Research

Using Participatory Action Research to operationalize Critical Systems Thinking for pluralistic definitions of wicked problems in social ecological systems

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1.

ABSTRACT

2. This paper presents a new research approach that seeks to develop and strengthen Participatory
3. Action Research (PAR) when applied in social-ecological systems (SES), by combining it with Critical
4. Systems Thinking (CST). This research approach -in this paper referred to as CARS (Critical Action
5. Research in Social-Ecological Systems)- responds to the urgent societal need to move beyond
6. pre-defined project framing in development projects. While Participatory Action Research acts as a
7. basis for operationalizing participatory research processes, Critical Systems Thinking supports PAR
8. by including explicit questions about system and problem boundaries. We first present our approach,
9. and then go on to illustrate it by investigating a social-ecological systems case study on Saba as
10. part of a project to protect sharks from extinction. The case study illustrates that strengthening
11. PAR with CST in SES can help: 1) (re)frame the problem definition and -scope as perceived by the
12. different stakeholders, 2) understand, co-create and implement viable solutions to improve a
13. social-ecological system based on local needs and diverse stakeholders' perspectives on potential
14. solutions.

15. Key words: Participatory Action Research, Critical Systems Thinking, Social-Ecological Systems,
16. wicked problems

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INTRODUCTION

Social-ecological systems (SES) involve multiple stakeholders with widely diverse interests and perspectives on problems and solutions; therewith, each of them has an incomplete understanding of system-functioning as a whole. As a result, problem and solution definitions are often diverse and unclear, and the fulfillment of one interest may cause challenges for other stakeholders. At the same time, many NGOs and government interventions engage with SES challenges using pre-existing problem framings (Cuppen 2012), while aiming to avoid or resolve conflict (Cuppen 2012, van Laerhoven and Andersson 2013) and to convince other parties of the validity of the organizing actor's perspective on problems and solutions (Eelderink et al. 2010). This poses a challenge, because such pre-existing problem framing may miss important underlying or contextual challenges that should be of primary concern to the ones exploring interventions to solve the problem. Moreover, failure to explore and embrace the diversity of perspectives may hinder proper communication between stakeholders, and may lead to unproductive conflicts where stakeholders are prone to stick to their own perspectives (van Eeten, M. 1999, Cuppen 2012, Watkins et al. 2018). Therefore, when a tightly predefined problem framing, objectives and project boundaries are developed without understanding the systemic challenges and opportunities and their interrelatedness, project failure often follows, especially when they concern wicked, messy or unstructured problems within social-ecological systems (Cuppen 2012, Midgley 2016, Helfgott 2017, Watkins et al. 2018). To avoid such limiting predefinitions and move towards improving social ecological systems with all involved actors, approaches are needed that: 1) are conscious of how social-ecological systems are being framed by its different users, and 2) operationalize the development of such systems' understanding and potential solutions in an inclusive, participatory manner. As Ostrom (2009) puts it, describing one of her second tier variables of a SES (U7: knowledge of SES/mental models): "When users [of a social-ecological system] share common knowledge of relevant SES attributes, how their actions affect each other, and rules used in other SESs, they will perceive lower costs of organizing." In addition, Helfgott (2018) has advocated moving from problem-based to strength-based approaches, building upon community strengths focused on 'empowering communities to foster positive change from within'.

In this paper, we offer an inclusive, open and reflexive approach to identifying problems and solutions in a social-ecological system and to co-creating Community Action Plans (CAPs) to improve such SES. While Helfgott (2018)'s work departed from systems thinking, we start from Participatory Action Research (PAR) - a strong tradition of research that focuses on the full integration of and iteration between action and research (e.g. Stringer 2014, Migchelbrink 2018). We seek to strengthen the ability of PAR to engage with the definition of systems, problems and solutions within complex social-ecological systems. This is done by integrating Critical Systems Thinking (CST) into PAR -

because CST poses explicit questions about system and problem boundaries that can be integrated into PAR processes. We will first develop this combined approach conceptually and outline its benefits. We then apply this approach to a case study on Saba Island in 2016 for a project from a Dutch nature organization, which was originally framed as 'saving sharks from extinction'. We draw lessons on the implementation of CST-empowered Participatory Action Research. We end by proposing avenues for future research based on our findings.

THE DANGERS OF PRE-FRAMED DEVELOPMENT INTERVENTIONS

Over the past few decades, numerous development projects have failed to meet the needs and priorities of local beneficiaries, often related to a limited understanding of the local social-ecological system (e.g. Sirolli, 1998, Douthwaite 2017, Watkins 2018). Although there are many additional reasons for the failure of such development projects, one major pitfall is that local NGOs' dependence on financial assistance from donors makes them prone to stick with tightly pre-defined development goals of their donors, leaving them with no space to adapt development projects to the local needs and the social-ecological and -cultural context in which the project is to be implemented (Amutabi 2006, Risal 2014). This problem is often combined with a limited understanding of the social-ecological system -including social-cultural, economic, biophysical, power dimensions and other factors- in which the project is embedded, which often results in a mismatch between the services provided by the NGO and the beneficiaries' needs and priorities (Amutabi 2006, Risal 2014). These challenges seem to indicate that a lack of an open, reflexive systems perspective -i.e. understanding the local social-cultural and social-ecological context- could lead to project failure and/or unintended negative consequences (e.g. Wilson 2017).

INTEGRATING SYSTEMS FRAMING IN PARTICIPATORY ACTION RESEARCH

To help overcome the issue of limiting problem framings leading to the failure of development projects, we propose to strengthen the ability of Participatory Action Research to engage specifically with systems framing in social-ecological systems by combining PAR with Critical Systems Thinking (CST). In this approach, PAR, a research tradition that already focuses on shared understanding and problem solving through collaborative action (e.g. Stringer 2014, Migchelbrink 2018), is empowered by integrating more robust systems framing questions distillated from CST. Here, we characterize social-ecological systems as the type of systems where CST-enabled participatory action research offers unique benefits, and then go on to discuss PAR and CST as building blocks for our combined approach.

Social Ecological Systems

In systems where human wellbeing is tightly linked to the natural environment, a systems perspective is crucial to engage with the dynamic, complex, and cross-scale challenges that characterize such systems (Apgar et al. 2017*b*). The social-ecological systems (SES) framework (Ostrom 2007) serves as an analytical tool to study and fully appreciate system dynamics in coupled human-nature systems. It recognizes system *components* -i.e. resource systems, resource units, actors, and governance systems, *interactions* that take place in so-called 'focal action situations', and *outcomes* and *feedback* that result from these interactions. Social-ecological systems research sees human and natural systems as fundamentally integrated, and studies the resilience of such integrated systems, aiming to understand non-linear dynamics across multiple system levels, scales and dimensions (Cash 2006, Folke et al. 2010, Vervoort et al. 2012). However, social-ecological systems research does not inherently foster the development of a stakeholder-driven, reflexive systems framing, nor the implementation of well-fitted solutions to improve a social ecological system for humans and nature.

Participatory Action Research in social-ecological systems

Participatory Action Research (PAR) offers many benefits for attempts to overcome the pre-framing of development problems by single organizations such as funders or policy makers. PAR is an action-based research method, which fosters reflection and collective social learning (Pahl-Wostl and Hare 2004, Apgar et al. 2017a,b), equity among different stakeholders (Apgar et al. 2017b), empowerment of the disempowered and community-based action (e.g. Stringer 2014). Worldwide, numerous PAR projects are conducted in many different arenas; characterized as strength- and values-based, action oriented and participatory (Apgar et al. 2017a). Rather than delivering a research report as an end product or -on the other side of the spectrum- implementing development programs without prior research on the problem context and opportunities for action, PAR uses research results as a means to trigger community action and vice versa: action to trigger research and reflection. Through co-researching the problem context and potential solutions with stakeholders and sharing its results during the PAR process with them, PAR opens up space for stakeholders to 1) understand the entire system in which the problem is embedded -rather than their proximate problem context solely, 2) understand the problem context from the perspective of other stakeholders, triggering social learning, a cooperative mindset and innovation power and 3) co-create and implement a strategic plan based on stakeholder's intrinsic motivation and needs, which tackles the problem by improving the system in which the problem is embedded. Framing and co-researching the problem-context and community-assets (such as manpower, resources, past successes and existing initiatives) with the involved community brings the knowledge of different stakeholders together to help co-create the best fitting strategies among them. This strength based aspect of PAR is what Helfgott (2018)

advocates for as the fuel for community empowerment. Moreover, this triggering of innovative power reaches beyond the creative capacity of each of the stakeholders solely. This way, PAR has the potential to unlock energy, willpower and a cooperative mindset among those involved in the process to bring positive change into the system, leading to results that often reach beyond previously set goals, as the co-designed initiatives reinforce each other and the system as whole improves respectively.

Participatory Action Research has been researched as a suitable methodology to operationalize Social-Ecological Systems thinking. Using PAR in a SES context has been connected to the fostering of learning among stakeholders (Trimble and Lázaro, 2014), to capture and address complexity in science and society (Shirk et al. 2012) and to increase resilience (Ballard and Belsky, 2010). Case studies combining SES and PAR overall conclude that a PAR approach is a valuable tool for environmental learning (e.g. Ballard & Belsky 2010, Trimble & Lázaro 2014, Shirk et al 2012, Apgar et al 2017); however the extent to which learning can actually promote system change and greater resilience must also be understood in context, especially in terms of political realities (e.g. Ballard & Belsky 2010, Apgar et al 2017). PAR approaches often do not include specific questions tailored to the explicit definition of social-ecological systems and their associated challenges and opportunities. To empower PAR methodology in terms of system definition, we turn to Critical Systems thinking.

Critical Systems Thinking in social-ecological systems

Elucidating multiple perspectives -and possibly conflicting views- on system- and subsequently problem boundaries has been argued to create mutual understanding between those holding varying perspectives (Midgley 2016) and encourage social learning among multiple stakeholders (Pahl-Wostl and Hare 2004, McCarthy et al. 2011, Cuppen 2012). In order to take a systemic approach to social-ecological systems challenges, yet critically reflect with stakeholders on the boundaries used to investigate them, the use of Critical Systems Thinking has been proposed by Midgley (2016). Critical Systems Thinking is an approach to scientific and practical inquiry which holds a primary commitment to a systemic approach and human emancipation, grounded in critical theory and emancipatory- and pragmatic philosophy (Raymaker 2016). CST as a theoretical perspective is widely accepted and applied in literature (e.g. Ulrich 1993, Mc Carthy et al 2011, Stephens 2013).

Raymaker (2016) states that CST has challenged organizational leaders and researchers to attend to power and human emancipation (Flood 1990, Flood and Jackson 1991; Jackson 1990 as cited in Raymaker 2016). From this challenge, two CST informed methods have been developed: Ulrich's *Critical Systems* Heuristics (Ulrich 1993) and Midgley's *boundary critique* (Midgley 2001, Raymaker 2016). Both CST approaches challenge practitioners to critically reflect on their assumptions, to include those that

are involved in as well as affected by the issue in the process and to determine the agenda based on local perspectives rather than top-down led agendas. While these CST approaches stimulate reflexive and participatory thinking, it seems to lack a methodological approach to operationalization of its outcomes (Midgley 2001, Raymaker 2016). This is where we propose to bring in Participatory Action Research.

Several studies have applied CST to social-ecological systems, concluding that the combination of SES and CST helps defining boundaries of a problem context and rational planning within complex social-ecological systems (e.g. Ulrich 1993, Mc Carthy et al. 2011, Midgley 2016). A key paper for our purposes is Helfgott (2018) who combines the notion of resilience (strongly related to SES research but also more widely applicable to complex systems) and CST and operationalizes it in a context of stakeholder participation through Community Operations Research (COR). COR has some relationships to PAR and the combination of resilience, CST and COR is therefore a highly relevant point of comparison for this study.

Combining PAR and CST in other fields

Several studies conducted outside of the social-ecological systems domain already emphasize the value of using PAR together with CST in enacting successful change in the interest of local communities under conditions of uncertainty (e.g. McIntyre-Mills 2008, Stephens 2013, Ariyadasa and McIntyre-Mills 2015). As such, PAR is used as a way to operationalize CST and to move from problem analysis to intervention. Combined PAR-approaches with CST include Community Based Participatory Research (CBPR) (Raymaker 2016), Research in Development (Douthwaite et al 2017) and Community Operational Research (Midgley 2016). These approaches have in common that they acknowledge the need to develop effective ways to manage inquiry in 'wicked problems', 'messy' areas (Raymaker 2016:409) and intractable (Douthwaite et al 2017) or complex (Midgley 2016) problems. Both value human emancipation, systemic perspectives and complementarism on multiple levels. They start in a broader context wherein different stakeholders can find shared visions, leading to mutual understanding of perspectives, greater motivation and ownership of the emerging agendas (e.g. Cuppen 2012, Apgar et al. 2017*a*,*b*, Douthwaite et al 2017,). They complement each other in that CST *uncovers* complexity while PAR approaches generate strategies for *engaging with* complexity (Raymaker 2016, Midgley 2016). Concluding from this literature outside of social-ecological systems *and* the use of either PAR or CST in social-ecological systems, it seems that the combination of CST and PAR offers great potential to be used in solving complex issues within social ecological systems.

Summarizing the aforementioned review, we conclude that:

- Participatory Action Research has been recognized as a powerful approach to more inclusive

engagement with Social-Ecological Systems challenges.

- Critical Systems Thinking has been used to study Social-Ecological Systems problems in a more reflexive, participatory manner.
- Participatory Action Research has been linked with Critical Systems Thinking as a way to follow systems understanding with intervention in fields outside of Social-Ecological Systems research.

A logical next step, then, is to use CST and PAR together to tackle problem framing in social-ecological systems. We argue that the most productive way to do this is to integrate CST-based questions into existing PAR approaches to make the focus on systems definitions in PAR more explicit for all involved.

CARS: AN APPROACH TO COMMUNITY[1] PROBLEM SOLVING IN SOCIAL-ECOLOGICAL SYSTEMS

Here, we present a cycle of iterative, reflexive stages that integrates CST into a PAR approach specific to social-ecological systems. We will refer to this integrated approach as CARS (Critical Action Research in Social-Ecological Systems) for the sake of brevity.

Stage 1. Orientation. The practitioner[2] prepares the approach and build(s) rapport at location. This stage breaks up the limitations of theoretical reasoning and is the first step towards what Ulrich (1993) calls 'identifying the normative content', i.e**.** the value-laden premises and life-practical implications of the propositions it helps to find.

a. Preliminary PAR design. An initial, preliminary PAR structure is outlined by the practitioner focusing on a broadly defined draft objective, main PAR question, sub-questions, stakeholders that should be involved, methodology and to be defined concepts - to be revised with stakeholders at the *first checkpoint,* described below.

b. Rapport Building & Training. Once at location, the practitioner introduces him/herself to the community, identifies co-researchers from diverse members/actor perspectives in the community and establishes a basic relationship with the community members. If applicable, local stakeholders will be trained in the chosen set of PAR-methods.

c. Multi-stakeholder system framing of the SES, using CST. The CARS practitioner conducts informal interviews in order to frame the system in which problem definitions are embedded, based on different stakeholder perspectives, using 1) the principles of SES thinking as a basis for these interviews, using its four components (resource systems, resource units, actors, and governance systems) (Ostrom 2009); and 2) Critical Systems questions to help establish who should be involved

and how the system should be bounded. A first set of critical systems questions (Ulrich, 1993) that help identify the four SES components are: 'Who is (ought to be) the client of the system (S) to be designed or improved, i.e., belong to the group of those whose purposes (interests and values) are served?' 'What is (ought to be) the purpose of S, as being measured not by the declared goals of the designers but by the design's actual or potential consequences?' 'Who is (ought to be) the decision maker, i.e., who has (should have) the power to define and to change S's measure of improvement?' 'Who is (ought to be) involved as planner or designer of S? Who belongs (ought to belong) to the witnesses representing the concerns of those affected by S but not involved in its design, including those who cannot speak for themselves because they are handicapped, unborn, or part of the nonhuman nature?' And 'what worldview actually underlies (ought to underly) the design of S? Is it the worldview of (some of) the involved or of (some of) the affected?' The answers to these questions help to refine the PAR-design based on the stakeholders first shared perspectives (stage 1d.) and form the basis of the system exploration phase.

d. *First Checkpoint: Community PAR-design*. This first system framing is reviewed with local stakeholders and adaptations will be made to the preliminary PAR-design, which will then become the operational community PAR-design.

Stage 2. System Exploration. The CARS practitioner explores the issue addressed in the PAR-design and its context from the perspective of multiple stakeholders. Now that the system boundaries are set, its content can be further explored.

a. The Context. The practitioner explores with local stakeholders the historical, social-cultural, social-ecological and legal context of the issue, as well as its causal relations and power- and social relations between stakeholders using the SES-framework (Ostrom, 2009).

b. The Current- and Desired Situation. Using the Critical Systems questions, the current situation and the desired situation from the perspective of multiple stakeholders is mapped and compared, thereby further defining the system boundaries where necessary. CST questions under stage 1c. will be further explored, as well as the following questions (Ulrich 1993): 'What is (ought to be) S's built-in measure of improvement, as judged by the trade-offs accepted in respect to conflicting purposes?' 'What components (resources and constraints) of S are (ought to be) controlled by the decision maker, that is, what conditions of successful planning and implementation of S are (should be) under his control?' 'What resources and conditions are (ought to be) part of S's environment, i.e., not controlled by the decision maker?' 'What kind of expertise is (ought to be) considered in the design of S, i.e., who is (ought to be) considered an expert and what is (should be) his role?' 'Who or what is (ought to be) assumed to be the guarantor of S, i.e., where do (should) the involved seek some guarantee that the design will be implemented and will secure improvement?' 'To what

extent and in what way are the affected given (ought they be given) the chance of emancipation from the premises and promises of the involved? Are they (should they be) treated not only as means but also as "ends in themselves"?'

c. The 'Gap' and the 'Need'. Based on the former comparison, the 'gap' between current and desired situation is substracted and turned into a common shared 'need'.

d. Motivations. Values and intrinsic motivations of each stakeholder to reach their desired situation is identified.

e. Assets. Strengths, opportunities and social capital of the community and involved institutions is identified, in order to explore how these can fulfill the requirements and overcome barriers for reaching the desired situation.

f. Analysis. The practitioner analyzes the results of former stages and creates an appropriate overview of the findings to be shared with stakeholders in stage 3.

Stage 3. Insights Sharing & Solution Identification. Based on insights from stage 2, stakeholders identify a solution that is mutually agreed upon.

a. Second Checkpoint: Insights sharing. The CARS practitioner presents the overview of findings so far to the community and facilitates reflection. This facilitates knowledge co-creation and social learning among stakeholders: they learn about the social-ecological system researched, recognize their perspectives and get an understanding of other stakeholders' perspectives. Any missing information is added to the yet existing results.

b. Solution Identification. Stakeholders connect the problem context, assets and the first solutions mentioned in order to identify a range of solutions to the issue(s) and to add concrete ideas or elements to those solutions.

Stage 4. Solution Co-creation. Stakeholders co-create a concrete Community Action Plan (CAP).

a. Priority Ranking of Solutions. Stakeholders rank identified solutions according to applicability and importance using insights from former stages and chose the most appropriate solution(s).

b. Third Checkpoint: the practitioner checks with other actors whether prioritized solution(s) are ethical and legally appropriate.

c. Solution Co-creation. The practitioner and local stakeholders set up a strategic Community Action Plan in which each stakeholder can contribute to the desired situation from their own intrinsic motivation and set a starting date of implementation.

d. Roles & Responsibilities. For each activity of the CAP, roles and responsibilities are divided among stakeholders.

Stage 5. Formalization & Transferal. The CAP is formally accepted by and handed over to its executors and other involved stakeholders.

a. Solution Formalization. If required, the CAP is formally acknowledged and appointed by the local government and/or other institutions.

b. Celebration. The kickoff of the CAP is celebrated as well as each of its (first) successes.

c. Implementation. The activities of the CAP is executed by the appointed and responsible stakeholders at the by them determined date(s).

Stage 6. Monitoring. During its execution, local stakeholders monitor and reflect on their CAP.

a. Activities Monitoring. Local stakeholders keep track of their activities in terms of successes and challenges.

b. Fourth Checkpoint: reflection on activities. The practitioner and stakeholders reflect on the outcome of the activities and determine strategies to tackle or bypass any challenges.

c. Adaptation. Where necessary, local stakeholders adapt the CAP to increase project uptake and/or success.

Stage 7. Evaluation. After (most) activities of the CAP are executed, stakeholders evaluate the outcomes of each activity and its impact on the social ecological system.

a. Fifth Checkpoint: reflection on outcomes. Using PAR and/or other evaluation techniques, the practitioner and local stakeholders reflect on the CAP's outcomes.

b. Upscaling. Based on stakeholders' perspectives on CAP outcomes, using PAR techniques, they identify new needs and ways to adapt or upscale the CAP where necessary and appropriate.

Although the above is described as a seemingly linear process, it is in fact an iterative process where practitioners move back and forth between stages and sub-stages, where required, as the example in the next section will demonstrate.

TESTING THE CARS APPROACH: SABA CASE STUDY

To illustrate the relevance and potential of the CARS approach, we present a 7-week case study

conducted on Saba Island between July and August 2016, of a project called "Save our Sharks". In order to chronologically describe how PAR methodology was combined with CST and SES thinking at various moments over time, and outline how each subsequent step of the process was adapted based on the outcomes of previous steps, this section describes methodology and results of this case study together. This step-by-step description is crucial to highlight the essence of our combined approach: subsequent steps involve participatory system framing, but also participatory method selection, prioritization of solutions and co-creation of a Community Action Plan (CAP), which means that the results of each step have to be described in order to understand the logic behind the rationale underlying the design of the next step.

The main outcome of the Saba case study was a fishermen's agreement on 'Seasoning for Redfish'[3] -i.e. establishing a closed season for redfish in order to revive the redfish population- as the fishermen claimed its population has been declining at an alarming rate for the last 15-20 years. The agreement was co-created by local Saban fishermen with input from other stakeholders such as divers, experts, the local government and nature organizations. The fishermen's agreement was an unexpected outcome, considering the goals of the nature organization to save sharks from extinction. Yet, increasing the redfish population is an *indirect* contribution to saving sharks[4], co-created by local stakeholders based on their needs and intrinsic motivation. The section below describes the steps that led to this outcome.

Stage 1. Orientation

Prior to fieldwork, a *preliminary PAR design* was created. During a first visit to the island, informal conversations with local stakeholders were held using SES thinking and a first set of CST questions. This revealed that among Sabans, there was little interest in saving sharks, yet many other challenges regarding the marine ecosystem were reported. Therefore, the scope of the research was broadened from 'sharks' to 'marine ecosystem' in order to give all stakeholders space to share their views within this broader social ecological system. As part of *Rapport Building*, the research project was introduced in church and informal settings. A local fisherman was appointed and trained to assist in the PAR project. As a *First Checkpoint*, based on the first outcomes, the preliminary PAR design was adapted with local stakeholders to a suitable, final design.

Stage 2. System Exploration

This stage aimed to understand the context and the main concerns with regards to the marine ecosystem from the perspective of different stakeholders.

Interviews, seasonal diagrams and first set of focus groups

Semi-structured interviews were conducted with respondents from 15 different stakeholder groups (N=56) among which fishermen and their family (wife, children), divers, Saba Conservation Foundation, government- and church representatives, local and international experts, elderly and others. Homogeneous focus groups were conducted with the Island Council members (N=4), fishermen (N=10 and N=8), Saba Conservation Foundation staff (N=7) and divers (N=4). The aim of the interviews and focus groups was to explore: 1) the *Context* of problems addressed by each stakeholder using the SES-framework, 2) *the Current and Desired Situation* as perceived by the different stakeholders, using CST questions, 3) *The Gap and the Need*: the needs of the different stakeholders as distillated from the gap between the current and desired situation, 4) *Intrinsic Motivations* to change the system and 5) *Assets* that can be used to change the system. Interviews and focus groups were very open in structure and content, to give respondents full freedom to talk about what they considered relevant. After each interview, licensed fishermen filled in (anonymous) seasonal diagrams to indicate how much fish and/or lobster they catch each month of the year. *Analysis* was done using Argumentative Policy Analysis theory (Grin et al 1997).

Results stage 2

1. Urge to increase the redfish population

All interviewed fishermen, as well as other stakeholders, expressed their concern with regards to the decline of the redfish, as exemplified by the following quotes:

"*Sometimes fish is low, especially redfish. We can say we have a good catch when we have 200 kilos* of fish. But even with the full moon we don't get that much, we have like 150 kilos. A couple of years back we had much more. […] *I think it is because of overfishing.*" [Fisherman, S.F.8]

"*In my work as a cook I see the snapper [i.e. redfish] becoming smaller and smaller. The cause is* overfishing I suppose." [Cook, S.HR.3]

Fishermen's proposed solutions for this problem of declining redfish included most prominently 'seasoning' -i.e. establishing a closed season- for redfish. However, opinions on how to season differed in terms of length and location, causing major hiccups in establishing an agreement on seasoning for years. In addition, fishermen were worried about their income during the closed season for redfish. All licensed fishermen also fish for lobster, yet lobster income does not suffice to support their families.

2. Worries about the lionfish plague

In addition, divers (N=3), fishermen (N=2), a cook (N=1), a nature organization staff member (N=1) and a tourist sector representative (N=1) claimed independently that lionfish are a big threat to

(red)fish, coral reefs and the marine ecosystem as a whole. The following quote exemplifies this impression:

"*Overfishing is the biggest threat to the redfish, then second comes the lionfish. They are an* invasive species. […] *With these threats, within 10 years there will be no red snapper* [i.e. redfish] *anymore.*" [Fisherman S.F.10].

Some of the divers and nature organization staff spear shoot lionfish, however this does not suffice to control the population. One diver proposed to experiment with lionfish specific traps:

"[catching] *lionfish could be a good* [alternative] *income* [for the fishermen, for seasoning for redfish]. […] *So if we can get specific lionfish traps, then that could be a viable option.* […] *There are specially designed traps now, which catch lion fish. It's done by a company* called Frapper [Team Frapper[5]]. *They are definitely testing it now. I don't know when it's going* to become official." [Diver, S.D.1]

On Saba, but especially St Maarten, there is a market for lionfish as it is considered a delicacy.

3. Worries about coral reefs

Worries about coral reefs have been explicitly expressed in 7 comments, and 5 times as part of a general worry about the marine ecosystem, 3 times as part of fisheries, (i.e. creating more fish), 3 times in relation to sharks and 2 times in relation to landslides, by a government representative (N=1), SCF staff members (N=2), a medical student (N=1) divers (N=6), a farmer (N=1), a tourist officer (N=1) and fishermen (N=2), explaining causal relations ranging from e.g. global warming [S.O.1, S.O.6, S.DO.2], to local algae growth [S.O.1], anchors [S.M.1] and landslides [S.O.1, S.Fr.1].

To clarify, a dive operator states:

"*We can't control temperature, lionfish, hurricanes etcetera, and that is what causes most damage to* the coral." [Dive Operator, S.DO.2]

A farmer explains the relation with landslides:

"*When rain comes, it* [garbage, soil] *flushes into the water. It kills the coral. Any bit of silt* [i.e. fine particles of soil] *must be* detrimental *to marine life.*" [Farmer, S.Fr.1]

And:

"*There is pesticides & herbicides, weed killers and pest killers, but it all ends in the ocean.*" [Farmer, S.Fr.1]

Numerous solutions have been mentioned that would go beyond the scope of this article[6]. However, it clarifies the commonly shared worry about the coral reefs in Saba territorial waters.

Seasonal diagrams

Fishermen were asked to draw seasonal maps from which we learned that redfish spawn all year round and that catches are generally low from May until September.

Analysis on these first set of data revealed that there were several needs identified among different stakeholders with regards to the marine ecosystem and that there was intrinsic motivation to establish a closed season for redfish (fishermen), to eliminate the lionfish plague (divers, fishermen and the nature organization) and to increase the shark population (nature organization). Few assets and solutions had already been mentioned by stakeholders to achieve this. Experts and literature (e.g. Albins & Hixon 2013, NIWA 2016, Roff et al, 2016) confirmed that an increased redfish population and a reduced lionfish population[7] have positive effects on the sharks population.

Stage 3. Solution identification

The second stage of the action research aimed to determine what issues and their solutions are most prioritized among stakeholders. Based on our first findings, it was decided with the local nature foundation and fishermen to focus on facilitating the fishermen in getting to an agreement for a closed season for redfish. Given the tense situation among fishermen and between fishermen and the nature organization which became clear in a first meeting (fishermen N=11, nature organization representative N=1), upon fishermen's request an anonymous questionnaire was developed to identify the most valued set of solutions. The results of the questionnaire were shared (i.e. the second checkpoint) in stage 4.

Solution Identification: questionnaire (N=12)

A questionnaire was developed based on all outcomes from the individual interviews with the fishermen. The questionnaire aimed to assess what measures fishermen collectively considered most important. The questionnaire consisted of all proposed solutions from interviews, with options for prioritization of those solutions in the categories of A: Seasoning systems, B: Additional measures and C: Alternative Income. Per proposed solution, three options were provided: 'very important', 'important' or 'not important'. Analysis was done by counting the scores: 3 points for 'very important', 2 for 'important' or 1 for 'not important'.[8]

Results

Highest score for category A 'seasoning options for redfish' was to 'close the entire Saba Bank for 4 months' (score: 20). 11 out of 12 fishermen claimed that a maximum of 4 longlines[9] should be allowed during the closed season.

In category B, 'Additional measures to increase the redfish population', establishing a fishermen's organization came out to be most popular (score: 35), followed by 'throwing sharks back alive as they keep the reefs healthy that redfish depend upon' (score: 32). Furthermore, fishermen considered 'arranging duty free fuel' from the government (score: 31), patrolling for illegal fishing (score: 29) and using 'bigger mesh sizes'[10] for their traps (score: 28) as most important.

In category C, 'Alternative Income', only Fishing Aggregating Devices (FAD's) for mahi mahi was considered relatively important. There were few other types of alternative income mentioned during interviews, which scored relatively low. Only after this questionnaire, the option of fishing for lionfish was proposed by a diver.

Stage 4: Outcome sharing & Solution Co-creation

This stage aimed to present results from the questionnaire and seasonal diagrams, priority ranking of solutions and finally, co-create the Community Action Plan.

Second Checkpoint & Priority ranking: first focus group with fishermen (N=10)

As a second checkpoint, the aim of the first focus group with fishermen was, as indicated by the attending fishermen, to come to an agreement for a closed season for redfish. After discussing the questionnaire- and seasonal diagram outcomes, priorities for seasoning options were set by the fishermen and a draft-agreement was developed. Three significant observations characterized this focus group. First, instead of choosing the highest prioritized option of seasoning for 4 months, using the seasonal diagrams, fishermen decided together to extend this period to 6 months, starting April 2017 - during redfish low season. Second, although fishermen claimed sharks were a nuisance to them, they acknowledged their importance and decided to include in the agreement to throw back sharks alive after catching them. Where seasoning for redfish is an indirect way to help saving sharks from extinction, throwing back live caught sharks is a direct way to save them. Thirdly, after this focus group, fishermen were standing on the dock as a group, having a beer together. Given the earlier tense atmosphere, this was remarkable.

Third Checkpoint: reflection on the established agreement (N=12)

As a third checkpoint, the rules fishermen set for this agreement were checked with the laws of the EEZ[11], to confirm its alignment. After the prioritized measures were documented in the agreement, fishermen were individually asked to reflect on it and sign when agreed upon. Three fishermen who

did not attend the meeting did not or not fully agree with the articles that were put together. In particular, the number of months to be seasoned turned out to be an issue, as exemplified by the following quote:

"*This ain't gonna make me happy. I am sure all fishermen want 4 months instead of 6 months. I will* call all of them and let you know tonight. Then I would like to have a new meeting." [S.F.3]

That evening, the fisherman in question called and stated that all fishermen had agreed upon a closed season of 4 months. A new meeting -a focus group- was organized to further discuss this.

Solution Co-Creation: second focus group with fishermen (N=8)

The second focus group with fishermen was organized to discuss and confirm the final set of articles of the agreement. At its opening, fishermen stated again they aimed to come to an agreement for a closed redfish season. Due to the tension that had developed over the amount of months to season, the practitioner emphasized her goal of facilitating the process towards an agreement rather than pushing to a certain direction.

After dialogue, fishermen again concluded that seasoning for 6 months would be the best option, starting in April 2017. Articles were adapted with fishermen to make sure all were clear to them. Finally, all articles were read out loud by the practitioner, to which all fishermen one by one confirmed to agree.

Roles & responsibilities

A final version of the agreement was put together and signed by all licensed fishermen and some of their co-workers to confirm their role, commitment and responsibility as fishermen to comply to their closed season for redfish and sustainable fishing for redfish afterwards.

Stage 5. Formalization & Transferal

During this stage, the agreement was formalized and prepared for its implementation from April 2017 onwards.

Solution formalization: Island Council meeting (N=6)

As a continuance of the *Roles and Responsibilities* stage, in the last week of the action research a final meeting was held with Island Council members (N=3), the Griffier (N=1), the Island Governor (N=1) and a fisherman (N=1). All results from the action research so far were presented. Island Council members consulted the fisherman on several subjects regarding fishing, seasoning, (plans for) establishing a fishermen's organization. Wishes, goals and concerns from the part of the

fishermen were shared, leading to action points from the side of the government, regarding formalizing the agreement in the licenses and supporting the fishermen. The fishermen's agreement was officially handed over to and signed by the Island Governor.

Celebration

The formalization of the agreement was celebrated among fishermen, nature organization staff, an Island Council member and the practitioner toasting drinks at a local bar.

Implementation: Initiation of the closed season for redfish

On April 1st 2017, fishermen pulled out their redfish traps. Informal phone conversations with fishermen and other local stakeholders confirm that they complied to the rules on their co-created agreement.

The Lionfish Trapping Pilot

Early May 2018, the first lionfish traps were designed and launched in the water, which are currently being tested.

Stage 6 -Monitoring- and 7 -Evaluation- were not part of this 7-week case study. Instead, with local stakeholders was discussed how the closed season for redfish could be monitored, controlled and evaluated per year and how each of the articles in the agreement could be altered and adapted to the new circumstances.

SABA CASE: FINAL OUTCOMES

The Saba case describes the process leading to the co-creation of Community Action Plan to improve living circumstances for sharks through improving the marine ecosystem's balance and how solutions were co-created to seemingly separate problems, translated into new economic incentives for nature conservation, visualized by figure 1.

INSERT FIGURE 1 HERE

The action research started from the perspective of the nature organizations (Figure 1, top circle), expressing the urge to save sharks from extinction. However, Saban fishermen showed no interest in shark-saving activities. Broadening the scope from 'sharks' to 'marine ecosystem' opened up spaces for local stakeholders to express their concerns, their ideal situation and solutions on how to achieve that ideal situation.

Main outcomes from interviews and focus groups with several different stakeholders, (Stage 1) were the urge to increase the redfish population (Figure 1, bottom left circle) and to improve coral through tackling the lionfish plague (Figure 1, bottom right circle).

Solutions included: 1) the closed season for redfish, in order to save redfish from extinction (proposed by mainly fishermen) and 2) setting up a Lionfish Trapping Pilot (proposed by a diver), in which fishermen fish for invasive lionfish using specific traps (as opposed to the ineffective spear shooting), in order to mitigate the damage lionfish cause to coral and other fish types such as redfish, and provide an alternative income for fishermen during the closed season for redfish (Figure 1, arrows).

As sharks depend on -among others- redfish and coral reefs for their survival, re-balancing the marine ecosystem through increasing the redfish population and saving coral through taking out lionfish is expected to help saving sharks, which serves the goal of the commissioning nature organizations (Figure 1, arrows).

Reframing the issue from 'sharks' to 'marine ecosystem', thereby using PAR combined with SES and CST has shaped ground to co-create a Community Action Plan where economic incentives established new driving forces for conserving the marine ecosystem. First, it clarified what different mental models were used by different stakeholders to define the problem and potential solutions from their perspective. Second, this opened up the opportunity to find interrelations between problems and solutions. Third, sharing this system of co-existing mental models with involved actors enabled processes of social learning and double loop learning, as mutual understanding was improved and the process enabled a shift in mental models respectively. For example, fishermen were at first not interested in saving sharks, yet by the end of the process, in their agreement on seasoning for redfish, they took up a clause "to not intentionally catch sharks and to throw unintentionally caught sharks back alive" which refers to a shift in their mental model (see Sendzimir, Magnuszweski and Gunderson (2018) for detailed discussion on mental models and double loop learning in social ecological systems).

As far as our knowledge goes, this is the first time fishermen and other stakeholders have co-created a Community Action Plan to improve the marine ecosystem from multiple angles. A fisherman stated:

"*We have been waiting for this* [establishing a fishermen's agreement for a closed season on redfish] *for 20 years, since we realized the redfish is declining. Nobody has ever accomplished this, not* even the experts. Now we have done it ourselves in just seven weeks." [Fisherman, S.F.4]

In the Saba case, facilitating local stakeholders in the process of co-creating solutions that fit

their values and needs through this approach lead to the establishment of ownership, pride, motivation and willingness to cooperate.

As stated in the introduction, in the design of projects in social-ecological contexts, we propose for practitioners to avoid imposing predefined boundaries. Rather, according to the CST approach, system boundaries in SES need to be probed. In the Saba case, these boundaries were initially predefined by a nature organization -i.e. 'shark conservation'- however probing these boundaries at location widened the scope towards 'marine ecosystem' enabling all stakeholders to share their perceived issues and options for improvement, leading to a synergistic way of problem solving without having to reach consensus *between* the different stakeholders.

The CST approach, i.e. elucidating the 'what is' and 'what ought to be' questions of Critical Systems Heuristics, opened up spaces to reflect upon the gap between these from the perspective of multiple different stakeholders and to define the boundaries of the social-ecological system.

Applying PAR in the Saba case study enabled the operationalization of CST in the SES 'marine ecosystem' through problem- and scope identification, prioritization, and the co-design and implementation of a Community Action Plan to achieve the desired situation. Through the combination of SES, CST and PAR -now launched as CARS- fishermen (in collaboration with other stakeholders) managed to establish a closed season for the endangered redfish. A replenished redfish population in turn leads to an improvement of the balance of the marine ecosystem and a better living environment for sharks, thereby indirectly complying to the goals of the commissioning nature organization. Through the closed redfish season, combined with the Lionfish Trapping Pilot, stakeholders are co-creating new economic incentives for nature conservation.

Nevertheless, this study came with some limitations. First, seven weeks of field study was not enough to comply to all stakeholders' proposed solutions. Analysis of results showed the potential for improvement of the marine ecosystem from multiple more angles. Due to time constraints it was not possible to address them all. Second, the set of questions from the CST approach have not been applied systemically. Only after the study it was concluded that the 'what is' and 'what ought to be' was identified using a more open interview approach in PAR. Third, literature on SES, PAR and CST solely and in duo-combinations was so extensive that not all could have been analyzed.

DISCUSSION

This paper explored the benefits of using Social-Ecological Systems (SES) and Critical Systems Theory (CST) to inform Participatory Action Research (PAR) - in order to overcome development

challenges associated with non-inclusive, pre-framed problem approaches in development research and planning. A combined approach was presented and then illustrated with a case study performed on Saba.

Our literature findings indicated that PAR had been combined with either CST (McIntyre-Mills 2008, Stephens 2013) or SES (Trimble and Lázaro, 2014, Ballard & Belsky 2010) in specific cases; that CST and SES had been linked to each other (Mc Carthy et al. 2011, Midgley 2016); and that PAR elements had been used to support SES/CST research (Helfgott 2018). This existing research demonstrated the benefits of these partial combinations, and indicated that using both SES and CST elements to develop the new PAR approach described in this paper would have unique potential for reconsidering system boundaries and multi-stakeholder problem-solving. We demonstrated this new PAR approach, dubbed Critical Action Research in Social-ecological Systems (CARS) in a case study in Saba that yielded synergistic results in a problem space, defined in a participatory, reflexive fashion. In the case study, the combined approach was used to co-create and implement solutions based on local needs and the local social-ecological context. This approach led to transdisciplinary, locally co-created solutions to seemingly separate problems, translated into new economic incentives for nature conservation. The Saba case illustrates that through applying the CARS approach, different stakeholders such as the commissioning nature organization, fishermen and divers could reach their own objectives while contributing to a broader system -the marine ecosystem- which in addition helps each of the separate stakeholders reach their objectives without the need to convince any of the other stakeholders. SES was necessary to understand the interaction of stakeholders with the marine ecosystem of Saba territorial waters. CST was necessary to break open the predefined framing of 'saving sharks' towards 'improving the marine ecosystem' in order to give stakeholders space to come up with solutions that fit their values, needs and objectives. The backbone of the approach, PAR, was necessary to learn from practical engagements, and to operationalize the findings in a Community Action Plan to improve the marine ecosystem. These results suggest that the outcomes of the Saba case -the fishermen's agreement on a closed season for redfish and the Lionfish Trapping Pilot as an alternative income- could not have been reached without this combined approach.

Furthermore, the Saba case provides some notable insights. First, having no strongly defined agenda as a practitioner contributed to a comfortable atmosphere between the practitioner and respondents. For fishermen this was especially important, as they expressed have 'laws pushed down their throats' by experts flying in to Saba. Second, using no pre-defined knowledge framework about the system paved the way for asking questions where experts may have taken knowledge -possibly wrongfully- for granted. Third, asking the fishermen at the beginning of a focus group what they would like to achieve created a comfortable, open and cooperative atmosphere, presumably because it clarified that

the practitioner had no conflicting agenda. Fourth, presenting results of the research -i.e. the multiple local perspectives on the problem and potential solutions- was highly appreciated by fishermen. It was confirmed by the local nature organization as well as the fishermen themselves that the high attendance rate was due to the fact that results of the research would be shared with participants, when fishermen commented that they would normally be excluded from such knowledge sharing. Presenting co-designed knowledge contributed to group dynamics that resembled dialogue and a cooperative mindset rather than antagonistic discussion.

We recommend to further explore the development of PAR using CST and SES, conceptually as well as in new case studies. For theory development, more research is needed to identify the gaps and the potential benefits of using this combined approach. For new case studies, the CST list of questions could be applied more systemically in order to further elucidate power dynamics and leadership in the co-creation of new projects for nature conservation. Similarly, more elaborate and/or specialized interpretations of SES could be used for questions and discussion points in a PAR approach in specific cases and purposes (Preiser et al. 2018) as wel as SES approaches focused on imagining and enacting transformation processes (Hebinck et al. 2018, Pereira et al. 2018) when transformative ambitions and needs exist.

For development actors, the illustration of the CARS model in the Saba case demonstrates that there are practical and effective alternatives to top-down problem and solution framing in development contexts (Amutabi 2006, Risal 2014). Broadening up the context of the issue addressed opens up the space for local stakeholders to express their genuine concerns and ways to address them based on their intrinsic motivation. This leads to solutions that go beyond the initial focus of a development actor. However, this requires from development actors such as NGOs and donor agencies to understand, and importantly, trust, that the CARS approach follows a different dynamic, in which: 1) the broader social ecological system is mapped out based on multiple stakeholders' perspectives, 2) the solution remains unclear until the later stages of the action research, that 3) the solution(s) may defy expectations and 4) the solution becomes embedded in a Community Action Plan to improve the broader system with multiple stakeholders, rather than a unilateral/top-down plan. If so, people can be moved, and move each other, to collectively solve unstructured, messy and wicked problems in development contexts.

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[1] By 'community' we mean all involved stakeholders of the issue under research.

[2] In this paper, practitioner is referred to as the person executing the CARS approach.

[3] Articles in the fishermen's agreement include: 1) To establish a fishermen's organization -starting its development in August 2016- aiming to be officially formed before the end of 2016. 2)To establish a closed season for Red Fish for 6 months for the entire Saba Bank from the 1st of April 2017 until the 30 st of September 2017, after which leaving room for reflection and adaptation of the seasoning system for the next years based on the results of the seasoning system of 2017. 3) To set a trap limit of 25 Red Fish traps from the 1st of October 2017 until the next agreed upon closed season. 4) To allow a maximum of 4 vertical longlines for Red Fish per fishing boat during closed season for Red Fish. 5) To not intentionally catch sharks and to throw unintentionally caught sharks back alive -when using traps, longlines and FADs and/or other methods- as they keep the

marine ecosystem healthy. 6) To use bigger mesh sizes: all fishermen will use 2 inch square mesh wire for at least the doors of the Red Fish traps. 7) To, in cooperation with the government and the coast guard, arrange patrolling for illegal fishing, meaning breaking the above mentioned rules, for foreign as well as local boats.

[4] According to local divers, experts and literature, an increased redfish population contributes to a better living environment for sharks (NIWA 2016).

[5] Team Frapper is an American organization experimenting with lionfish specific traps.

[6] Proposed solutions range from goat elimination programs to planting bamboo trees and rezoning the Marine Park. More information about these proposed solutions can be provided upon request.

[7] Sharks prey on redfish but not on lionfish. Reduced lionfish population allows coral to recover, providing a range of ecological benefits for sharks (e.g. Albins & Hixon 2013, Roff et al, 2016).

[8] In addition, a section was dedicated to perspectives on a -to be established- fishermen's organization, to verify fishermen's preferences (not presented here).

[9] According to respondents, longlines allow fishing for redfish in a different, deeper area where non-threatened redfish reside.

[10] Bigger mesh sizes in traps allow smaller fish to escape, allowing them to spawn.

[11] Exclusive Economic Zone, where the Saba Bank belongs to.

Fig. 1. Figure 1. The interrelatedness of different perspectives within the marine ecosystem (simplified version).