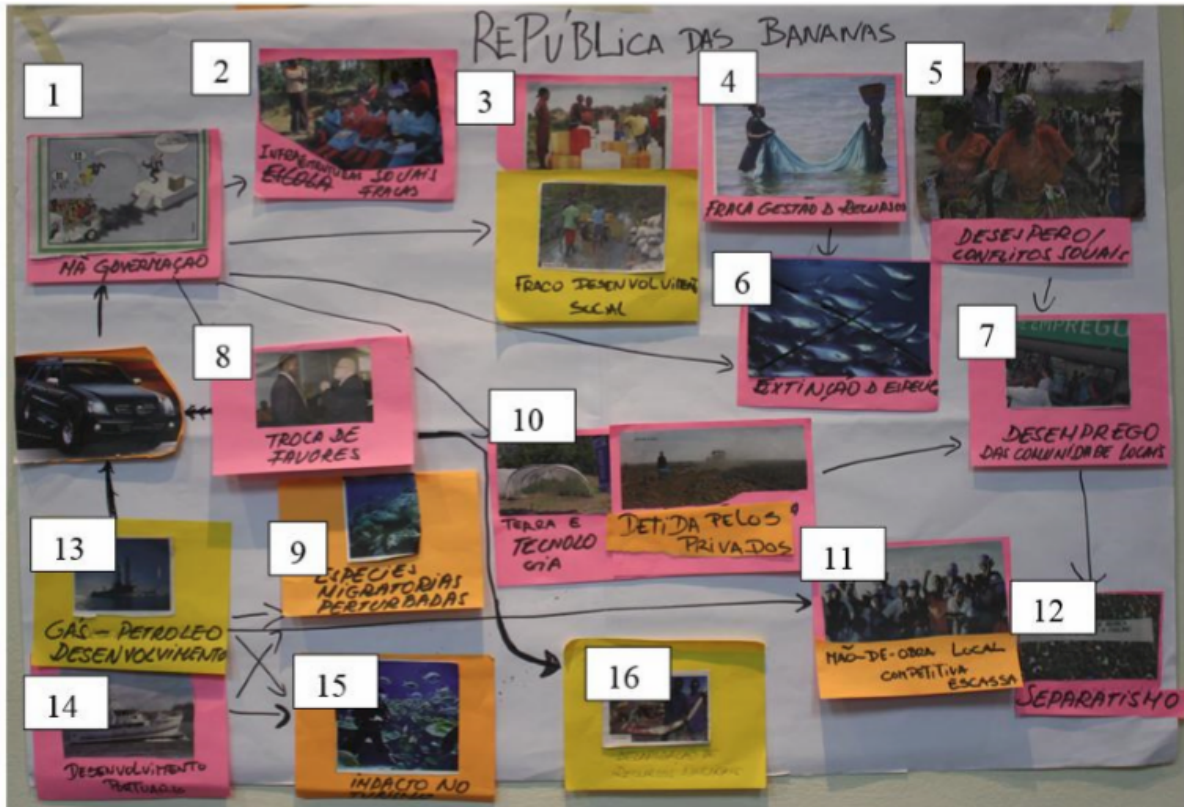


Figure S11: The scenario created by Group 2 in Mozambique with the title “Banana republic”



Figure S12: The scenario created by Group 3 in Mozambique with the title “New Japan/ A trustable government”



Figure S13: The scenario created by Group 4 in Mozambique with the title “There is hope if there is good governance”

2.3. Systemic Interventions

In the second workshop, participants were asked to identify key interventions that would improve ecosystems and poverty alleviation strategies (Table S4). The robustness of these interventions were then “tested” in each scenario. Adjustments to the interventions were then suggested.

The following steps were taken to determine the systemic interventions:

- Step 1: Revisit the stories from workshop 1
- Step 2: Get familiar with narratives and bring them to life
- Step 3: Name the scenarios
- Step 4: Presentation on well-being research
- Step 5: explore and discuss which needs were found to be frequently met or not met in rural and urban settings, and apply to scenarios
- Step 6: review policies and identify interventions for poverty alleviation and sustainable ecosystem management
- Step 7: Build an interventions bank with suggestion from participants
- Step 8: Stress-test interventions

Table S4. Most voted policy interventions identified by participants in each country

Kenya	Mozambique
Implementation of conservation areas Implementation of participatory forest management plans Ensure ban of illegal gears and empower community institutions Organizing saving groups	Sensitization and training of fisherfolk to adopt better fishing practices Development of monitoring system and coordination across governance actors Encourage communities not to use corals for the production of lime

Create a gear exchange program	Restore mangroves Empower women to move away from fishing toward other forms of income generation
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Both in Kenya and Mozambique, changes in communities fishing and extractive practices were amongst the most voted. These include banning gears, restoring traditional fishing, discourage the use of corals for lime production. In Mozambique, raising community awareness was overwhelmingly more voted.

A few “innovations” in the form of multi-actor actions were envisioned. In Mozambique these were the creation of a system for resource monitoring and the development of projects for mangrove restoration. These innovations would involve government, communities and specialized organizations. In Kenya, a greater number of innovations were considered. Amongst the most voted ones were the creation of Saving Groups (for BMUs, women groups, youth), carbon sequestration through mangroves plantation, a gear exchange program where government and NGO’s would remove illegal gears while at the same time providing other gear and training to fisherfolk.

2.4. “Seeds” session

Another methodology was also used to create future scenarios. The technique received relatively less time than the scenario approach described above. The design was inspired by the ‘seeds approach’ (Bennett et al. 2016). The “seeds approach” utilizes an appreciative inquiry approach [1] focusing on the aspects of the present that are positive (seeds) and could be scaled up to generate a positive future. The approach has been applied in a range of different cases. In this workshop series due to time constraints a limited version was conducted.

To set up the scene, two key ideas were presented in plenary. First participants were introduced to the notion of the Anthropocene and the challenges that this new social-ecological context engenders.

Then the three-horizon framework [2] was introduced as a way to think about how existing projects can evolve, connect and scale-up to impact the unsustainable regimes.

From here, using a standard form, participants were asked to describe one “seed” (existing initiative, a project, an idea, a way of thinking) that they knew of and consider important in creating a sustainable and just future. In the next step, in small groups, each participant took the turn to describe the “seed” to other group members, explaining what it was about, who are involved, and were asked to reflect on factors that may “make the seed grow” or restrict it.

Finally, participants were invited to develop a positive story of the future by finding linkages between the seeds. Other “random” seeds were also distributed by convener scientists that represented “disrupting elements”, for example “electric trains”, “free open internet access”.

After each of the storylines were created, each group took turns to present them in plenary using pictures, and role-play.

2.5. Monitoring and participant observation

Participant observation methodology was applied in each of the meetings. Break-out groups were audio recorded and notes were taken both about the content and the flow of the conversation. 4 notetakers worked in each workshop. Their first task was to capture the content of the discussions in the break-out groups. Secondly, they captured the way in which conversations unfold. A common framework based on Muro et al. (2008) was used for observation (Table S5).

Table S5. Categories of observation

- Key learning moments :	Was there an aha! moment? What led to it? Was there a particular concept or topic that was important at that moment?
- Participant experience (moods, attention):	are people tired? bored? alert? happy?

- Roles of participants:	are participants playing different roles, for example, is someone an expert, is someone rephrasing others and helping bridging?
- Facilitation	how are comments being taken? are these comments being heard by all?
- Inclusiveness: are different views being represented?	
- Opportunities for in-depth dialogue:	are there in-depth discussions and dialogue happening?
- Open communication:	Are participants openly sharing information and articulating and exposing their views and interests? Is everyone being respected?
- Unrestrained thinking:	Are there signs of stretching thinking, exploring ideas together openly?
- Egalitarian atmosphere:	
- Power dynamics	: are people being constrained by power dynamics?

At the end of each session, notetakers debriefed with another member of the team following responding to the following summary questions:

Time/ Session
Facilitator
Note takers
First impressions
How creative were people? was it easy to imagine?
Were there important learning moments? Aha! moments?
Were there interesting/important past stories?
How was facilitation?
Was everybody speaking / being invited?
Were there conflicts?
What steps were difficult to people?
quietest? loudest? roles of participants?
Respectful interactions (From 1-10 scale)
Free thinking (From 1-10 scale)
Open communication (From 1-10 scale)
Imagination (from 1-10 scale)
creativity (from 1-10 scale)
inclusiveness (from 1-10 scale)

3. Data Analysis

3.1. Coding scheme

Key themes were drawn from Newell 2012.

- Key concept
 - Abstract
 - Story
 - Defining concept
 - Conflictual views
 - Key term
- Metaphorical mappings
 - Divergent metaphors
- Narrative
 - Discussing assumptions
 - Not questioning assumptions
 - Intervention
 - Narrative strengthens via artefacts
- Dynamics
 - Imagination
 - Role play
 - Mood (laughter, tiredness)
 - Sharing knowledge
 - Imaginative leap
 - Idea
 - Realization
 - Productive dialogue
 - Power dynamics

3.2. Supplementary results

	Codes	Quote
Developing a shared conceptual repertoire	Defining concept	Concept of “community acceptance” in Kenya had 7 meanings 1. Accepting/owning projects 2. Not only yes / educated community 3. Acceptance to change; to new ideas; to participate; to technology; to development 4. Fighting back 5. Acceptance of change 6. The mindset – “people willing to listen to what others propose, e.g. education” 7. “they won’t accept anything from the outside”
Developing a shared conceptual repertoire	Story	This quote is taken from a discussion around the notion of “trade-offs” and “winners and losers” of conservation plans. “Some people have gained, others no. People benefiting feel good, others that don’t benefit directly don’t.. some say oh a school was roofed, but what is doing it for me”. We know that in our community those people exist, like in Gazi, they are always against everything, they are the people that are in the high-rank in terms of economic wellbeing. Even the cutters are people who have good position in the society.. he doesn’t take kids to that school, of course he will always be against this.. because he initially had the whole area of 650hectars to go and cut but now 100hectars is set aside.. and this place has good poles for him.

		So you cannot always please everyone, maybe this year they won't be happy about it and next they will. And so these things we need to always talk to these people, and we try as much as possible to bring them on board, to make them feel that we're not losing anything out of this, yeah?"
Developing a shared conceptual repertoire	Story; Metaphor	In discussing the concept of "support" one group discusses: "There are many different types support. Like with the use of mosquito nets for fishing. It is very difficult for them because they are very poor and you cannot only have a rule saying they can't fish. To buy a net with 3 or 4cm mesh costs. They need support". Another participant said: "There is a group of PCE, an association, they are saving money weekly, and by that they contribute. But with time they also need support. If we see a person carrying something heavy, we need to come and help to carry it."
Developing a shared conceptual repertoire	Abstract	During a conversation about the system diagram. "If we would like to have support, if we create rules, support will followed. Here we have two influencers rules and support. But we also have one that is highly influenced: conservation. Conservation depends on many aspects: it is necessary to sensitize, to have rules, to have support, to have alternative, it does not depend on market."
Developing a shared conceptual repertoire Dynamics	Abstract; Power dynamics; Not questioned assumptions	Participants discuss the concept of "collaboration", a representative of NGO states a "micro-narrative" of "community organizations without government or NGO will not be able to do any project" The community group seeks to explain what they mean by "collaboration": <i>Community representative:</i> we're here to find out is how to reduce poverty through ecosystems. Ok, so let's create a project to reduce poverty. How are we going to do this? First we need to create a group? <i>NGO:</i> group? what do you mean <i>Community representative:</i> for example, one group to conserve the ecosystems. The CCP (community management group) for instance.. <i>Community representative:</i> this CCP cannot work if there is no collaboration between members, but it can also not work without observing laws, and also if there is no support, technical and financial.. So here we highlighted collaboration as key. Because if there is confusion between CCP members, as in the case that we were talking.. if they don't observe laws, then the support might go away <i>NGO representative:</i> yes, that's what I mean, collaboration is not only about the CCP. Because the CCP without government or NGO will not be able to do any project." Laughter is heard and the discussion ends there.
Developing a shared conceptual repertoire Narrative	Abstract; Narrative strengthened via artefacts	"So we have here a map. If there is good governance (pointing at laws/rules), good laws and good rules that relate to all activities, or better, between all actors there is collaboration (pointing at collaboration concept). Just to make it more clear.. what is it going to happen at sea? today people will go for petroleum, fisherfolk have been there for long, and in a while we will be the ones loosing those areas.. our fishing resource will probably be reduced and we will have no place to fish.. but having good collaboration, we will not feel this directly. There needs to have a very strong support in the form of projects.. as

		neighbors. Fisherman is there, the other is there extracting salt, the other is petroleum.. and all of that happening in the area of the fisherfolk.. and so the fisherfolk should have access to education and capacity building.”
Narratives	Not questioning assumptions	Micro-narratives are expressed and their assumptions are not questioned. For instance, Participant says “For poverty level, you know we depend on donor funding, I don’t think low security will be good. In terms of ecosystem health it will be good if there is a project they accept in the community. Conservation is a requirement, so our coastal ecosystems will be there.” The assumption of dependence of poverty alleviation on donor funding has not been questioned. Nor the assumption of positive impact of conservation on community.
Breaking away from narratives: Transformative ideas	Narrative strengthened via artefacts	During the pre-workshop interview the participant emphasized the need for collaboration across actors to better tackle poverty. During the final plenary of workshop 1, while all participants were convened in plenary, the participant utilized the visual representations of the systems to resonate the view on collaborations: Participant: “The biggest lesson here to put into practice the synergies, because they exist, but what happens is that we work in isolation and there is no way that we will find any solution if each one wants to pull the fish to his fire. These systems show clearly that one isolated institution is very unlikely to find a solution. The most important is to find the common denominator to solve the equation in the sense of encompass the various perspectives.”

3.3. Knowledge co-creation illustration

An artistic representation was developed to illustrate the movement of knowledge co-creation taking inspiration of the work of Newell (2012) (Figure S14). Newell (2012) describes Figure S14 as “dependence of conceptual overlap on level of abstraction. The horizontal axis represents the range of concepts that make up a person’s conceptual repertoire. The vertical axis represents the level of abstraction of the concepts needed to reason and communicate about a given situation. The curved areas labelled RA and RB represent the extent of the conceptual repertoires of Persons A and B, respectively. The horizontal lines labelled S1, S2 and S3 represent situations at three different levels of abstraction”.

Based on insights from our process we propose that knowledge co-creation can build shared understandings and social-ecological narratives from less abstract forms of communication.

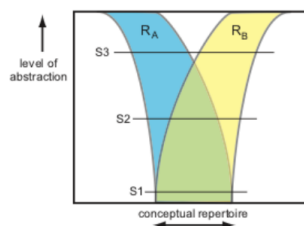


Figure S14. Conceptual framework utilized to develop the artistic representation in the manuscript. Adapted from Newell (2012).

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