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Complexity, climate change and evaluation

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About this Working Paper

This paper examines the implications of complexity and complexity science for evaluating climate change programmes. It then creates a simple 'index' to understand complexity levels of programmes and suggests a path forward for including complexity in evaluations.

About the authors

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CONTENTS

TABLES

FIGURES

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ABSTRACT

As governments and multilateral institutions establish projects and programmes to mitigate and adapt to climate change, a question arises as to how we can determine their effectiveness. Impact evaluations have emerged in the social sciences as a prominent tool to determine the causal effect of policies and programmes in fields like health and economic development. However, climate change programmes tend to exhibit high levels of complexity, which may challenge their ability to be measured and thus evaluated.

This paper examines the overall question of complexity and uses a selection of climate change programme approved by the Green Climate Fund Board to understand how complexity may be analyzed based on a set of criteria. By exploring perspectives from complexity sciences, this paper examines how effects of climate change projects and programmes may be understood. Viewing a climate change programme as a complex system – wherein the whole is greater than the sum of its parts – may help us devise new methods or combine existing ones to evaluate it effectively.

ABBREVIATIONS

BOOT	Build-Own-Operate & Transfer
CAF	Development Bank of Latin America
CAS	Complex adaptive systems
CBDRM	Community-based disaster risk management
CFM	Community forest management
CIS	Climate information systems
CLEWS	Climate early warning systems
CPS	Complex physical systems
DSS	Decision-support system
EbA	Ecosystem-based Adaptation
EMP	Environmental management plans
EWS	Early warning system
FFS	Farmer's Field Schools
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	Greenhouse gas
GIS	Geographical information systems
GLOF	Glacial lake outburst flood
IEU	Independent Evaluation Unit
IT	Information technology
LGED	Local Government Engineering Department
PES	Payment for environmental services
REDD	Reduced emissions from deforestation and forest degradation
REDD+	Reducing Emissions from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
ToC	Theory of Change
ToNC	Theory of No Change
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change

I. Introduction

Under the landmark Paris Agreement, developed countries have committed to devoting USD 100 billion per year by 2020 to climate finance funding. Institutions such as the Green Climate Fund (GCF) have begun to funnel some of these funds to programmes that address climate change mitigation and adaptation. On the surface, these programmes appear to have much in common with development programmes funded by traditional multilateral development institutions. However, beyond superficial similarities, climate change presents a fundamentally unique and complex challenge. The problems and solutions related to climate change are large scale, interdisciplinary and uncertain. While there is an urgency to act quickly and systemically on climate change, there exists only a weak evidence base to tell us what kinds of interventions work, and which do not, to reduce greenhouse gas emissions and strengthen the resilience of those affected by changing weather patterns.

Programmes designed to address climate change tend to include multiple different interventions, as programme designers seek to achieve transformational change in a system. However, these multiple interventions can make it challenging to understand which specific intervention causes which change. When interacting together, the multiple interventions may produce 'emergent' outcomes that are different from those one would expect if each intervention were implemented on its own. In addition to unclear impact pathways and emergent properties, there exist 'unknown unknowns' in the climate change problem space, both in terms of predicting the behaviour of the Earth system with a warmer climate, and of understanding the horizons of technological innovations and resource use in the future. For these and other reasons, climate change is a highly complex problem at many levels of analysis (see for example Rosser, 1999).

In trying to gain a clearer understanding of the evidence of what works to address climate change, the emerging field of complexity science can offer conceptual tools for analysis. Complexity science is a multidisciplinary scientific field that studies systems "with many interconnected parts" (Holland, 2014). Examples of systems with interconnected parts, range from a rainforest to an economic market to a multi-celled organism. What these systems have in common is the property of emergence: the system as a whole is greater than the sum of its parts. Complex systems can share other common properties such as nonlinear behaviour and feedback loops that maintain and accelerate processes in the system.

Where systems exhibit such complex behaviour, standard approaches to evaluating the programmes may not provide a full understanding of impact. Causal approaches generally test the links of a theory of change and use experimental or quasi-experimental methods. Under complexity, however, different evaluation approaches may be needed. These include new and additional methods, viewed from the perspective of a systems-based rather than an intervention-based approach to evaluation.

This paper explores applications of the complexity perspective to climate change and evaluation. First, we give an overview of concepts from the field of complexity science. Next, we examine research on complexity as it relates to evaluation and suggest methods that could be used to evaluate complex programmes. We then outline the unique challenge of evaluation for climate change and illustrate what a complex climate change programme looks like. Subsequently, we present an illustrative index to rate a climate project's level of complexity. We explain the assumptions behind it and rank the complexity of 10 randomly selected GCF projects based on the index. Finally, we present our findings and discuss their limitations and implications.

II. Review of complexity approaches

Overview of complexity

Beyond emergence as a defining characteristic, most complex systems exhibit other common properties. With nonlinearity, for example, inputs in the system can lead to changes that do not progress in predictable linear trends. Many complex systems exhibit self-organization into patterns, like when a flock of birds knows to change directions in a synchronized manner, despite not having a single leader signalling it to do so. Another common property is 'adaptive interaction', in which agents in the system change their behaviours based on the behaviours of other agents. Finally, complex systems display 'hierarchical organization' with different phenomena occurring at different levels of the hierarchy – the building blocks of emergence.

Under the broad umbrella of complex systems, Holland (2014) delineates two main categories: complex adaptive systems and complex physical systems.

Complex adaptive systems

Complex adaptive systems (CAS) are composed of agents that interact and learn from one another to form emergent properties (Holland, 2014). CAS often have feedback loops: causal loops in which one action feeds into another in a pattern of self-reinforcement. In a CAS, constant adaptation and evolution mean that no two situations are the same, though some common patterns can be used as guidelines. However, because these systems very rarely settle on an 'equilibrium' – wherein opposing forces are in balance and lead to a constant state – it can be challenging to predict or measure them.

An ant colony is a well-known example of a CAS. A colony, made up of numerous individual ants, is an emergent force capable of creating remarkably intricate nests, carrying heavy objects and building bridges with the ants' own bodies (Mitchell, 2009).

Complex physical systems

Holland (2014) describes complex physical systems (CPS) as "geometric (often lattice-like) arrays of elements, in which interactions typically depend only on effects propagated from nearest neighbours" (p. 31). An example of a CPS is a cellular automaton, a discrete grid of geometric cells that is self-reproducing based on a set of governing laws. At the time it was created in the 1950s, the cellular automaton demonstrated that self-reproducing behaviour was not only limited to living systems – computer algorithms could reproduce themselves, too.

Holland (2014) outlines examples of characteristics that are present in some (but not all) CPS:

- Self-similarity: In fractal curves, the same geometric patterns repeat at progressively smaller scales. Scientists have observed this sort of self-similarity in various natural systems, including tree branching, seashells, snowflakes and Romanesco broccoli.
- Scaling: Some CPS exhibit scaling patterns, in which a system's growth adheres to a uniform set of rules. The metabolic rate in animals of many different sizes, for example, scales according to a 3/4 power law, meaning each doubling of organism size requires a 75 per cent increase in food intake, rather than an (intuitively assumed) increase of 100 per cent. (West, 2014) Similar scaling patterns are pervasive in biological systems and can also extend to social systems such as cities and corporations.

Systems thinking

Related to concepts from both CAS and CPS, Meadows (1999) describes an approach to thinking about and interacting with systems. Meadows first describes some basic principles of a system: A system contains stocks – amounts of some important variable – that set the system at its current state; the system has inflows and outflows that increase

and decrease the stock; and feedbacks control and correct the inflows and outflows for discrepancies in the stock and the desired state. An example of a stock is the amount of carbon stored in a forest system. The inflow is plant growth and the outflows are logging and plant death. Feedback mechanisms include conservation efforts, reforestation and ecological changes, and – conversely – deforestation, forest management changes and fires. Meadows uses these systems-thinking concepts to then identify leverage points – areas in any system that can be used to change the system. These leverage points include ways to change the rates and sources of inflows and outflows, ways to influence the structure of the system, ways to affect feedback loops, and ways to identify and transcend the fundamental goals and paradigms of a system.

Complexity applications: Biology

The emerging field of systems biology aims to convey biological phenomena in a holistic, global way (Ma'ayan, 2017). From the systems biology perspective, Ma'ayan (2017) cites the aggregation of human cells as a prototypical example of a complex system. While all human cells contain copies of the same genetic code, they can specialize and create structures informed by the signals they receive through intercellular communication. Cells display self-reproducing behaviour through the cell cycle apparatus and self-repairing behaviour in their reaction to viral pathogens. Mitochondria can initiate programmed cell death (apoptosis) where they see it could be beneficial to the organism as a whole.

Ma'ayan (2017) describes the potential of new computational techniques, including artificial intelligence and machine learning – particularly a subfield called deep learning – to provide insight on phenomena through knowledge imputation. However, while these techniques can predict events in a system, they are not able to describe how or why they are occurring, which is where complex systems lenses can be of use.

Complexity applications: Cognitive science

In the field of psychology, researchers have struggled to find an overarching theory that unites various lines of enquiry, from memory to neurology to behavioural science. The field of cognitive science, which encompasses "cognitive psychology, artificial intelligence, and cognitive neuroscience" (Goertzel, 1997), shows promise as a potential unifying concept. Goertzel (1997) argues, however, that cognitive science researchers have placed too much emphasis on the mind/brain debate, in which they argue that either the mind's processes or its underlying physiological structures in the brain are most important to understanding human psychology.

Goertzel (1997) contends that a complex systems view of cognitive science can help overcome the challenges of reconciling disparate understandings of cognition. Mitchell (2009) notes that the brain and its emergent cognitive properties can be viewed as a complex system. While the brain is made up of simple subcomponents called neurons, upon signalling to one another, neurons give rise to complex thoughts, emotions and behaviours that researchers do not yet fully understand. The modelling of neural structures is one of four applications of complexity science to cognition that Goertzel (1997) identifies. Also, he posits, concepts from complexity such as adaptation and self-reproduction can be used to create models of psychological phenomena, analyze empirical data about cognition and examine the underpinnings of the philosophy of mind.

Complexity applications: Economics

Economic systems can be seen as examples of complex systems, exhibiting emergence and nonlinear dynamics. Rosser (1999) highlights a debate within the field between those who see complexity science as a set of unifying concepts that can be applied across disciplines, and those who are sceptical and see complexity as a "mere metaphor". The author argues that, regardless of the extent of its utility, the complexity framework upends the assumption that human actors are rational

agents. Kirman (2016) echoes this idea in his review of Colander and Kupers's book *Complexity and the Art of Public Policy*. Kirman agrees with claims by Colander and Kupers that thinking about economics through the lens of complex systems is a paradigm shift. In contrast to the current accepted ideas in economic theory, which are based on assumptions such as the principle of rationality and the idea of adjusting economic parameters to converge towards some socially optimal economic equilibrium, the complexity sciences require a shift towards viewing economies as emergent properties that have constantly shifting, rather than fixed, "basins of attraction" (gravitation towards one state of being or another).

Even having accepted the premise of economies as complex systems, debate remains over the implications for governance. Nobel Laureate Richard Thaler (2008), building upon the work of Kahneman and Tversky (1979) on biases and rules of thumb commonly used in decision-making, defined the field of behavioural economics with his work on choice architecture. Thaler argues that it is possible to engineer the set-up of systems (such as health care, education and insurance) to "nudge" people into making socially desirable decisions. Similarly, while Colander and Kupers assert that governments can influence individuals to self-organize in a socially beneficial way, Kirman (2016) disagrees, arguing that decision makers have limited power to engineer the evolution of a complex system. Rosser (1999), too, highlights the deep uncertainty of outcomes that lead to widely differing conclusions over the role of government in supporting and regulating a complex economy.

III. Complexity and evaluation: What has been done

Complexity as a framework for evaluation

So, what do all these complex systems concepts have to do with evaluation? In designing programme interventions, we are attempting to manipulate the flows in and out of a system so that we can bring this system to a harmonious equilibrium or desirable "basin of attraction". Fundamentally, we are using evaluation to understand whether an intervention or set of interventions is working to achieve this desired state or outcome.

In standard empirical theory-based evaluation, evaluators lay out a theory of change that establishes causal links between inputs and outputs in a programme. For example, an intervention may seek to establish a causal link between the provision of vaccines to a community and improved health outcomes for programme recipients. After establishing this hypothesized causal relationship, evaluators test the causal link by carrying out randomized experiments or quasi-experiments to support or refute the hypothesis that the input of vaccines leads to better health outcomes. In a situation of high complexity, however, empirical evaluations based on simple theories of change may not sufficiently capture the multiple working parts that lead to an emergent outcome; thus, they may overstate the causality attributed to a single intervention or report the contribution of others in a biased way (Rogers, 2008). To fully understand the context and effectiveness of a complex programme, different approaches to evaluation may be necessary.

Westhorp (2012), for example, delineates the connection between complexity theory and realist evaluation approaches. Realist evaluation, like empirical evaluation, relies upon a programme theory. However, realist approaches work to specify the mechanisms underlying the change and pay special attention to the context at hand (Marchal, Van

Belle, & Westhorp, 2015). Westhorp (2012) argues that complexity approaches can be applied to evaluations in two ways: First, a realist evaluation can layer multiple theories of change to reflect the complexity of a programme while still measuring the outcomes of its subparts. Second, both the realist and the complexity perspective can be incorporated into the design of evaluations.

To improve the design of evaluation in CAS, Preskill, Gopal, Mack and Cook (2014) recommend several approaches. These include embracing flexibility in evaluations; approaching evaluation from a holistic level; identifying interactions, feedback loops, leverage points and non-linearities; and watching for patterns. In addition to these approaches, USAID (2016) recommends that to become "complexity-aware", a monitoring framework should embrace leading indicators to gain insight on effects before the results are finalized, and to "consider relationships, perspectives, and boundaries" that effect and are affected by change within the complex system.

Suggested approaches to evaluating complex programmes

What does it look like in practice to incorporate complexity approaches in evaluation?

Table 1, below, outlines suggested methodologies that can enhance experimental evaluation approaches in complex situations.

Table 1. Suggested approaches from the literature on evaluating Complex systems

Method	Description	Benefits	Suggested by
Emergent logic models	Convey multiple causal strands at different levels of analysis in a logic model and adapt the model as new outcomes emerge.	Addresses the challenge of overly simplistic single causal models by capturing emergent outcomes, which occur only during and after interventions as a product of interactions.	Rogers (2008)
Network Theory	Present agents in the system as nodes and the connections between them as networks. Analyze the behaviours and frequency of interactions between nodes.	Helps understand patterns in peer effects, cooperation and the spread of information (Chandrasekhar, n.d.).	Preskill, Gopal, Mack and Cook (2014); Banerjee, Chandrasekhar, Duflo, and Jackson (2013)
Most Significant Change	Collect and analyze stories on which interventions appear to stakeholders to have provoked the most significant change.	Engages stakeholders in the evaluation process and helps recognize unanticipated emergent properties.	USAID (2016); Preskill, Gopal, Mack and Cook (2014)
Time Series or Panel Data	Analyze data from multiple periods (time series) and/or for multiple different outcomes (panel data) to measure change over time.	Facilitates the capture of trends that are not observable in a randomized setting due to temporal and feasibility constraints.	Preskill, Gopal, Mack and Cook (2014); Douthwaite, Mayne, McDougall, and Paz-Ybarnegaray, (2017)
Outcome evidencing	Identify outcomes that appear most important to measuring change in a programme, examine critical linkages and who are experiencing change, analyze findings, and repeat this process (Douthwaite and Paz-Ybarnegaray, n.d.).	Allows for iterative and real-time learning; the evaluation can adapt as the complex system evolves.	Douthwaite, Mayne, McDougall, and Paz-Ybarnegaray, (2017); USAID (2016)

Method	Description	Benefits	Suggested by
Sentinel indicators	Identify outcomes that act as "keystone species" to indicate the overall health or success of a system.	Prioritizes the evaluation's most important outcomes; creates a simple decision rule as to whether an intervention is successful.	USAID (2016)

In addition to innovation in research approaches, the advent of new technologies and data management techniques may serve our understanding of complex interventions. Examples include the following:

Spatial analysis and remote sensing: Where interventions are spatially explicit, geographical information systems (GIS) and remotely sensed data (including satellite data) could be used to measure outcomes from an intervention. Examples include using GIS to measure forest cover change, integrating data from climate models into early warning systems, and using night-time satellite imagery to measure light intensity as a proxy for electrical connectivity and poverty.

Automated data collection: As the use of communications technology has widely expanded, many project beneficiaries are now using personal electronic devices. With proper permissions and access, data can be collected by text message or through smartphone apps, to replace or complement manual survey tools traditionally used in evaluations.

Machine learning for inference and prediction: Machine learning can infer the output of data as a function of the input without being explicitly programmed with exactly what to look for. A machine learning algorithm is set up to learn the patterns in a data set such that it can accurately classify a new input to the system as being in one category or another. These processes can find new patterns in existing data (beyond the purview of evaluators) and predict the outcomes of an intervention over time.

Agent-based modelling: Agent-based models simulate the behaviour of autonomous agents in a system, given a set of starting inputs and parameters. While the models rely upon simplified assumptions, they can offer insight into potential future outcomes in a system and can be especially useful in coupled social-ecological systems.

Network theory: Some CPS and CAS can be represented through network theory, in which a system is mapped as a set of "nodes" connected by "linkages". (Mitchell, 2009) Network theory aims to understand the relationships between elements or agents of a system, based on the number and frequency of interactions.

Examples of where evaluation techniques have tried to deal with complexity

To illustrate the above and other techniques, we now examine some examples of evaluations that have taken complexity into account. In the first example, Banerjee, Chandrasekhar, Duflo and Jackson (2013) conducted a social network analysis to examine the diffusion of information about a new microfinance programme introduced into villages in India. In their results, they found that participants in the programme were more likely than non-participants to pass information about the programme on to their neighbours. Such a social network analysis approach can also provide information on how to approach the 'last mile problem' of behaviour change: Presuming we have set up infrastructure, systems and policies, how can we convince people to change their behaviour to meet the objectives at hand? Behavioural insights from social network analyses can also be applied to climate change programmes that rely on behavioural change, such as payments for ecosystem services or early warning systems.

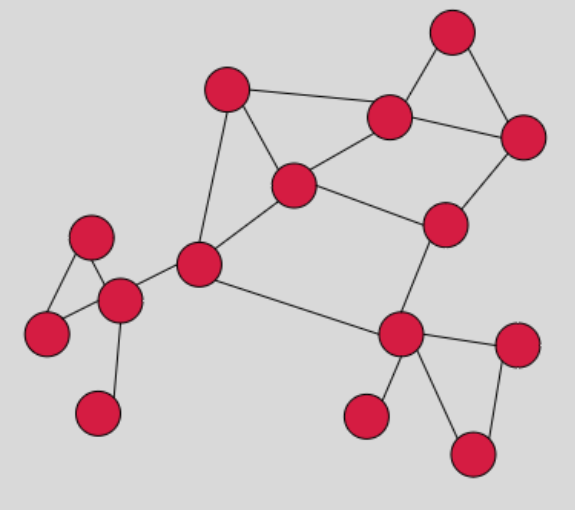

Figure 1. A simple visual representation of a social network

Note: Nodes represent individual agents and connections represent their interactions. The analysis can then observe the frequency and closeness of interaction among agents.

In an illustration of a realist evaluation approach, Douthwaite, Mayne, McDougall and Paz-Ybarnegaray (2017) conducted a multi-method evaluation of the CGIAR Research Programme on Aquatic Agricultural Systems. The combination of multiple methods for monitoring and evaluation was designed to capture the complexity of the interdisciplinary programme, which sought to reduce poverty in communities dependent on aquatic agricultural systems in five countries. Methods used included "trend lines, panel data, after action reviews, building and testing theories of change, outcome evidencing and realist synthesis" in an integrated monitoring and evaluation system that allowed continuous learning through the programme lifetime.

A third example is an evaluation by Matheson et al. (2017) of the Healthy Families New Zealand programme, which aims to improve preventative care regarding chronic disease in 10 regions. The evaluation included a comparative analysis between two cycles of data collection at different points in the intervention. Each cycle included community consultations, interviews, social network analysis and an in-depth analysis of new and existing data – culminating in two case studies that were compared to one another.

Despite these examples, it appears that there may be room for innovation in methods for causal inference where programmes operate within highly complex systems.

The uniqueness of evaluation for climate change

How doevaluation for climate change programmes differ from that of interventions in development and other social programmes? According to Jimenez and Puri (2017), climate change is a multi-sectoral problem that necessitates multiple interventions, which may lead to unintended non-linear effects. The authors note that there is no commonly agreed upon definition of adaptation, a major subcategory of climate change efforts. They also note the presence of (high) discount rates, interconnectedness, and coordination (of small actors to make large impacts) amongst concerns that assail climate change action, and consequently evaluation.

Within the complexity framework, adaptation can be seen as the process of evolution as a system shifts away from an initial "attractor" (Timmermans, López, & Roggema, 2012). Once the system is no longer able to adapt and return to its baseline, it may enter a 'chaotic state' or a 'state of adaptation'. In the context of adaptation to climate change, an

initial attractor might be the state in which climate events are relatively predictable and the population is resilient to fluctuations in weather. A 'state of adaptation' might be a social system that is repeatedly damaged by recurrent extreme weather events but which recovers in a predictable manner. A 'chaotic state' by contrast, could be one in which social systems would exhibit major disruption – such as social unrest – due to climate instability.

With the complex characteristics of adaptation in mind, the kind of simple causal model used in a theory-based evaluation may not be adequate to capture what adaptation looks like in practice. Relatedly, Christiansen, Schaer, Larsen and Naswa (2016) summarize five challenges they have identified in the monitoring and evaluation of climate adaptation programmes. First, there is a lack of standardized methodology for adaptation evaluations. Second, adaptation programmes have uncertain and shifting baselines as they are impacted by climate change; there tends to be a paucity of data on these baselines. Third, adaptation programmes tend to operate on longer timescales than regular development programmes, as they seek to reduce risk for the foreseeable future. Fourth, there is no defined metric for commonly used adaptation terms such as 'resilience' and 'vulnerability'. Fifth, where interventions are multi-scale and cross-sectoral, it can be challenging to attribute causality to a single causal strand.

Vollenweider (2015) echoes these challenges, noting that outcomes for climate adaptation programmes are different from other development projects on a spatial and temporal scale. The author notes that (reasons for) vulnerability and resilience cannot be reduced to poverty and prosperity; they are measured instead by the ability and speed of individuals to recover from climate shocks. Alternatively, resilience can be seen as the speed and ability of a system to reorganize after a shock. Christiansen, Schaer, Larsen and Naswa (2016) note that due to the high complexity of many climate adaptation programmes, evaluations will require a high degree of flexibility. This will be costly and require additional human resources.

Towards the evaluation of systems, rather than interventions

Whereas evaluators of development projects seek to assess impact at the level of a single intervention, a systems-level approach requires capturing more information about interacting agents to understand emergent patterns. In moving towards a systems approach to evaluation, we may have to amend the questions of causal attribution generally asked in an impact evaluation, such as: Did the intervention cause the change? If so, how much?

An alternative set of questions could be: What leverage points can we identify in the system? Which processes are causing which changes? Would changes occur in the absence of these processes? What happens when we tinker with these processes? Can we find the combination of processes that will lead to the outcomes sought? What parts of the system already function appropriately? How can interventions harness or build upon what already works?

On the practical side, qualitative approaches suggested in

Table 1 present a taxonomy of approaches that may be employed for analyzing complex systems for evaluation. However this listing is not sufficient (or necessary) and highlights the fact that these approaches need to be supplemented by monitoring and evaluation systems that capture data efficiently and have quick learning feedbacks to improve the programmes. An example is the structured experiential learning approach described by Pritchett, Samji, and Hammer (2013), in which multiple iterations of a programme design are implemented and tested to understand which permutation of a programme is most beneficial. Experiential learning with quick feedbacks is especially important in areas where we are not sure whether or how an intervention will work.

The increasing use of computational models to simulate the interactions between social and ecological systems holds promise to help us understand potential scenarios that may arise with climate change. In addition to simulating the behaviour of natural systems in climate models such as Earth System Models, newer Integrated Assessment Models also include data from social systems such as population, energy, and economic dynamics that may affect future climate scenarios (McSweeney and Hausfather, 2018). As these models improve in accuracy and resolution, evaluators and decision-makers alike may be able to use them in predicting potential and likely scenarios. It is compelling to think about a future in which coupled socio-ecological systems models, fed with data from evaluations and elsewhere, could bridge the gap between our understanding of evidence at the macro- and microeconomic scales – a future in which, knowing a certain extreme weather event is coming, we could have some understanding about the likely social implications on various scales. Going beyond prediction, we could use the evidence to select the interventions that would increase resilience for communities in the short and long term.

All that said, it does not necessarily make sense to shift away from the traditional theory-based evaluation approach in systems that are easily evaluable. If we can establish a counterfactual with relative ease (e.g. conventional randomized control trials or quasi-experimental methods), and we recognize the need to provide more evidence for the effectiveness of an intervention, there is merit in using established methods that will help expand the evidence base. The complexity-aware approach comes in where causal chains are unclear, hard to test or interwoven. And the complexity approach should, where possible, build in theory-based counterfactual analyses.

Climate change project as a complex system

A hypothetical project can illustrate what a climate change project with high complexity would look like and how we may evaluate it. This hypothetical project is an adaptation project that involves training farmers to grow crops that are more climate resilient, providing grants for structural housing upgrades to shield against the effects of frequent storms, and creating an early warning system to alert farmers of incoming storms. The agents in the system are the national housing agency, the national ministry of agriculture, the regional government's information technology division, a non-profit that works on agricultural training programmes, and the farmers themselves.

An example of a feedback loop in this system is if the proliferation of climate-resilient crops from the training programme that may work in combination with upgraded houses to decrease the loss of income from a storm, which would leave the farmers with more income to invest back into improved agricultural practices, which would, in turn, further reduce the loss of income from storms. An example of an unanticipated emergent property would be if the improved housing, in combination with new technological infrastructure installed for the early warning system, would increase the overall use of information and communications technology in the community. A challenge to the evaluability of this programme is the long and uncertain timelines over which adaptation should be measured, and the potential for differential effects of the programme on people living in different geographic areas (near the coast versus more inland, for example).

This is not to say that emergent outcomes and feedback loops will be present in all cases, nor that the effects will always be positive. Climate change projects also have the potential to have unforeseen emergent properties that render them ineffective or even damaging to communities.

IV. CREATING A COMPLEXITY - AWARE SCORING SYSTEM FOR CLIMATE CHANGE PROGRAMMES

The complexity index

To differentiate between levels of complexity levels, we use the example of GCF investments and create an index for measuring complexity. The complexity index aims to gauge the level of complexity that a given climate change project may exhibit. While it is difficult to systematically categorize the characteristics of complex systems due to their unique and situation-dependent nature, certain characteristics can serve as proxy indicators for predicting whether one system will exhibit more complexity than another.

Craig et al. (2008) note a set of criteria that may make an intervention complex: it includes the number of components within an intervention, the "number and difficulty of behaviours required", the number of groups targeted, the "number and variability of outcomes", and the degree of flexibility in the intervention (see Table 2).

In the context of social programmes, Rogers (2008) identifies the characteristics of a simple intervention: it would have a single implementing organization; a single causal strand; one universal mechanism to explain effects; linear causality with proportional impact; and outcomes that are pre-identified. A not-simple intervention might have multiple, interdisciplinary, implementing entities; multiple causal strands; different causal mechanisms that vary depending on the context; recursive causality with feedback loops; and emergent, rather than pre-identified, outcomes. However, according to Rogers, some interventions that are "not simple" can be labelled "complicated" rather than "complex". Complicated interventions are those that may have multiple implementing entities and multiple causal strands, but do not rely on feedback loops to propel their success through self-reinforcement or exhibit "tipping points", thresholds after which an input will amplify or accelerate effects in a nonlinear fashion.

With these criteria in mind, we identify criteria that are relevant to and obtainable from GCF project proposals. We include these criteria as proxies in the 'complexity rubric'. We assign weighted scores to the proxy indicators and compile them into an overall 'complexity score' for each investment/project. These complexity scores are then categorized as low, medium or high complexity. A low-complexity score implies that outcomes will occur from relatively few interactions in a way that is predictable given the inputs. A high-complexity score implies that a multitude of interventions and stakeholders will interact with one another to form emergent properties.

We then compare scores across projects (see ANNEX 1). The GCF Independent Evaluation Unit (IEU) may be able to use this ranking to determine methodological approaches and amount of resources to evaluate the projects' effectiveness.

While suitable evaluation techniques will vary depending on a project's context, a general principle may be to allocate more resources to projects that are highly complex for a more complexity-aware evaluation strategy.

Definitions used in the Complexity Rubric

An 'intervention' is defined as any activity that aims to change the outcomes of a situation through a series of planned steps (see Table 2). A GCF programme can have one or many different interventions – project proposals sometimes refer to them as 'components'. Related to a project's interventions are its 'theories of change', which lay out the steps and assumptions that underlie its plan for how a given intervention (activity) will *cause* an intended change in its outcomes.

The 'number of stakeholder groups' indicator is a count of the number of groups involved in

the project, including government agencies, community groups, co-financing agencies and programme beneficiaries, among others. The ‘number of sectors’ is a count of the number of sectors involved in the implementation of the project; examples include public administration, forestry, energy, agriculture, water, infrastructure and bio-business. The ‘target outcome’ is a project’s designation as Mitigation, Adaptation or Cross-Cutting and can be found in section A.1 of project proposals under “Brief project/programme information”. The ‘number of results areas‘, also found under section A.1, is a count of how many boxes are checked under the “Results areas” categories of “reduced emissions” and "increased resilience” (these are paradigm shift level objectives for GCF investments).

An indicator on the proposed timescale of projects was included initially but eventually removed because it did not contribute to the assessment of project complexity. However, it is worth noting that adaptation projects may face more uncertainty and thus a higher complexity due to the unpredictable and long-timescale effects of climate change. For example, evaluators may not be able to capture the effects of an intervention on resilience to climate impacts if the region does not face any extreme weather events during a three-year evaluation. We also use indicators such as ‘target outcome’ and ‘number of results areas’ are uniformly available in every project proposal.

A ‘theory of change’ is a means of representing the causal links we expect to see in a given programme intervention. It often takes the form of a visual map of ‘nodes’ connected by arrows. Each node is labelled with an input, an activity, an output, an outcome or an effect, such that it can make explicit a pathway from cause to effect.

The links in a theory of change help to break down exactly what needs to happen, step-by-step, for an intervention to attain a certain outcome (

Figure 2). Evaluators can then assess whether the connections between steps make sense and are grounded in prior evidence. For example, it might be a leap in logic to assume that establishing a new employment training programme (an output) will lead to higher rates of employment (an outcome) and thus lower rates of poverty (an effect) for a certain target population. We can check whether the assumption is reasonable by reviewing the literature of studies conducted on similar programmes. If there is little in terms of rigorous existing evidence, we may want to conduct a theory-based counterfactual-based evaluation of the most unexplored and/or critical 'link'.

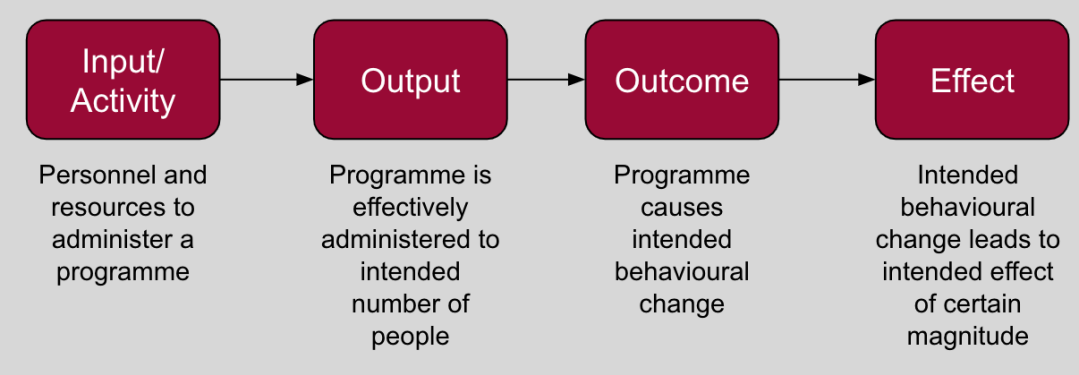

Figure 2. Example of a traditional theory of change model

In our complexity rubric, theories of change are ranked as strong, fair or weak. A theory of change is assessed based on three criteria: coherency, ability to be evaluated and foundations in rigorous evidence. A theory of change is *coherent* if it is explicitly laid out in a project proposal and is logistically feasible.

A theory of change is *evaluable* if it has measurable attributes that can be easily built into an impact evaluation. A theory of change is *based on quality evidence* if it is supported by multiple sources of rigorous evidence and exhibits consistent results across evidence sources.

Table 2. Proxies for assessing complexity included in the complexity rubric

PROXY	RATIONALE FOR INCLUSION IN THE COMPLEXITY RUBRIC
Number of Interventions	A larger number of interventions on the same population indicates a higher potential for interactions between the interventions to lead to emergent properties and feedback loops.
Theory of Change Quality	A weak theory of change indicates a higher amount of uncertainty as to whether projects will lead to their intended outcomes and challenges the ability of evaluators to understand its effectiveness.
Number of Stakeholder Groups	A larger number of stakeholder groups indicates a greater diversity of actions and interactions between agents.
Number of Sectors	When a project involves multiple sectors, it requires more interdisciplinary collaboration, which may involve the management of multiple stakeholders with competing priorities.
Target Outcome (Mitigation, Adaptation or Cross-Cutting)	Adaptation and Mitigation/Adaptation interventions tend to be more complex than projects that target only Mitigation because they often have more interventions in different sectors, longer timescales to understand effects and more uncertainty as to how climate change will affect the beneficiaries.
Number of GCF Results Areas	A larger number of intended impacts (as described in the "Results Areas" section of the project proposals) tends to map with a higher potential for interactions between causal chains and a higher level of uncertainty in project outcomes.

V. Applying the scorecard to GCF Investments

There are three reasons for rating complexity in GCF programmes/investments. First, we aim to better understand the unique challenges of evaluating complex interventions in climate change programmes. Second, we hope to understand the types of programmes in which traditional evaluation techniques will be sufficient for understanding programme impacts, and where gaps in evaluability due to complexity may require innovation in evaluation design. Third, we aim to improve the capacity of the GCF IEU to evaluate complex programmes and contribute to broader efforts in the evaluation of climate change programmes.

To apply the complexity rubric to GCF projects, we randomly selected 10 projects from the 45 projects that had been approved at the time. Of the 10 projects selected, two address mitigation, five address adaptation and three address both mitigation and adaptation. Three projects are based in Africa, four in the Asia-Pacific and three in Latin America. The projects contain interventions from a variety of sectors, including both private and public projects (see ANNEX 1).

In addition to rating each project against the criteria in the complexity rubric to obtain a complexity rating, we conducted qualitative analyses of the programme proposals. Each analysis (attached in appendices) includes a summary of the programme, a breakdown of the programme's theories of change, and challenges to the evaluability of the programme (including the potential for bias), suggestions as to how rigorous evaluation could be built into the programme, an overview of the evidence supporting similar programmes, and a reflection on the apparent level of complexity of the programme.

We present the findings in a table, analyze patterns between projects and discuss the implications for their evaluation.

VI. Findings and a discussion

The complexity rubric is applied to each investment/project (see ANNEX 2), and in

Table 3, we present the overall index. Table 3 shows that one project has a low level of complexity, six with medium level of complexity, and three with high level of complexity. The one low-complexity project is a mitigation project to establish a solar power facility. A common thread between the high-complexity projects is a very large number of interventions and stakeholder groups. The level of complexity of an intervention may not map perfectly to its evaluability or the number of methods needed to evaluate it effectively; however, highly complex projects do generally seem to require non-traditional evaluation approaches.

Common challenges to the evaluability of a project include weak baseline information against which to measure impacts; multiple interventions working simultaneously such that their impacts may be hard to differentiate from one another; a level of analysis that is too high to be measured in a randomized setting (e.g. policy changes or large infrastructure systems); and outcomes that may be confounded by the effects of climate change itself (i.e. the programme would have worked well if not for extreme weather impacts). The most commonly suggested evaluation methods for these investments (see Table 3) are randomized impact evaluation, time series analyses to measure non-randomizable trends, participatory community research (including methods like most significant change), and spatial analyses.

Table 3. Rating of 10 GCF projects based on complexity

Project Name Shortcut	Type of project	Complexity rating	Challenges to evaluability	Suggested evaluation methods
1: Building the Resilience of Wetlands in Peru	Mitigation and Adaptation	Medium	Limited baseline information; residents in rural Indigenous communities do not have registered IDs	Randomized impact evaluation; participatory community research; spatial analysis for forest cover outcomes
4: Climate-Resilient Infrastructure Mainstreaming in Bangladesh	Adaptation	Medium	Unclear baselines for previous disaster losses and co-benefits in education; Challenging to measure loss in disaster scenarios; Spatial and temporal confounds in shelter use	Randomized phase-in of shelter construction; time series of welfare and asset trends as connected to cyclone frequency
11: Ecosystem-based Adaptation in the Gambia	Adaptation	Medium	Confounding factors related to ecological changes from climate change itself	Randomized evaluation of bio-business programmes; spatial analysis of ecosystems; in situ measurements of ecosystem health; time series for institutional and policy changes
13: Improving resilience in coastal Viet Nam	Mitigation and Adaptation	Medium	Timescale of resilience to coastal events spans beyond that of the project	Randomized evaluation of climate-resilient house design and community-based disaster risk management (CBDRM); spatial analysis for mangrove rehabilitation; time series for climate risk mainstreaming
17: Solar Energy Development in Chile	Mitigation	Low	Hard to randomize a single large-scale solar project; cannot assume that additional solar energy will directly reduce the use of fossil fuels	Time series for energy usage patterns; "Theory of No Change" to measure barriers to success (Wörlen, 2011); network analysis of market stakeholders
18: Glacial Lake Outburst Flood risk reduction in Northern Pakistan	Adaptation	Medium	Hard to discern the impact of this programme as compared to the many programmes already operating in this region; Many sub-interventions to be measured; Unpredictability of flood frequency and magnitude	Randomized evaluation for early warning alert systems, CBDRM training, agriculture systems; Ecosystem monitoring for reforestation efforts; Participatory community research/Most significant change
19: Financial and Land-Use Planning Instruments to Reduce Emissions from Deforestation (Ecuador)	Mitigation	High	Large number of interventions; Many interventions work on a macroeconomic scale (policies and regulations); Interventions at various levels of analysis spanning a whole system	Spatial analysis for land-use plans; Randomized evaluation of farmer training and sustainable production grants; Time series for taxation, financial tools, and product certification; Process evaluation for REDD+, project funds, forest traceability programmes and inter-institutional agreements
26: Sustainable Landscapes in Eastern Madagascar	Mitigation and Adaptation	High	Lack of clarity and specificity of theories of change; Many interventions which may interact; Potential for spillovers in project	Randomized evaluation for sustainable agriculture programme; Process evaluation for climate-smart planning modules; Time series for climate investment fund activities; Spatial analysis for

Project Name Shortcut	Type of project	Complexity rating	Challenges to evaluability	Suggested evaluation methods
			impacts	forestry programme
35: Climate Information Services for Resilient Development in Vanuatu	Adaptation	High	Inconsistent baselines (assumes the absence of a baseline is zero); Unclear as to how systems will affect behavioural change; Many simultaneous interventions could be challenging to measure separately	"Participatory case studies" already planned in the programme, if these were to be randomized, they could serve as pilots for future scale-ups; web analytics to measure interventions based on IT and information and communications technology; Integrating information from climate information systems (weather pattern data) into measurements of human welfare outcomes
41: Simiyu Climate Resilience Project	Adaptation	Medium	Public infrastructure projects such as latrines and water treatment cannot be easily randomized	Randomized evaluation of agriculture programmes; pre-post surveys or instrumental variables for infrastructure projects; Participatory community research for capacity-building and training

Limitations and discussion

The complexity rubric is limited by subjectivity. Namely, it relies upon the assumption that more of something (interventions, stakeholders, sectors, etc.) entails more complexity in a project. Each of these assumptions is quantified and assigned a score, but the scores are weighted somewhat equally, when some factors may have a greater influence on whether a project is complex or not. Moreover, the inputs in the rubric must be entered manually and thus depend upon an accurate parsing of the information in the project proposal document. In the future, classification systems should be designed to obtain inputs through automatic searches of proposal text. Similarly, machine learning may be used to mine text indicating strong evidence to aid in the process of systematically compiling an evidence base for a given topic.

The complexity classification of GCF projects in this research is also limited to the information that is written in the project proposals themselves. GCF project proposals tend to reflect the projects in a favourable light. The level of complexity that exists on the ground may differ greatly from that which appears in the written proposal. A solution to this would be to consult project stakeholders directly to understand the variables of interest that could be input into a complexity rubric. Data from monitoring and evaluation systems, however, could allow for the collection of this information in a manner that is less resource-intensive.

If a more robust data set on each project were to be produced, a successful complexity rubric could include additional rubric proxies, including measures of diversity among actors and interventions, number and density of connections between stakeholders, and a measure of the capability to respond to system shocks. A more detailed classification of complexity might also include more information on the ecological changes at play as a project goes on.

A broader limitation is the challenge of systemically categorizing a phenomenon like complexity. Ramalingam, Jones, Reba and Young (2008) point out that the lack of a common definition of complexity limits the utility of the complexity perspective as applied to the humanitarian sector. Suitable approaches to complexity, they note, are context-specific for each intervention, so it is difficult to prescribe any single approach that works in all cases. However, Ladyman,

Lambert, and Wiesner (2012) provide an initial approach to the characterization of complex systems by surveying the existing approaches to classifying and measuring complexity. The authors list a number of conditions necessary for characterizing complexity, which include having an "ensemble of many elements," which interact with one another, exhibit robust order that arises from disorder, and exhibit systemic memory. Further research could apply some of these existing models of complexity to climate change programmes.

Relatedly, the suggestions for approaches to evaluation listed in the complexity rubric results table are based on subjective analysis and may not represent the full range of options or the feasibility constraints at play. These suggestions are biased towards randomized evaluations due to a preference for rigorous methods for causal inference. However, to work, randomized inference must be built into a programme's design from the beginning; we understand that some of these projects are already in the implementation phase and thus the suggestions serve more as examples than as action plans.

In the broader context of climate change and evaluation, what are the implications of complexity for GCF and similar projects? Complex climate interventions, with multiple interacting stakeholders and subparts over longer timescales, may yield different outcomes than those expected in a theory of change. The implication for this, as discussed earlier, could be that GCF projects will require evaluation approaches that extend beyond traditional theory-based evaluations. This is not to say that we should turn away from methodologies that attempt to establish causal inference rigorously. However, we may want to complement traditional qualitative and quantitative evaluation methods with innovative and flexible approaches. Evaluation can be made more nimble, flexible and rigorous through iterative learning mechanisms. Presuming individual privacy is protected, the GCF could source data at the community level and release it to the public. This data would be reviewed at regular intervals to indicate uptake of the programme and initial results. If the results indicate poor uptake, programme implementers can take alternative operational approaches.

Moreover, improving the standard of evaluation and evidence overall is key to understanding the impact of complex interventions. Standards for evaluability (such as collecting strong baselines, randomizing assignment to interventions, and creating explicit theories of change) should be built into every project proposal to facilitate effective collaboration between programme designers and evaluators.

Finally, a deeper understanding of approaches to capture complexity will require a more systematic examination of existing theories and research methods in complexity science. We would benefit from investigating how these theories and research methods might apply in each sector of climate change interventions, in order to come up with examples of project and evaluation designs that can be applied to future GCF projects. By applying complexity approaches from other sectors to establish a "systems view" in the novel context of climate change evaluation, we have the potential to establish methods for better contextual understanding and causal inference.

REFERENCES

Banerjee, A., Chandrasekhar, A., Duflo, E., & Jackson, M. (2013). The diffusion of microfinance. *Science*, 341. doi:10.3386/w17743

Chandrasekhar, A. (n.d.). Measuring networks. Lecture presented in MITx: Designing and Running Randomized Evaluations. Retrieved from https://www.edx.org/course/designing-running-randomized-evaluations-mitx-jpal102x-2

Christiansen, L., Schaer, C., Larsen, C., & Naswa, P. (2016). Monitoring & evaluation for climate change adaptation: A summary of key challenges and emerging practice. Understanding, discussing and exemplifying the key challenges of M&E for adaptation. Retrieved from http://orbit.dtu.dk/files/157400902/MandE_challenge_guidance_note_01_07_16.pdf

Craig, P., Dieppe, P., Macintyre, S., Michie, S., Nazareth, I., & Petticrew, M. (2008). Developing and evaluating complex interventions: the new Medical Research Council guidance. *BMJ*, 337:a1655. doi: 10.1136/bmj.a1655

Douthwaite, B., & Paz-Ybarnegaray, R. (n.d.). Outcome evidencing: A rapid and complexity-aware evaluation method. Retrieved from https://www.harper-adams.ac.uk/events/ifsa/papers/1/1.2%20Douthwaite.pdf

Douthwaite, B., Mayne, J., Mcdougall, C., & Paz-Ybarnegaray, R. (2017). Evaluating complex interventions: A theory-driven realist-informed approach. *Evaluation, 23*(3), 294–311. doi:10.1177/1356389017714382

Goertzel, B. (1997). Faces of psychological complexity. Retrieved from http://www.goertzel.org/papers/intro.html

Holland, J. H. (2014). *Complexity: a very short introduction*. Oxford, UK: Oxford University Press.

Jimenez, E., & Puri, J. (2017). The wicked cases of education and climate change - the promise and challenge of theory-based impact evaluations. In R. D. van den Berg, I. Naidoo, & S. D. Tamondong (Eds.), *Evaluation for Agenda 2030: Providing evidence on progress and sustainability* (pp. 347–369). Exeter, UK: IDEAS. Retrieved from https://ideas-global.org/wp-content/uploads//2017/12/IDEAS-web-REV_08Dec.pdf

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica, 47*(2), pp. 263-291. Retrieved from http://www.jstor.org/stable/1914185

Kirman, A. (2016). Complexity and economic policy: A paradigm shift or a change in perspective? A review essay on David Colander and Roland Kupers's Complexity and the Art of Public Policy. *Journal of Economic Literature, 54*(2), 534–572. Retrieved from http://www.rolandkupers.com/wp/wp-content/uploads/2016/06/JEL-Kirman.pdf

Ladyman, J., Lambert, J., & Wiesner, K. (2012). What is a complex system? Retrieved from http://philsci-archive.pitt.edu/9044/4/LLWultimate.pdf

Ma'ayan, A. (2017). Complex systems biology. *Journal of the Royal Society Interface, 14*(134). doi: http://dx.doi.org/10.1098/rsif.2017.0391

Marchal, B., Van Belle, S., & Westhorp, G. (2015). Realist evaluation. Retrieved from http://betterevaluation.org/en/approach/realist_evaluation

Matheson, A., Walton, M., Gray, R., Lindberg, K., Shanthakumar, M., Fyfe, C., Wehipeihana, N., Borman, B. (2017). Evaluating a community-based public health intervention using a complex systems approach. *Journal of Public Health, 40*(3), pp. 606-613, doi: https://doi.org/10.1093/pubmed/fdx117

McSweeney, R., & Hausfather, Z. (2018, January 15). Q&A: How do climate models work? Retrieved from https://www.carbonbrief.org/qa-how-do-climate-models-work

Meadows, D. (1999). Leverage points: Places to intervene in a system. Hartland, USA: The Sustainability Institute. Retrieved from http://donellameadows.org/wp-content/userfiles/Leverage_Points.pdf

Mitchell, M. (2009) Complexity: A guided tour. Oxford, UK: Oxford University Press. Retrieved from http://waltersorrentino.com.br/wp-content/uploads/2012/02/melanie-mitchell-complexity_a-guided-tour-366-paginas.pdf

Preskill, H., Gopal, S., Mack, K., & Cook, J., (2014). Evaluating complexity: Propositions for improving practice. Retrieved from http://www.pointk.org/resources/files/Evaluating_Complexity.pdf

Pritchett, L., Samji, S., & Hammer, J. (2013). *It's all about MeE: Using structured experiential learning ("e") to crawl the design* space (Working Paper 322). Washington, D.C., USA: Center for Global Development. Retrieved from https://www.cgdev.org/publication/its-all-about-mee-using-structured-experiential-learning-e-crawl-design-space

Ramalingam, B., Jones, H., Reba, T., & Young, J. (2008). *Exploring the science of complexity: Ideas and implications for development and humanitarian efforts* (Working Paper 285). London, UK: Overseas Development Institute (ODI). Retrieved from https://www.odi.org/resources/docs/833.pdf

Rogers, P. J. (2008). Using programme theory to evaluate complicated and complex aspects of Interventions. *Evaluation, 14*(1), 29–48. doi:10.1177/1356389007084674

Rosser, Jr., J. B. (1999). On the complexities of complex economic dynamics. *Journal of Economic Perspectives, 13*(4), 169–192. Retrieved from https://pubs.aeaweb.org/doi/pdfplus/10.1257/jep.13.4.169

Thaler, R., & Sunstein, C. (2008). *Nudge: improving decisions about health, wealth, and happiness.* New Haven: Yale University Press.

Timmermans, W., López, F.O., & Roggema, R. (2012). Complexity theory, spatial planning, and adaptation to climate change. In *Swarming landscapes: The art of designing for climate adaptation* (43–65). Netherlands: Springer

USAID. (2016). Complexity-aware monitoring. Retrieved from https://usaidlearninglab.org/library/complexity-aware-monitoring-discussion-note-brief

Vollenweider, X. (2015). Measuring climate resilience and vulnerability: A case study from Ethiopia: Final report. Washington, D.C., USA: USAID. Retrieved from http://pdf.usaid.gov/pdf_docs/PA00M8KW.pdf

West, G. (2014). Scaling: The surprising mathematics of life and civilisation. 31 October 2014. Retrieved from https://medium.com/sfi-30-foundations-frontiers/scaling-the-surprising-mathematics-of-life-and-civilization-49ee18640a8

Westhorp, G. (2012). Using complexity-consistent theory for evaluating complex systems. *Evaluation,18*(4), 405–420. doi:10.1177/1356389012460963

Wörlen, C. (2011). Meta-evaluation of climate mitigation evaluations. Berlin, Germany: Arepo Consult. Retrieved from http://www.arepoconsult.com/fileadmin/user_upload/pdf/MetaEvaluation_Woerlen.pdf

ANNEX 1. PROGRAMME ANALYSES FOR EVALUATION AND COMPLEXITY

We conducted analyses of 10 randomly selected GCF project proposals approved by the GCF Board. The purpose of the analysis was to gain a fuller understanding of the evaluability and complexity of the projects and identify patterns and learnings that may apply to other GCF programmes. In our analyses, we worked to break down the theories of change embedded within the interventions, identify challenges to their evaluability, think about ways to evaluate the programmes, and estimate their levels of complexity.

Memo 1

GCF FP001: Building the Resilience of Wetlands in the Province of Datem del Marañón, Peru

Programme objective:

The programme "Building the Resilience of Wetlands in the Province of Datem del Marañón, Peru" aims to preserve crucial carbon sinks by reducing deforestation in the Amazon, while increasing climate resilience and providing sustainable economic opportunities for the Indigenous people who live there.

Background context:

The Province of Datem del Marañón, Peru, is home to tens of thousands of Indigenous people, many of whom experience high levels of poverty. The region also faces some of the highest rates of deforestation in the Peruvian Amazon. While the Indigenous people would like to preserve their lands, many face hurdles when making claims for land tenure as they are not registered under the official national identity registry and speak only their Indigenous language. The province faces low institutional capacity, with a small budget, a lack of inter-stakeholder coordination, a remote jurisdiction, a lack of trust from local communities, and a lack of roads to connect to the rest of the country.

Interventions:

- Component 1: Support government organizations in the development of a land-use plan
- Component 2: Support community-based organizations in the development of environmental management plans (EMPs), including training activities and studies of the EMPs
- Component 3: Support the incubation of bio-businesses that will be run by Indigenous people, by providing technical assistance, business planning, marketing, management (especially finance and accounting) and business implementation, including equipment and maintenance
- Component 4: Implement science, technology, knowledge management, and monitoring and evaluation systems to support and learn from the above activities
- Implicit: Register about 3,000 Indigenous people under the official national identity registry

Theories of change:

The theory of change (ToC) provided by the project funding proposal is presented in Figure 3, below. However, this ToC is vague about which interventions lead to which results, and consequently which impacts they claim to cause. Following the chart is a more detailed breakdown of the proposed ToCs for each intervention.

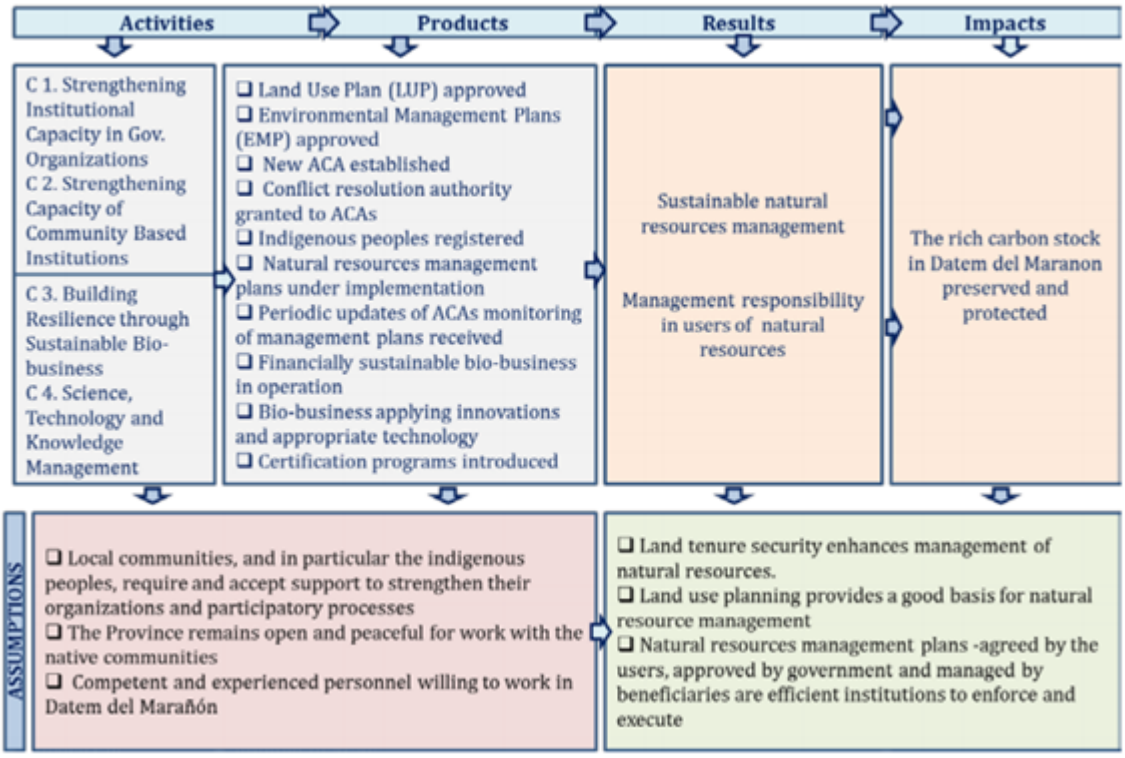

Figure 3. Theory of change: Building the resilience of wetlands in the province of Datem del Marañón, Peru

- Component 1: Support government organizations in the development of a land-use plan
  - Funds and staff to train government officials in land-use planning AND create land-use plan → land is protected from deforestation for agriculture, resource production, etc. AND governments have a new precedent/framework for regional and land-use planning → carbon mitigation from forest conservation AND strengthen government institutional capacity AND increase the climate resilience of Indigenous communities (through ecological means)
- Component 2: Support community-based organizations in the development of EMPs, including training activities and studies of the EMPs
  - Funds and staff to train community and Indigenous groups on environmental management → Indigenous groups design and implement their own EMPs AND community groups have new precedent/framework for environmental management planning and implementation AND land is protected from deforestation for agriculture, resource production, etc. → carbon mitigation from forest conservation AND strengthen capacity of community institutions AND maintain or increase community stewardship of land
- Component 3: Support the incubation of bio-businesses that will be run by Indigenous people, including providing technical assistance, business planning, marketing, management (especially finance and accounting), and business implementation including equipment and maintenance
  - Funds, staff, and equipment for bio-businesses → establish new Indigenous entrepreneurs AND

support new ventures or re-tooling for existing Indigenous entrepreneurs → increase incomes for Indigenous communities AND increase climate resilience of Indigenous communities (through economic means)

- Component 4: Implement science, technology, knowledge management, and monitoring and evaluation systems to support and learn from the above activities
  - Set up technology for info management systems → technology is used by Indigenous groups in their EMP → Environmental Management is high quality AND data is centralized to be used in learning
  - Conduct studies on ecology and deforestation in the region → understand the ecological and climate impacts of projects AND better understand climate resilience of the region
  - Conduct monitoring and evaluation activities → evaluate the success of programme implementation AND evaluate the actual impact of the programme on deforestation and economic development outcomes
- Implicit: Register about 3,000 Indigenous people under the official national identity registry
  - Register about 3,000 Indigenous people → registered individuals can more easily make claims for land tenure, license formal businesses, and participate in decision-making around land use and environmental management → increased autonomy and stewardship over the lands

Challenges to evaluability:

- Baselines:
  - Very poor descriptive data about the people affected (the proposal notes, for example, that they do not know the gender breakdown of the area because of lack of registration cards), and potential hostility from the group to provide more information
  - Are the economic activities occurring already?
  - Are forest conservation activities occurring already?
  - Lack of baseline for REDD+ (is this deforestation and/or carbon effects?)
- Unclear/ambiguous description of effects:
  - What are the specifics of programmes designed to strengthen institutions? How do we know they are based on evidence?
  - How did we determine the number of impacts without baselines?
  - How do we measure climate resilience? What are the specific indicators for this?
- Assumptions:
  - This programme assumes that Indigenous communities are willing and able to participate in the above activities. Is there evidence of the community's desire to participate? (e.g. Have there been community consultations?)
  - What is going to ensure the communities will a) perform the tasks adequately for them to be implemented as projected, and b) sustain their engagement with the projects over the long term?

The potential for causal inference:

We could conduct a randomized evaluation of the interventions.

- Unit: The project has selected 120 communities to participate. We can randomize at the community level.
- Treatment arms: We could use four treatment arms to evaluate the impacts of both the land-use plans and EMPs AND those of the bio-business incubator programme:

	Group initially included in bio-business training	Group not initially included in bio-business training
Group included in initial land-use plan	Bio-business + EMP (30 communities)	EMP without bio-business (30 communities)
Group not included in initial land-use plan	Bio-business without EMP (30 communities)	No EMP or bio-business (30 communities)

- The group that did not initially participate in both programmes can phase the programmes in after 3–5 years. This can also reduce initial strains on programme capacity.
- Assignment to treatment arms: Stratification by community size and region. There are eight regions included in the programme. Community populations range from 17 to 733, with a median and a mode somewhere in the 150s.
- Potential confounds:
  - Different outcomes for different communities based on ethnic group, amount of land with tenure status, relationship with project managers, proximity to areas with highest deforestation rates, differential impacts of climate change (based on geography), success of one type of bio-business over another (e.g. fish versus fruit), effects of the ID registration programme on livelihood
  - Spillover effects: If communities participating in the study are connected to or in communication with other treatment arms, they could potentially change their behaviour based on what they learn.

Similar programmes:

- According to 3ie's gap map report on the evidence for forest conservation interventions, there exists a research gap regarding the impacts of protection and EMPs on greenhouse gas (GHG) emissions (Puri, Nath, Bhatia, & Glew, 2016). The authors note the following:
  - "While investments in initiatives such as REDD and REDD+ exceed US$6 billion (UN-REDD Programme, 2014), no impact evaluations have investigated the environmental or social outcomes of these interventions as a whole" (Puri, Nath, Bhatia, & Glew, 2016, p. 16).
  - "While there is limited evidence of the efficacy of the full suite of REDD and REDD+ interventions, there are many studies that do examine the effectiveness of [payment for environmental services] schemes" (Puri, Nath, Bhatia, & Glew, 2016, p. 16).
  - "Few impact evaluations focus on community training and market linkages (3.2%, n = 4)" (Puri, Nath, Bhatia, & Glew, 2016, p. 16).
  - "Similarly, only one study (Weber et al. 2011) documents the impacts of microenterprises in forest systems. Weber et al. (2011) conclude that participation in microenterprise increased cash and total income as well as asset accumulation significantly, suggesting that the microenterprises contributed to the development goals of the broader integrated conservation and development project (ICDP) of which they were a part" (Puri, Nath, Bhatia, & Glew, 2016, p. 16).
- According to Lawry et al. (2014), improving access to land property rights improved land productivity in Ethiopia,

Nicaragua and Vietnam by an average of 15 per cent for outcomes related to human welfare.

- The evidence above suggests that this programme would likely be a good candidate for a randomized control trial. The project proposal framed this as a proof-of-concept project that could be scaled up if effective.

Notes on complexity:

- The number of stakeholders and the challenges in interacting with them are what bring much of the complexity to this programme. The remoteness and language and cultural barriers faced by the beneficiary communities may challenge communications between stakeholders with conflicting interests; moreover, interests in developing infrastructure and connectivity in the region may override concerns of environmental protection in terms of their importance in policymaking.
- Number of interventions: Five, if including implicit ToC to register Indigenous peoples
- Number of stakeholders: Nine, including Indigenous groups and government departments
- Sectors: Public administration, forestry and bio-business
- Theories of change: Fair
  - Coherence: Strong
  - Ability to be evaluated: Fair
  - Foundations in rigorous evidence: Fair

Sources:

GCF FP001 Project Proposal: *https://www.greenclimate.fund/documents/20182/574760/Funding_proposal_-_FP001_-_Profonanpe_-_Peru.pdf/c2d588e6-882b-47f8-a06d-0645a9a3382c*

Lawry, S., Samii, C., Hall, R., Leopold, A., Hornby, D., & Mtero, F. (2014). The impact of land property rights interventions on investment and agricultural productivity in developing countries: A systematic review. *Campbell Systematic Reviews, 2014*(1). doi: 10.4073/csr.2014.1

Puri, J., Nath, M., Bhatia, R., & Glew, L. (2016). *Examining the evidence base for forest conservation interventions* (3ie Evidence Gap Map Report 4). London, UK: International Initiative for Impact Evaluation (3ie). Retrieved from *http://www.3ieimpact.org/media/filer_public/2017/01/06/egm-4-forest-conservation.pdf*

Samii, C., Lisiecki, M., Kulkarni, P., Paler, L., & Chavis, L. (2015). *Decentralised forest management for reducing deforestation and poverty in low- and middle-income countries* (3ie Systematic Review 16). London, UK: International Initiative for Impact Evaluation (3ie). Retrieved from *http://www.3ieimpact.org/media/filer_public/2016/07/12/sr16-decentralisation-review.pdf*

Memo 2

GCF FP004: Climate-Resilient Infrastructure Mainstreaming in Bangladesh

Programme objective:

"Climate-Resilient Infrastructure Mainstreaming in Bangladesh" aims to protect lives in a rural coastal region of Bangladesh by creating new cyclone shelters, road access and urban infrastructure. It also aims to systematize the climate proofing of future infrastructure development by establishing a national centre for climate-resilience infrastructure.

Background context:

Bangladesh is considered one of the countries most vulnerable to climate risks. Yet its public infrastructure does not meet the need for protection from climate risks. Since the 1960s, the Government of Bangladesh (with support from international entities) has built almost 2,000 cyclone shelters, and deaths from natural disasters have reduced. The districts of Bhola, Barguna and Satkhira have the highest remaining gaps in cyclone shelter coverage. These regions also experience some of the highest poverty rates in the country, between 32 per cent and 39 per cent.

At the institutional level, government departments responsible for infrastructure planning in Bangladesh do not follow a systematic approach to climate proofing. The Bangladesh Local Government Engineering Department (LGED) is potentially one of the best suited to have climate change resilience systematically built into its decision-making processes for infrastructure provision.

Interventions:

- Component 1: Institutional development
  - Establish the Climate-Resilient Local Infrastructure Centre (CReLIC), a think tank and knowledge hub at LGED for adapting local public infrastructure to climate change
- Component 2: Pilot climate-resilient rural infrastructure
  - Build 45 new multipurpose cyclone shelters, rehabilitate 20 existing multipurpose cyclone shelters, and build 80 km of roads that lead to them in the rural districts of Bhola, Barguna and Satkhira
- Component 3: Pilot climate-resilient urban infrastructure
  - Build new pilot climate-resilient infrastructure in the city of Satkhira; exact projects have yet to be selected, but potential infrastructure could be city drainage, flood protection, water supply, sanitation or transport
- Component 4: Project management
  - Ensure effective implementation of Components 1–3 and support LGED in carrying over the project structure into a permanent LGED structure at the end of the project

Theories of change:

The project's funding proposal provides no explicit theory of change. However, it does note the expected impacts and potential indicators for their measurement.

The project claims to "directly increase the adaptive capacity of more than 134,000 people to climate change". This group of 134,000 breaks down as follows (quoted from the project proposal):

- "The 45 new shelters will each have the design capacity of 1,430 individuals (Total: 64,350 beneficiaries).
- The 20 existing shelters once rehabilitated will each be reinstated to their design capacity of 1,000 individuals (Total: 20,000 beneficiaries).
- It is here assumed that roughly one-third of all 153,969 inhabitants of Satkhira Municipality (the urban centre of the district) will benefit directly (50,000 people)."

Indirectly, the project claims to benefit 10.4 million people from the climate-resilient infrastructure planning and implementation brought in the long term by the climate

institute, CReLIC.

Furthermore, it claims to create 1,700 full-time jobs for the 6-year duration of the project. It also claims to provide "education support to more than 18,000 children", as the new cyclone shelters will be "used as primary schools in normal times".

Finally, the project claims to reduce local transport costs "by an estimated average of more than 20 per cent". This would allegedly lead to improved economic and educational outcomes because people can more easily transport goods and arrive at school.

Thus, the theories of change play out as follows:

- Component 1: Institutional development: Establish CReLIC, a think tank and knowledge hub at LGED for adapting local public infrastructure to climate change.
  - Funds and staff to establish CReLIC → Climate change adaptation is incorporated into infrastructure decisions in a systematized way → Bangladesh infrastructure becomes, in the long term, more resilient to climate change → In the long term, fewer people are vulnerable to climate change impacts than without the programme
- Component 2: Pilot climate-resilient rural infrastructure: Build 45 new multipurpose cyclone shelters, rehabilitate 20 existing multipurpose cyclone shelters, and build 80 km of roads that lead to them in the rural districts of Bhola, Barguna and Satkhira.
  - Funds, staff and materials → new and rehabilitated existing cyclone shelters are established AND 80 km of access roads are built AND the shelters are set up as schools → more people than baseline can access shelter during cyclones AND 18,000 children will go to the schools AND road transport costs go down → fewer deaths and less financial damage during cyclones AND improved educational outcomes for children in the region (literacy, scores, completion rates) AND road transport stimulates economic outcomes
- Component 3: Pilot climate-resilient urban infrastructure: Build new pilot climate-resilient infrastructure in the city of Satkhira. Exact projects have yet to be selected, but potential infrastructure could be city drainage, flood protection, water supply, sanitation or transport.
  - There is not enough information here to construct a full theory of change. The idea would be to increase the resilience of both human lives and physical infrastructure.

Concerns:

- Timescale:
  - The development of institutions is a long-term process that is challenging to measure in single impact evaluation. The project proposal states that "the full-scale impact of climate proofing on the LGED portfolio will not be realized immediately after the end of the project, but will evolve gradually with the institutionalization and roll-out of CReLIC services after the end of the project".
  - Similarly, because the specific projects of Component 3 (urban infrastructure) have yet to be decided, it will not be evaluable until after CReLIC has been running for at least a few years. Thus, Components 1 and 2 are the only ones suitable for an impact evaluation.
- Baselines:
  - The project's baseline assumptions are unclear or dubious, and thus estimates for impact may be incorrect.
  - The project proposal claims to reduce deaths and damage to livelihood and

physical shelter but provides little information as to the rates of loss and damage without these cyclone shelters. It assumes that in these regions, there are "0 people with all year round access to transport and shelter" and "0 people with access to climate-resilient urban infrastructure". These regions do have some existing cyclone shelters. Seemingly, they are inadequate, given the World Bank estimate for needs of new shelters (see Table 5 of the project proposal). However, how do we know that the alleged 80,000+ beneficiaries would not otherwise be accessing existing (albeit potentially insufficient) shelters and roads?

  - Further, the final target of the project is to reduce casualties by 84,000+ per supercyclone, but they have not provided base rates of casualties from cyclones. The project proposal notes an ethical dilemma in evaluating the cost-benefit relationship of saving a human life. Also, there are ethical concerns when it comes to determining causal inference in life-or-death settings.
  - Moreover, the claim to additionally benefit more than 18,000 children through the normal use of cyclone shelters as primary schools is made on unclear grounds. Does this mean that 18,000 children who were not previously in school will now be educated? Alternatively, will the schools simply relieve pressure on existing schools? Is there a demand for these schools? If we are simply moving children from existing schools to new ones, there will not necessarily be an improvement in educational outcomes.
- Measurement:
  - It will prove challenging to measure the marginal impact of programmes that aim to prevent deaths and minimize economic loss due to both ethical concerns and the variability of climate impacts themselves. Cyclones and other extreme weather events can vary in frequency, size and severity, and increasingly so due to climate change. Individuals also face variable risk to climate impacts based on geographic and socioeconomic factors.
  - Moreover, an evaluation's sample group could face contamination due to imperfect isolation between treatment and control groups: members of communities without a cyclone shelter may simply travel to another shelter anyway.

The potential for causal inference:

- KfW, the project's Accredited Entity, has an evaluation team that may select this project from a programme lottery for an independent impact evaluation two to three years after the project closes, at which point KfW may invite the GCF to join the evaluation at GCF's own cost.
- It will be hard to determine the evaluability of Component 3 until the entities choose the specific climate-resilience projects they will carry out. Component 2, the cyclone shelter/primary school and road project, has the best potential for a randomized impact evaluation.
- To gain a better understanding of the impact of this programme, we should design evaluability into the project right from the start (ex-ante rather than ex-post).
- The project proposal specifies: "Construction of pilot infrastructure shall be realized in two phases (construction cycles) to enable intensified monitoring and field testing of CReLIC in two feedback loops." The two-phase project provides an opportunity to measure the impacts of the first shelters for two years before developing the second phase. To

fully capitalize on this opportunity, the shelters for the first phase of construction should be chosen randomly from the pool of approved shelters.

- A qualitative or process evaluation approach might work best for understanding the effectiveness of CReLIC in systematizing climate proofing in infrastructure decision-making.
- The details for a potential randomized evaluation are as follows:
  - Unit: Component 2 involves the building of 45 new shelter/schools + ~2.3 km of access roads per shelter and the renovation of 20 existing shelter/schools. We can randomize at the shelter level.
  - Treatment arms:
    + Phase 1: Build 22 new shelters + access roads and renovate 10 existing shelters. The communities surrounding the other 23 new shelters and 10 existing shelters will serve as a control group.
    + Phase 2: The remaining 23 new shelters + roads and 10 shelter renovations will be opened two years after the first group of shelters is built.
  - Outcome indicators: We can measure the following outcomes in the above groups:
    + Number of deaths from cyclones
    + Money spent on transportation
    + School enrolment rates
    + School outcomes on standardized testing
    + Use of shelters among community members during cyclones
    + Health, income and assets before and after cyclones.
- Potential confounds:
  - There may exist variation in cyclones' impact based on the geographic location of the shelters. Thus, we should stratify the sample by geographic region to ensure that each region in the sample is represented equally in the control and treatment groups.
  - Sample contamination may occur due to individuals from communities in the control group without cyclone shelters using shelters newly built for treatment communities. One solution to this would be to restrict shelter usage to individuals in specific shelter catchment areas and require ID to access the shelters. However, this is unethical because denying access to shelters could result in the loss of lives. One way to record sample contamination effects without restricting access to shelters would be to record what communities shelter users come from, and adjust the sample excluding the shelter users who come from control group communities. All that said, this is a major limitation to determining causal inference for this project.
  - There may not be a major cyclone during the two years between the first and second phases of construction, so it may be hard to measure the effects on climate resilience.
  - Overall, the ethics and uncertainty in this programme make it challenging to measure with counterfactual inference.

Evidence base/Similar programmes:

- The project proposal notes several similar projects that could be used as points of reference for this project. These include
  - the Emergency 2007 Cyclone Recovery and Restoration Project (supported by the World Bank),
  - the Coastal Climate Resilient Infrastructure Improvement Project

(supported by the Asian Development Bank (ADB)),

- the City Regions Development Project (supported by ADB),
- the Sustainable Rural Infrastructure Improvement Project (supported by ADB), or
- the Multipurpose Disaster Shelter Project (supported by the World Bank).
- An ex-post evaluation conducted by KfW on a similar cyclone shelter/primary school project in Bangladesh in 2008 did not use rigorous methods for causal inference: it claimed the project's impact was very high despite no attempt at establishing a counterfactual (whether it was the project itself that caused the change, and if so, to what extent).
- A community-based disaster preparedness programme for the management of cyclone shelters carried out by the German Red Cross had no baseline data and experienced no cyclone during the period of evaluation; it thus used community discussions to assess the programme.
- Haque et al. (2012) recommend that "Operational research should be conducted on the precise impacts of cyclone shelters, coastal embankments and awareness programmes on cyclone-related mortality".
- If there exists regionally disaggregated historical data from previous cyclones, it would be beneficial to compare outcome data of the regions with cyclone shelters to the data of those without or with fewer shelters during the same natural disasters.
- A search of 3ie, JPAL, IPA, World Bank and other online resources reveals a lack of randomized impact evaluations on the effects of cyclone shelters.

Notes on complexity:

- This programme exhibits moderate complexity in its stakeholders and interventions. The complexity in this scenario comes mostly from the uncertainty brought about by extreme weather events. The addition of more cyclone shelters may not have linear effects on their use, due to behavioural and climatic factors.
- Number of interventions: Three
- Number of stakeholder groups: Five
- Sectors: Public administration, infrastructure
- Theories of change:
  - Coherence: Fair
  - Ability to be evaluated: Weak
  - Foundations in rigorous evidence: Weak

Sources:

GCF FP004 Project Proposal: https://www.greenclimate.fund/documents/20182/574760/Funding_proposal_-_FP004_-_KfW_-_Bangladesh.pdf/76e10421-f9eb-4543-81e0-732cb1aa8690

Asian Development Bank. (2017). Bangladesh: Coastal climate-resilient infrastructure project. Retrieved from https://www.adb.org/projects/45084-002/main#project-pds-collapse

Asian Development Bank. (2017). Bangladesh: Sustainable rural infrastructure improvement project. Retrieved from https://www.adb.org/projects/40515-013/main#project-pds-collapse

Haque, U., Hashizume, M., Kolivra, K., Overgaard, H., Das, B., & Yamamoto, T. (2012). Reduced death rates from cyclones in Bangladesh: what more needs to be done? *Bulletin of the World Health Organization, 90*(2), 150–156. doi: 10.2471/BLT.11.088302

Japan International Cooperation Agency. (n.d.) Ex-post evaluation: The project for

construction of multipurpose cyclone shelters. Retrieved from *https://www.jica.go.jp/english/our_work/evaluation/tech_and_grant/project/ex_post/asia/bangladesh_2002_2.html*

KfW Entwicklungsbank. (2008). Bangladesh: Primary schools/cyclone shelters. Retrieved from *https://www.kfw-entwicklungsbank.de/migration/Entwicklungsbank-Startseite/Development-Finance/Evaluation/Results-and-Publications/PDF-Dokumente-A-D/Bangladesh_Primary_Schools_2008.pdf*

Mahmood, M., Dhakal, S., & Keast, R. (2014). The state of multi-purpose cyclone shelters in Bangladesh. *Emerald Insight, 32*(9/10), 522–532. doi: *http://dx.doi.org/10.1108/F-10-2012-0082*

UN HABITAT and Norwegian Ministry of Foreign Affairs. (2012). Cyclone shelter assessment: Draft-summary report. Retrieved from *http://www.humanitarianlibrary.org/sites/default/files/2014/02/cyclone_shelter-_summary_final.pdf*

World Bank. (2014). Multipurpose disaster shelter project. Retrieved from *http://www.projects.worldbank.org/P146464?lang=en*

World Bank. (2017). Emergency 2007 cyclone recovery and restoration project. Retrieved from *http://projects.worldbank.org/P111272/emergency-2007-cyclone-recovery-restoration-project?lang=en&tab=results*

Memo 3

GCF FP011: Large-scale Ecosystem-based Adaptation in the Gambia River Basin: developing a climate resilient, natural resource based economy

Programme objective:

The project "Large-scale Ecosystem-based Adaptation in the Gambia River Basin" aims to improve the climate resilience of communities in rural Gambia by developing the region's natural resource-based economy through ecosystem-based adaptation, community-managed forest reserves and wildlife conservation areas.

Background:

Citizens of the Gambia face challenges due to poverty and environmental degradation. The country's economy is heavily reliant on agriculture, and many rural households turn to natural resource-based products for a supplementary livelihood. However, livelihoods in both agriculture and resource-based products are becoming increasingly vulnerable due to environmental damage and the effects of droughts and flooding, which are becoming more frequent and severe due to climate change.

Interventions:

- Create a large-scale Ecosystem-based Adaptation (EbA) plan to build a natural resource base across the country that is climate resilient
  - Implement EbA in agricultural landscapes and degraded ecosystems
  - Create EbA protocols for 125 community-managed forest reserves
  - Establish plant nurseries to support natural resource-based development
- Establish and strengthen natural resource-based businesses in the Gambia
  - Support the development of natural resource-based businesses
  - Invest in infrastructure to develop natural resource-based businesses
- Provide policy support and institutional strengthening to support the implementation of the EbA
  - Strengthen policy support for participatory management and benefit sharing of natural resources
  - Create an online information platform for natural resource-based livelihoods
  - Strengthen the use of EbA across the Gambia through an EbA upscaling and mainstreaming strategy at the national level

Theories of change:

- Create a large-scale EbA plan to build a natural resource base across the country that is climate resilient
  - Funds and personnel for EbA → EbA plans are implemented in degraded landscapes (community forests, parks, protected areas and agricultural areas) → soil erosion is reduced AND communities have improved access to natural resource-based products → soil deposition is reduced in the Gambia River AND community members can more easily create bio-businesses → increased plant cover and soil stability increases resilience to climate events AND plant biodiversity reduces agricultural vulnerability to climate shocks AND community members improve their livelihoods
- Establish and strengthen natural resource-based businesses in the Gambia
  - Technical and financial support AND community training for bio-businesses in 125 communities → communities develop business plans for natural resource-based products → businesses are successful in bringing natural resource-based products to market → bio-businesses improve the livelihoods of community members → community members are more easily able to recover from climate shocks

  - Equipment to support at least two businesses in each of 125 communities → communities have increased capacity in the production of firewood, handicrafts, beekeeping or timber collection → bio-businesses improve the livelihoods of community members → community members are more easily able to recover from climate shocks
- Provide policy support and institutional strengthening to support the implementation of the EbA
  - Funding of a knowledge management officer to provide research and technical support → Officer generates summary reports and reports gaps in capacity → Summary report recommendations are implemented to bridge gaps and address shortfalls in EbA programming → EbA and community management policies are better implemented → EbA programmes are more effective
  - Funds and personnel for the development of an online information platform → information platform hosts information including case studies, lessons learned, and best practices on EbA → platform partners with international collaborators to build knowledge in the field of EbA/climate resilience
  - Funds and personnel to develop an EbA upscaling/mainstreaming strategy and policy recommendations → governments will integrate lessons learned from EbA into upcoming climate change and development planning → the use of EbA is expanded across the Gambia → ecosystems across the Gambia are restored AND the general resilience of individuals vulnerable to climate change is increased

Concerns:

- The programme's theories of change related to bio-businesses appear to be adequately detailed, based on findings from previous assessments of market viability.
- The programme builds upon existing initiatives from UNEP, UNDP and the national government. It is also built in such a way that the government can take over responsibility to continue operating EbA programmes once the GCF programme has finished.
- The proposal also lays out the ecosystems selected for restoration, beyond those which will serve the bio-business intervention.
- For these reasons, this project proposal and its theories of change are fairly strong. However, the plan for training communities to manage ecosystems is not laid out entirely clearly.
- A challenge to evaluating the effects ecosystem-based programmes may be the changes to ecosystems due to climate change that lower the baseline ecosystem health of regions where the programme is applied, confounding what may appear to be an intervention with low effectiveness. Hence the importance of comparing EbA interventions with landscapes that have not received the intervention.

Potential for causal inference:

- Programme designers have identified four bio-businesses that hold potential to create revenue across 125 communities. Ideally, they could also identify another 125 nearby communities that would serve as control groups to observe the effects of the bio-businesses on the livelihoods and climate resilience of community members. Alternatively, the programme could be rolled out to these 125 communities in two phases, wherein half of the communities would receive the bio-business intervention at first, and after a few years it would be extended to

the other communities as well.

- The proposal identifies four different prototypes for EbA that replicate regional EbA practices. Each prototype is based on a different kind of vegetation and is to be implemented in a specific region of the country. These prototypes can be rolled out and measured by comparing them to similar landscape tracts that have not received the prototype EbA. This comparison between land tracts can combine geospatial analysis of ecology and geomorphology with in situ measurements of attributes such as soil quality, primary productivity, and species richness and abundance.
- Institutional and policy changes should be measured, but they fit less clearly into a randomized experimental framework. These interventions can be measured using time series or panel data to understand the prevalence of policies related to EbA.

Evidence base/Similar programmes:

- A systematic review by Doswald et al. (2014) found that there is some evidence to support the effectiveness of ecosystem-based programmes for climate change adaptation. However, there still exist gaps in the literature including the most effective timescales and thresholds for use.
- IIED's research programme on EbA (Seddon et al., 2016) seeks to understand the effectiveness of these interventions and the barriers to their implementation by collecting evidence from EbA projects in various countries. It is unclear as to whether these studies will be randomized.
- ADB (2015) notes that some evidence exists to support the use of EbA, but much of the evidence is framed in a positive, rather than a critical, lens.
- In a systematic review of forest conservation interventions, Puri, Nath, Bhatia and Glew (2016) found "no impact evaluations that investigated the role of forests in helping to mitigate or adapt to climate change". EbA can be seen as a conglomerate of landscape-based interventions, many of which would benefit from randomized evaluations.
- Puri et al. (2016) identified only one study, Weber et al. (2011), that measures the effects of small bio-businesses in forests; the effects were positive on income and asset accumulation.

Notes on complexity:

- This programme appears to have a medium level of complexity. The project focuses on adaptation and works across a broad spatial scale that is distributed among many communities in different regions. The multiple stakeholders involved in the project increase the possibility of competing priorities among them or interaction effects that challenge the ability to evaluate the programme. However, the interventions are complementary and well supported by earlier programming.
- However, these interventions mostly centre on forests and the ecosystem services they offer, and thus the programme does not appear to be overly ambitious in scope. If there is evidence to support the effectiveness of forestry programmes for adaptation and bio-businesses, we can presume that a scale-up of these programmes would add only some additional level of complexity that was not there before.
- Number of interventions: Three
- Stakeholders: the Gambia Ministry of Environment, UNEP, communities, NGOs on the ground, Department of Park and Wildlife Management, Department of Forestry
- Sectors: Public administration, forestry, bio-business
- Theories of change: Strong
  - Coherence: Strong

- Ability to be evaluated: Fair
- Foundations in rigorous evidence: Fair

Sources:

GCF FP011 Project Proposal: *https://www.greenclimate.fund/documents/20182/574760/Funding_proposal_-_FP011_-_UNEP_-_Gambia.pdf/02d12b49-a5bf-4da3-8272-7a59b641960f*

Asian Development Bank. (2015). Ecosystem-based approaches to address climate change challenges in the greater Mekong subregion. Retrieved from *https://www.adb.org/sites/default/files/publication/158165/ecosystem-based-approaches-gms.pdf*

Doswald, N., Munroe, R., Roe, D., Giuliani, A., Castelli, I., Stephens, J., Möller, I., Spencer, T., Vira, B., & Reid, H. (2014). Effectiveness of ecosystem-based approaches for adaptation: review of the evidence-base. *Climate and Development, 6*(2), 185–201. doi: *10.1080/17565529.2013.867247*

Puri, J., Nath, M., Bhatia, R., & Glew, L. (2016). *Examining the evidence base for forest conservation interventions* (3ie Evidence Gap Map Report 4). London, UK: International Initiative for Impact Evaluation (3ie). Retrieved from *http://www.3ieimpact.org/media/filer_public/2017/01/06/egm-4-forest-conservation.pdf*

Seddon, N., Reid, H., Barrow, E., Hicks, C., Hou-Jones, X., Kapos, V., Rizvi, A. R., & Roe, D. (2016). *Ecosystem-based approaches to adaptation: strengthening the evidence and informing policy.* London, UK: International Institute for Environment and Development. Retrieved from *http://pubs.iied.org/pdfs/G04045.pdf*

Memo 4

GCF FP013: Improving the Resilience of Vulnerable Coastal Communities to Climate Change-Related Impacts in Viet Nam

Programme objective:

The programme "Improving the resilience of vulnerable coastal communities to climate change related impacts in Viet Nam" aims to scale up tested interventions that will reduce vulnerability for coastal communities, including building storm- and flood-resilient features into new houses for poor families, rehabilitating mangroves for flood mitigation and ecosystem services, and systematizing the use of climate risk assessments in the public and private sectors.

Background context:

Viet Nam has seen substantial recent economic growth and political change, transitioning from a poor to a middle-income country within 25 years. However, the country is also at extreme risk for increasing damage from climate change. Coastal communities face both more poverty and more vulnerability to climate change than the average population in Viet Nam. They are heavily reliant on agriculture and fisheries, and many people live in precarious housing in informal settlements. While mangroves can provide protection from the effects of storms and flooding, they have been in decline due to population pressure and shrimp farming.

Interventions and theories of change:

- Component 1: Climate-resilient house design: USD 20.152 million (GCF: USD 12.152 million)
  - Funds to support the addition of climate-resilient design features (roof, windows, drainage, monitoring) on 4,000 new houses in 100 target communities AND train families on the house design → storm-resistant features are installed effectively on these houses → upgraded houses are less likely to face damage from storms and floods → reduced loss in life and livelihood due to damaged houses each time there is a storm or flood for 20,000 beneficiaries
- Component 2: Rehabilitation of mangroves: USD 12.937 million (GCF: USD 11.53 million)
  - Funds to regenerate 4,000 hectares of coastal mangroves to create storm surge buffer zones → scale-up of good planting and maintenance practices and technologies in multiple phases AND community groups from the Community-Based Disaster Risk Management programme (see below) receive training in mangrove forest management → rehabilitated mangroves reduce risk of damage from flooding and storms AND community groups improve their livelihoods from the management programme
- Component 3: Streamlining of climate risk assessment: USD 7.441 million (GCF: USD 5.841 million)
  - Upgrade existing loss and damage databases AND develop GIS-based socioeconomic risk mapping model → climate risk and loss and damage information is digitized and systematized → government uses databases and GIS risk models to factor climate risk and information into infrastructure investment decisions → new infrastructure is designed to be more climate-smart
- Component 4: Community-Based Disaster Risk Management programme (listed under the housing component)
  - Communities in the selected villages "develop climate sensitive Community-Based Disaster Risk Management (CBDRM) action plans" to identify and manage risk→ CBDRM plans are implemented at the commune level → communities are better equipped to deal with future climate risk reduction processes

Concerns:

- Baselines: Compared to those of some other projects, this project proposal includes relatively strong baselines, especially since the programme extends on existing programmes. The following pieces of baseline information, among others, are included in the project proposal:
  - 60,000 houses are destroyed in coastal areas each year from floods and storms. Public social programmes for housing already exist, but the construction is not up to par with standards for storm and flood resilience.
  - Mangrove rehabilitation is expensive and has a high rate of failure. The government ran a mangrove restoration programme between 2008 and 2015, which was partially successful but had low survival rates. Of existing mangroves in Viet Nam, 62 per cent are newly planted monocultures.
  - The government is making efforts to collect data on loss and damage that can influence planning processes, but these efforts are underdeveloped. UNDP has ongoing programmes to contribute to the national capacity for collecting and using climate risk data.
- Quality of evidence: The project proposal notes that the UN and other international agencies have identified the CBDRM programme as an effective practice, and it cites this as a reason the programme should be expanded. However, it is unclear as to how it was decided that this programme is effective, and whether that evidence employs credible methods for causal inference. More information on the CBDRM programme is listed in one of the annexes, but the annexes are not available on the GCF website.
- Timescales: The programme is set to run for five years; however, it may be challenging to predict its impact in reducing loss and damage in the future given the increasing frequency and severity of extreme weather events that will likely come after the official programme is over.

The potential for causal inference:

- The climate-resilient house design intervention is the intervention best suited to a randomized evaluation. Project implementers can select the recipients of housing upgrade grants from the qualified applicant pool by lottery at the household level (note that there may be some ethical concerns and secondary effects from "neighbourly envy" dynamics, but a phase-in of more grants could occur after evaluators collect initial evidence).
- The CBDRM programme can also be applied in a randomized setting.
- The effect of the rehabilitation of mangroves on storm buffering can be analyzed using GIS and satellite data. However, it would be more challenging to apply a rehabilitation programme randomly because of complex interactions in ecosystems.
- Climate risk assessment mainstreaming can be assessed through a time series that will analyze new infrastructure investments to understand whether the government is including climate risk assessment proposals.

Evidence base/Similar programmes:

- The project's implementers have conducted pilot trials of the housing programme that targeted 700 households, from which they have learned that the pilot houses still did not provide adequate protection from flooding and storms. The subsequent project phase introduced an enhanced design, but there is still room for improvement in terms of its climate resilience. The Ministry of Construction knows which additional design features the houses will require, but the cost estimates for these require outside

funding (from the GCF and UNDP).

- The project proposal itself cites a number of references pertinent to the effective restoration of mangrove forests and flood- and storm-resilient house design, which indicates that project implementers commit to basing their decisions on evidence.
- Despite efforts to support the project proposal with evidence, it is unclear as to whether the evidence collected from the pilot trial or surrounding mangrove restoration is based on randomized or other rigorous methods for causal inference. Thus, while evidence from pilot programmes is a valuable addition to the design of this project, we cannot with confidence attribute causation of changes in outcomes to the pilot project itself, nor does it appear that we have measures of how much change occurred due to the project.
- Puri, Nath, Bhatia and Glew (2016) found in a systematic review of forest conservation interventions that there were "no impact evaluations that investigated the role of forests in helping to mitigate or adapt to climate change", indicating there is still room to build rigorous evidence to help understand if mangrove restoration interventions are effective in protecting against climate-induced storms and floods.

Notes on complexity:

- This programme appears to exhibit a medium amount of complexity. The spatial, temporal and climatic aspects of this programme bring about complexity; it may be challenging to measure the effects of the programme due to the differential impacts of various climate events on beneficiaries over time.
- Number of interventions: Four
- Number of stakeholders: Seven, including communities, government agencies, implementing entity
- Sectors: Housing, forestry, public administration
- Theories of change: Fair
  - Coherence: Fair
  - Ability to be evaluated: Fair
  - Foundations in rigorous evidence: Weak

Sources:

GCF FP013 Project Proposal: *https://www.greenclimate.fund/documents/20182/574760/Funding_proposal_-_FP013_-_UNDP_-_Viet_Nam.pdf/e1b576a6-cccc-46bc-8678-a57636bd7202*

Puri, J., Nath, M., Bhatia, R., & Glew, L. (2016). *Examining the evidence base for forest conservation interventions* (3ie Evidence Gap Map Report 4). London, UK: International Initiative for Impact Evaluation (3ie). Retrieved from *http://www.3ieimpact.org/media/filer_public/2017/01/06/egm-4-forest-conservation.pdf*

Memo 5

GCF FP017: Climate Action and Solar Energy Development Programme in the Tarapacá Region in Chile

Programme objective:

The "Climate Action and Solar Energy Development Programme in the Tarapacá Region in Chile" aims to mitigate CO2 emissions while accelerating the transition of Chile to renewable energy through investment in a large solar park in the sunniest region of South America.

Background context:

Chile relies mostly on imported fossil fuels and hydropower for energy. Much of its energy use comes from copper mining, on which its economy is heavily reliant. However, due to the variability and environmental issues resulting from hydropower, and the GHG emissions that result from burning fossil fuels, Chile has set the target of increasing the use of renewable energies from 11.4 per cent to 20 per cent of its energy mix by 2025.

The Atacama Solar Project is "shovel ready" and expandable, with large potential for emissions reductions. While the private sector leads it, domestic commercial banks will likely not fund this project and others like it because unfavourable market conditions restrict them. Thus, this project would likely not move forward without funding from the GCF and CAF (Development Bank of Latin America), the accredited entity. The GCF will provide USD 49 million in loans as a co-finance contribution to the overall project cost of USD 255 million. The GCF contribution will serve as countercyclical and patient capital, permitting the ability to take a risk in the electricity spot market.

Interventions:

The Atacama Solar Project aims to build out 250 MW of solar power in two phases. The first phase, the focus of this project, will develop 143 MW of power.

The interventions are as follows:

- Component 1 – Solar Park: Develop, construct, commission and operate a large-scale solar park (143 MW)
- Component 2 – BOOT Transmission Line: Connect the solar park to the Lagunas Substation (part of the electrical interconnection system) via a Build-Own-Operate & Transfer (BOOT) model transmission line
- Additionally, a Stakeholder Engagement Plan will provide engagement, gender mainstreaming, grievance mechanisms and corporate social responsibility proposals

Theories of change:

The theory of change for this project is as follows:

- Funds, materials, and staff → solar park is built AND transmission line is built → 143 MW of solar power is generated AND that power is transmitted to the Lagunas Substation → the energy distributed replaces a proportionate amount of fossil fuel energy → an additional 193,949 tons/year of carbon are prevented from entering the atmosphere (3,697,440 tons of C02e over 20-year lifespan) AND Chile increases the proportion of its energy that comes from renewables by displacing more polluting power plants AND the market is made more favourable for the addition of new solar energy projects
- This theory of change is not clearly explicated in the project proposal, but it is straightforward compared to the theories of change in other GCF projects, especially those that focus on adaptation.

Concerns:

Additionality and replacement: If we are aiming to reduce carbon emissions from the project, we are assuming that these reductions will be additional to any other emissions that would have occurred. However, the additionality requirement assumes that overall energy use will reduce or hold constant, and thus that the solar energy produced in this

project will replace fossil fuel use rather than support increased use of energy. We cannot take for granted that the energy market will stay constant in the period in which the project is implemented.

The potential for causal inference:

- The crucial link we want to assess in the theory of change is whether the solar energy produced successfully replaces a proportionate amount of fossil fuels.
- A secondary point of enquiry is whether the programme improves market conditions for renewable energy.
- Neither of these questions would be well suited to a randomized impact evaluation because they are not at the right levels of analysis for randomization.
- Replacement/Additionality question: We can use a time-series/panel data analysis to measure the proportion of solar versus fossil fuel-derived energy usage over time from the Lagunas Substation, before and after the opening of the solar park.
- A tool to gain a cursory understanding of the market's operating conditions before and after the project is implemented to conduct a network analysis of the multiple stakeholders involved in shaping the markets. Identifying key stakeholders could inform strategy for the remaining barriers to market transformation, and the programme can be adapted where possible to address those barriers.

Evidence base/Similar programmes:

- Market question: Wörlen (2011) outlines the challenge of measuring causal attribution in climate mitigation programmes that aim to change market conditions or improve institutional buy-in to renewable energy and other mitigation programmes. Tokle and Uitto (2009) define the results of a market transformation as adhering to the following criteria:
  - "Enabling policies, strategies, standards and certification in place
  - Adequate financing available
  - Adequate business infrastructure
  - Awareness created
  - Innovation and technology diffused"
- Acknowledging that it is hard to create generalizable indicators from this positive framework, Wörlen (2011) recommends a "Theory of No Change" (TONC), which measures the absence, rather than the presence, of criteria similar to these, in order to measure whether an intervention is likely to cause transformation in a market environment. Wörlen identifies the following barriers to transformational change:
  - Ignorance
  - Lack of expertise
  - Lack of access to technology
  - Lack of cost-effectiveness
  - Lack of motivation
  - Lack of business model
  - Lack of affordability
- Miyaguchi (2017) used the TONC framework laid out by Wörlen (2011) to assess the barriers faced by several Global Environment Facility (GEF) mitigation projects in changing market environments. The author found that GEF projects addressed barriers surrounding ignorance, expertise, technology access, affordability and business model existence, but were less successful in addressing barriers surrounding interest/motivation and cost-effectiveness.
- While the TONC holds promise in terms of understanding transformational change at the market level, its lack of rigorous attribution limits its efficacy at understanding the effectiveness of the present programme.

Notes on complexity:

- At the programme intervention level, this project is low in complexity. The two central interventions use existing and tested technology and do not

require behavioural change on the part of energy users. Presuming the intervention is successfully carried out, we can assume it will generate renewable energy linear to the number of solar panels installed.

- However, at the market level, the project exists within a complex adaptive system. If the project is to succeed in transforming market conditions in favour of renewable energy in Chile, it will need to probe the change in multiple domains (finance, supply chain, technology, energy policy, regulation) via multiple stakeholders (investors, businesspeople, policymakers, workers).
- Number of interventions: Two
- Number of stakeholders: Three
- Sectors: Energy
- Theories of change: Strong
  - Coherence: Strong
  - Ability to be evaluated: Weak
  - Foundations in rigorous evidence: Fair

Sources:

GCF FP017 Project Proposal: *https://www.greenclimate.fund/documents/20182/574760/Funding_proposal_-_FP017_-_CAF_-_Chile.pdf/58cc53a6-c82e-4d75-b307-5dc753809382*

Miyaguchi, T., (2017). Evaluating mitigation projects through a theory of no change. In R. D. van den Berg, I. Naidoo, & S. D. Tamondong (Eds.). *Evaluation for Agenda 2030: Providing evidence on progress and sustainability* (pp. 335–346). Exeter, UK: IDEAS. Retrieved from *http://web.undp.org/evaluation/documents/Books/Evaluation_for_Agenda_2030.pdf*

Tokle, S., & Uitto, J. (2009). Overview of climate change mitigation evaluations: What do we know? In R. D. van den Berg & O. Feinstein (eds.), *Evaluating climate change and development* (pp.141–150). New York, NY: Transaction Publishers.

Wörlen, C. (2011*). Meta-evaluation of climate mitigation evaluations.* Berlin, Germany: Arepo Consult. Retrieved from *http://www.arepoconsult.com/fileadmin/user_upload/pdf/MetaEvaluation_Woerlen.pdf*

Memo 6

GCF FP018: Scaling-up of Glacial Lake Outburst Flood (GLOF) risk reduction in Northern Pakistan

Programme objective:

The project "Scaling-up of Glacial Lake Outburst Flood (GLOF) risk reduction in Northern Pakistan" aims to protect communities vulnerable to flooding from post-melt glacier lakes by empowering them to manage glacial flood risk while establishing climate-resilient livelihoods. This project is an extension and scale-up of existing development and climate programmes in the region run by UNDP, GEF and KfW.

Background:

As glaciers in Northern Pakistan melt increasingly quickly due to the effects of climate change, communities face the loss of and damage to life, assets and livelihood through sudden and voluminous flooding. In 2015, for example, the Chitral district faced estimated costs of USD 100 million after a GLOF. Floods in 2010 caused almost 2,000 deaths and destroyed 1.6 million homes. This risk is compounded by the fact that glaciers in Pakistan are melting faster than those in most parts of the world, as Pakistan is set to have higher surface temperature increases than the global average.

Pre-existing programmes in the region:

- UNDP: Reducing Risks from GLOFs – Flood diversion infrastructure and weather measurement technology for early warning systems
- KfW: Water and Sanitation Extension Programme – Access to potable water and sanitation facilities
- UNDP/GEF: Mountain and Markets – Bio-businesses for livelihoods and ecosystem services
- UNDP/GEF: Sustainable Land Management – Enabling environment for Sustainable Land Management
- Government of Pakistan climate planning processes, including the UNDP/DFID programme to strengthen the use of climate planning in the national budget

Interventions:

Strengthen planning for climate-resilient development

- Component 1 – Climate Mainstreaming:
  - Build technical knowledge to mainstream climate development plans into provincial and territorial government planning
  - Coordinate between subnational institutions for climate mainstreaming

Scale up early warning systems and risk reduction mechanisms

- Component 2 – Early Warning Systems:
  - Install 50 automatic weather stations and 408 river discharge sensors
  - Create hydrological modelling for GLOF hazard scenarios
    + Expand early warning alerts systems that have been tried in other districts
- Component 3 – Adaptation infrastructure:
  - Build 250 small adaptation structures (gabion walls, dams, etc.)
- Component 4 – Reforestation:
  - Reforestation and vegetation of slope sides to decrease the likelihood of a landslide
- Component 5 – CBDRM fund:
  - Expand a revolving fund for post-emergency recovery by providing a funding endowment to CBDRM Committees
  - Train stakeholders to improve delivery of different programmes and CBDRM funds
- Component 6 – Irrigation:
  - Install 240 water-efficient agricultural irrigation systems to reduce agricultural vulnerability

Theories of change:

Strengthen planning for climate-resilient development

- Funds and personnel to support climate change mainstreaming → develop integrated Climate Change Action plans in key government sectors in regions of interest AND integrate glacial flood risks into existing provincial climate change policies AND build capacity of government departments to mainstream climate change risks in development plans → climate change mainstreaming is effectively achieved across all relevant government sectors → government sectors are better equipped to prepare for and respond to risks from glacial floods → over the long term, reduced loss of life and livelihood and property damage due to GLOFs than would otherwise occur

Scale up early warning systems and risk reduction mechanisms

- Early warning
  - Funds and personnel for early warning system (EWS) equipment and planning → 50 automatic weather stations and 408 river discharge sensors installed AND hydrological modelling created for GLOF hazard scenarios → system operators can more quickly and accurately predict the onset of a GLOF → system operators have better inputs to communicate flood risks to community members
  - Early warning alerts systems from other districts expanded → community members are more quickly and accurately alerted of flood risk → community members take the recommended actions once they become aware of flood risks → reduced loss of life and livelihood and property damage in each specific flood event
- Adaptation
  - Funds and personnel for infrastructure construction → 250 small adaptation structures (gabion walls, dams, etc.) constructed → floodwaters are diverted from communities at risk → reduced loss of life and livelihood and property damage in each specific flood event
    + Assumption: These constructions do not increase the risk of large, infrequent flood or other detrimental secondary effects by disturbing geomorphological and ecosystem processes
  - Funds and personnel for reforestation supplies → slope sides are effectively reforested → strengthened slope sides reduce the risk of landslide → reduced loss of life and livelihood and property damage due to a landslide
    + Assumption: Reforestation does not alter the ecosystem such that it operates in a way that is no longer predictable compared to its current state
- Resilience
  - Funds and personnel for fund management and training → funding is increased to CBDRM post-emergency recovery fund AND stakeholders are trained to improve the delivery of risk reduction programmes and CBDRM funds → community more effectively handles disaster preparedness AND community more effectively handles post-disaster recovery → reduced loss of life and livelihood and property damage from flood events
  - 240 water-efficient agricultural irrigation systems are installed in communities → communities use these new irrigation systems and the systems work → farmers have a more steady water source for their crops → crops have larger and more consistent yields → farmers are less vulnerable

to losing livelihoods in the event of uncertain precipitation and glacial melt patterns and in the case of flooding

Concerns:

- Midterm evaluation of the UNDP GLOF programme finds it is successful in reducing risk from GLOFs through infrastructure investments and weather stations. However, the design of the midterm evaluation is unclear in the project proposal (which, online, does not include the appendices). That said, the positive finding is at least a good indicator for whether this programme should be scaled up. Researchers have conducted studies on this project from multiple angles (ecosystem, socioeconomic and infrastructure design studies).
- Other programmes and additionality: If these many programmes exist already and communities still face losses and damage, how will we ensure that this project brings in additional benefit on top of existing programmes?
- The number of sub-interventions grouped under the two main outcomes (EWS and climate-smart planning) may make it hard to measure the impact of any one specific aspect of a sub-intervention. Specifically, we have broken down the "early warning and risk reduction" interventions into three intervention categories (early warning, adaptation and resilience). However, these categories overlap and thus may be hard to delineate clearly in an evaluation.
- It may be challenging to measure these programmes on the appropriate timescales due to the unpredictability of flood frequency and magnitude.
- It is unclear how the programme will go about carrying out the interventions under the climate-smart development and planning outcome. How, specifically, will the programme work to "build capacity" of departments and "raise awareness" to coordinate climate change initiatives?

The potential for causal inference:

- A randomized impact evaluation of this programme could measure outcomes for programmes in EWS, CBDRM training and funds, and water-efficient agricultural irrigation systems. Other interventions, such as planning, reforestation and infrastructure construction, can be monitored for effectiveness and measured with time-series data. Note that the project proposal names UNDP (the accredited entity) as the entity that will conduct monitoring and evaluation for the interventions.
- Early warning
  - The river sensors and the weather stations would likely not need to be implemented in a randomized manner; the assumption is that these technologies are effective at improving data collection and modelling surrounding flood risk.
  - The roll-out of EWS flood alert programmes from other communities could be effectively randomized, however. The necessity for testing these programmes would depend upon whether they have been evaluated in their original communities. If the programmes have not been evaluated, this programme could be randomized at the community level and be measured between communities to understand whether and how much it improves disaster response outcomes. Assuming a large enough sample size, this intervention could also test different warning system designs against a control group that does not receive any EWS intervention at first.
  - All that said, it may be difficult to tease out the effect of the EWS from that of the interventions that focus on strengthening adaptation and

resilience.

- Adaptation
  - It would likely not be feasible to randomize the roll-out of adaptation infrastructure (dams, walls, etc.) due to the unique needs of each community regarding the landscape in which they are situated. However, evaluators could collect information on damages from flooding post-installation of infrastructure and conduct time-series analyses.
  - Similarly, reforestation efforts can be monitored and managed through adaptive management to promote soil stability, but due to the unpredictable nature of landslides, randomized inference would not make sense for this intervention.
- Resilience
  - The CBDRM training programme can be randomized at the community level to measure its effectiveness. However, some previous impact evaluations do support the effectiveness of these programmes.
  - The CBDRM resilience fund can be randomized at the individual recipient level, presuming there is some ability to hold the other intervention variables constant (thus, the fund interventions should be distributed evenly among communities throughout the various iterations of the other randomized interventions). Among all qualified applicants to the fund, the committee could select grant recipients by lottery, and compare the post-disaster recovery of grant recipients with those who qualified for the grants but did not receive them. This is presuming there would not be enough resources to provide grants to each person who applied.
  - The water-efficient agriculture programme could be randomly assigned at the farm level and tested for outcomes relating both to agricultural yield and socioeconomic outcomes for farmers.

Evidence base/Similar programmes:

- Several existing development and climate programmes in the region have undergone or are undergoing evaluations by the implementing entities. It is unclear as to whether these evaluations use rigorous tools for causal inference. In any case, there is reason to believe that baseline data exist for various outcomes of interest, which would be useful for future evaluations.
- There is an abundance of research on CBDRM programmes, but most of it is not randomized. Oxfam (2012) conducted a quasi-experimental evaluation of Oxfam's CBDRM and Livelihoods programme in Pakistan, which works to reduce damage to life and livelihoods from flooding. Researchers found evidence supporting a strong positive impact of the programme on reducing damage and loss of life and livelihood in the event of a flood. Zwi et al. (2013) created a protocol for a systematic review of the effectiveness of CBDRM programmes, but it appears that the review has not yet been conducted and there is a still a lack of systematic understanding of the effectiveness of CBDRM programmes.
- There is also an abundance of literature on the effects of agricultural technology (including irrigation) on farmer outcomes such as income, nutrition and crop yields. Generally, agricultural technology helps improve yields and thus incomes. However, Rosenstock et al. (2016) point out that there has been no systematic approach to analyzing evidence on the effectiveness of interventions for climate-smart agriculture and, as such, they have defined a protocol for that systematic review to be carried out.

- Duflo and Pande (2007) found in an instrumental variables study in India that the construction of dams was beneficial for agricultural yields and rural poverty reduction in villages downstream of the dams but led to an increase in rural poverty for the communities in which the dams were directly built. This suggests that dams can be useful for increasing the stability of water sources in the face of shocks but can still have adverse effects on the communities closest to them.
- We could not find sufficient evidence on EWS to support their effectiveness, and therefore we believe there is room for randomized impact evaluations and systematic evidence aggregation to understand these programmes better.

Notes on complexity:

- It appears that this project has a moderate to high level of complexity. The several existing development projects in the region provide a tractable baseline for this project and inform best practices for programme design. However, the various sub-interventions span multiple sectors (agriculture, public administration, infrastructure, climate science/EWS) and involve multiple stakeholder groups (community members, farmers, various government jurisdictions and ministries). These multiple interacting parts may lead to unanticipated emergent properties and feedback loops.
- Number of interventions: Six
- Stakeholders: Pakistan Ministry of Climate Change, UNDP, communities, government line departments, provincial project teams
- Sectors: Infrastructure, public administration, forestry, agriculture, information and communications technology, climate science
- Theories of change: Fair
  - Coherence: Strong
  - Ability to be evaluated: Fair
  - Foundations in rigorous evidence: Fair

Sources:

GCF FP018 Project Proposal: https://www.greenclimate.fund/documents/20182/574760/Funding_proposal_-_FP018_-_UNDP_-_Pakistan.pdf/b2f56ddd-d01a-4f1a-821e-21a3705b689e

Duflo, E., & Pande, R. (2007). Dams. *Quarterly Journal of Economics, May 2007*, 601–646. Retrieved from https://scholar.harvard.edu/files/rpande/files/dams_0.pdf

Oxfam. (2012). *Effectiveness review: Community-based Disaster Risk Management and Livelihoods Programme, Pakistan. Oxford, UK: Oxfam Policy & Practice.* Retrieved from https://policy-practice.oxfam.org.uk/publications/effectiveness-review-community-based-disaster-risk-management-and-livelihoods-p-247231

Rosenstock, T., Lamanna, C., Chesterman, S., Bell, P., Arslan, A., Richards, M., Rioux, J., Akinleye, A., Champalle, C., Cheng, Z., Corner-Dolloff, C., Dohn, J., English, W., Eyrich, A., Girvetz, E., Kerr, A., Lizarazo, M., Madalinska, A., McFatridge, S., Morris, K., Namoi, N., Poultouchidou, A., Ravina da Silva, M., Rayess, S., Strom, H., Tully, K., & Zhou, W. (2016). *The scientific basis of climate-smart agriculture: A systemic review protocol* (Working Paper No. 138). Copenhagen, Denmark: CGIAR Research Programme on Climate Change, Agriculture, and Food Security. Retrieved from https://cgspace.cgiar.org/rest/bitstreams/66359/retrieve

Zwi, A., Spurway, K., Marincowitz, R., Ranmuthugala, G., Thompson, L., & Hobday, K. (2013). *Do community based disaster risk management (CBDRM) initiatives reduce the social and economic cost of disasters?* London, UK: EPPI-Centre. Retrieved from https://eppi.ioe.ac.uk/cms/Portals/0/PDF%20reviews%20and%20summaries/CDBRM%202013%20Zwi%20protocol.pdf?ver=2013-06-12-143922-063

Memo 7

GCF FP019: Priming Financial and Land-Use Planning Instruments to Reduce Emissions from Deforestation

Programme objective:

The project "Priming Financial and Land-Use Planning Instruments to Reduce Emissions from Deforestation" aims to reduce deforestation in Ecuador and its ensuing emissions by mainstreaming land-use planning, supporting the transition to sustainable production, and strengthening forest conservation and resource management policies. The project works to co-finance the Ecuadorian REDD+ Action Plan.

Background:

Ecuador has experienced high levels of deforestation in the last few decades, as it has converted large areas of forest into agricultural land. The country must now reduce deforestation drastically if it is to reduce emissions; the Ecuadorian REDD+ Action plan calls for an end to net deforestation by 2020. However, many agricultural smallholders are reluctant to change to more sustainable practices because they perceive a high risk of failure in terms of future profits.

Interventions:

- Land-use planning: Investment in enabling policies to address drivers of deforestation
  - Update 18 Land Use and Zoning Plans and five Life Plans to incorporate climate mitigation and adaptation (activities can include water supply, irrigation, production infrastructure, waste management, etc.)
  - Strengthen local capacity to supervize and implement land-use zoning plans through training
  - Strengthen forest control for traceability and enforcement of protocols, including monitoring illegal forestry, training communities to monitor forests, scientific research and so forth
  - Facilitate inter-institutional coordination around land-use zoning
- Sustainable production transition: Financial and economic incentives for the transition to sustainable production in non-forest areas
  - Technical support and direct payment grants to farmers who will transition towards sustainable production methods
  - Implement or modify existing environmental tax incentives to transition towards sustainable production
  - Capacity support to redesign public credit lines for agricultural producers to support sustainable production
  - Promote public and private procurement of deforestation-free products on the demand side by providing policy advice, communications and training materials for responsible procurement
  - Certify deforestation-free products, including coffee, cocoa and palm oil, coordinating between the Agenda for Transforming Production in the Amazon and Marca Pais systems for product certification
- Forest protection: Financial and non-financial mechanisms for restoration, conservation and connectivity
  - Expanding and supporting the Socio Bosque Programme (payments for ecosystem services and alternative livelihoods) to reach areas directly threatened by deforestation
  - Strengthen integrated water resource management, including protecting forests, in key watersheds (mitigation)
- REDD+ support: Implementation of REDD+ systems and REDD+ National Fund

  - Support implementation of the Warsaw Framework (information system) for REDD+
  - Support the operationalization of an Environmental National Fund, which will distribute funds for environmental projects such as the REDD+ Action Plan; support an inter-institutional coordination platform for land-use planning and financial and non-financial incentives

Theories of change:

This programme employs various methods to reduce deforestation in Ecuador. The theories of change are as follows:

- Land-use planning: Investment in enabling policies to address drivers of deforestation
  - Personnel to update 18 Land Use and Zoning Plans and five Life Plans → plans are updated to incorporate climate mitigation and adaptation → land-use plans are best optimized to reduce deforestation and emissions → additional emissions are reduced
  - Funds and personnel for training → train non-government stakeholders to supervize and implement land-use zoning plans → stakeholders are better equipped to supervize land use and zoning plans → additional emissions are reduced
  - Funds and personnel → traceability regulations are defined AND certification of origin protocols are developed AND Forest Administration Tools are strengthened AND species identification catalogues are developed AND monitoring system is established for illegal timber extraction → forest products are more traceable to their source → illegal deforestation is reduced AND we have a better understanding of true deforestation rates → additional emissions are reduced
  - Funds and personnel work to improve inter-institutional agreements → inter-institutional agreements are created and enhanced → institutions become more coordinated in their work on land-use zoning AND redundancy between institutions is reduced → land-use zoning is made more effective → additional emissions are reduced
- Sustainable production transition: Financial and economic incentives for the transition to sustainable production in non-forest areas
  - Funds and personnel for grants and technical support → farmers are provided technical support to learn sustainable production methods AND farmers are provided grants during the transition to these methods → farmers use the new sustainable production methods rather than those they previously used AND farmers do not lose overall income from this shift due to supplementary income from grants → farmers are able to shift towards sustainable production without a loss of net income → additional emissions are reduced
  - Personnel and funds → environmental tax incentives are created or modified to prioritize sustainable production → farmers are more likely to transition towards sustainable production due to tax incentives → there is a broad shift from unsustainable towards sustainable production → additional emissions are reduced
  - Personnel and funds for training → training and building capacity with financial institutions → financial institutions adjust financial products to include sustainable production → farmers are more likely to transition towards sustainable production due to favourable loan incentives → there is a broad shift from unsustainable

towards sustainable production → additional emissions are reduced

  - Funds and personnel → staff give policy advice on deforestation-free procurement AND create materials for communications and training for responsible procurement → public and private organizations understand how and are incentivized to purchase deforestation-free products → there is a broad shift from unsustainable towards sustainable production AND deforestation is reduced → additional emissions are reduced
  - Funds and personnel → certification created for deforestation-free products including coffee, cocoa and palm oil (in coordination between other product certification systems) → certified products made available to consumers AND increase in export of certified products → market demand for deforestation-free products increases → market demand for unsustainable products decreases → deforestation is reduced → additional emissions are reduced

- Forest protection: Financial and non-financial mechanisms for restoration, conservation and connectivity
  - Funds to expand the Socio Bosque Programme (payments for ecosystem services and alternative livelihoods) → payment for environmental services (PES) and livelihoods programme is expanded to areas directly threatened by deforestation → areas under the programme are less susceptible to deforestation → deforestation is reduced → additional emissions are reduced
  - Funds and personnel → capacity support for three existing integrated water resource management funds → funds increase the number of projects in REDD+ areas → forests conservation and restoration are prioritized → reduced emissions from forests
- REDD+ support: Implementation of REDD+ systems and REDD+ National Fund
  - Funds and personnel → establish an integrated information system for REDD+ → coordination on the management REDD+ improves → better reporting to the UNFCCC
  - Funds and personnel → Support the operationalization of an Environmental National Fund AND support an inter-institutional coordination platform for land-use planning and financial and non-financial incentives → fund will distribute funds for environmental projects such as the REDD+ Action Plan → improve efficiency and efficacy of REDD+ planning

Concerns:

- The programme appears to rely upon fairly strong baseline information about existing programmes in the region and potential barriers to success. There have been multiple scoping studies preceding this project's proposal. Data likely exist about the multiple programmes that this programme will support to expand: Socio Bosque, certification schemes, REDD+ initiatives and the water funds, for example.
- Some interventions, such as that involving the measures for traceability, have many sub-facets that could be better explained. It is hard to measure what we do not understand in detail.
- For intervention 2 (grants to farmers), the project proposal explicitly mentions the efforts it will take to establish a baseline and continue monitoring outcomes from this programme.
- This programme builds upon concepts such as capacity-building and improved planning, which are concepts that may be

challenging to measure in practice. There appears to be little evidence as to what it means to build effective capacity, especially given the heterogeneity of skills needed for different types of programmes.

- A few of these interventions focus on scaling up existing projects. However, it is not made clear as to whether these programmes have been deemed effective in their pilot phases. Also, it may be more difficult to design randomized evaluations into programmes that are already well established.
- For macroeconomic interventions such as taxation, regulation and product certification, measuring change at the individual behavioural level is challenging. Rather, we will have to rely on larger economic trends to discern the effects of these interventions.
- The interventions relating to the sustainable production transition appear to have some elements of transformational change. By targeting multiple points in the supply chain, programme implementers aim to alter the behaviour of consumers to ultimately favour the purchase of more sustainable products, a change that (if it occurs) can be seen as self-sustaining. However, this raises new challenges as to how this component's interventions can be evaluated.

The potential for causal inference:

- The programmes that would be most easy to randomize include the application of land-use plans, farmer's training and grants for the sustainable production transition, and the expansion of the Socio Bosque PES programme into critical conservation zones.
  - Land-use plan upgrades can be applied in two stages, with half of them implemented in the first two years and the other half implemented in the second half of the programme. However, due to a small sample size and a fairly large unit of randomization (land-use plan region), this randomization may not lead to a strong causal inference. An alternative could be to measure areas to which land-use plans will be applied against similar areas without them. These plans can be measured with spatial analysis.
  - The farmers' training and grants for sustainable production programme can be randomized. Training would likely need to be randomized at the community level for practical reasons, whereas grants could be randomized at the individual level. However, there may be issues with ethics and attrition in the case where a farmer is persuaded to transition to sustainable production without receiving a grant to bridge the gap in income predicted in the transition process.
  - The expansion of the Socio Bosque PES programme to key conservation areas can be randomized at the land plot level, presuming the sample size is large enough.
- The interventions regarding taxation, financial tools and product certification are not well suited to randomized evaluation; rather, they can potentially be measured using time series or other more macroeconomic tools, because their success will occur at the market level.
- For the interventions relating to REDD+ programming, the water funds, the environmental fund, forest product traceability and inter-institutional agreements, process evaluations and/or results-based management may be beneficial to understand whether they are meeting intended targets. However, establishing a counterfactual to measure the actual impact of these programmes is more difficult.

Evidence base/Similar programmes:

- In an evidence gap map report, Puri, Nath, Bhatia and Glew (2016) examine the evidence base for various forest conservation interventions. They note that very little rigorous evidence exists on the ecological and social effectiveness of conservation programmes. Among the existing evidence, much of it focuses on forest conservation and poverty outcomes and neglects other outcomes like biodiversity and behavioural change. It focuses mainly on PES, decentralized community management and protected areas, while neglecting international policy programmes such as REDD+. The authors suggest that quasi-experimental methods can be employed to establish causal relationships where experimental methods are impractical.
  - The authors also call for more attempts to evaluate the effects of strategic forest interventions such as certification schemes and national forest policies.
- In a systematic review of quantitative and qualitative PES research, Samii, Lisiecki, Kulkarni, Paler and Chavis (2015) found a paucity of studies measuring the causal effects of PES on conservation and/or human welfare outcomes; the studies they did find tended to be methodologically weak; and those studies found modest effects on forest conservation outcomes. None of the studies used a randomized experimental design, and none of them measured both forest conservation and human welfare outcomes jointly.
  - Thus, Samii et al. call for more and better empirical evidence (randomized, where possible) on the effects of PES programmes on forest conservation and human welfare outcomes. A few other studies on PES impacts have been conducted since the systematic review.
- In a gap map report on land-use change and forestry interventions, Snilstveit et al. (2016) note a strong evidence gap in studies that measure both environmental and social impacts and their trade-offs (such as in GHG emissions reductions versus food security). They find that most studies do not measure direct GHG emissions from forestry interventions; rather, they measure forest cover change. Many of these studies are quasi-experimental rather than experimental, and those that are experimental are largely in agriculture rather than forestry. The authors recommend broadening the evidence base of randomized or quasi-randomized forestry and land-use change interventions used in tandem with qualitative methods, including process evaluations.

Notes on complexity:

- While some mitigation programmes exhibit less complexity than adaptation programmes, this one appears to be highly complex due to the number of interventions it employs and its focus on various interventions for policy and regulation that operate on a macroeconomic scale. It is challenging to measure the outcomes of policy, regulation and taxation with the tools traditionally used in evaluation, as they operate more on a systems level than on an individual stakeholder or institutional level.
- Number of interventions: Nine
- Stakeholder groups: Government ministries, three water funds, UNDP, communities, local governments, line ministries, Indigenous groups
- Sectors: Forestry, agriculture, public administration, bio-business, regulation and taxation
- Theories of change: Fair
  - Coherence: Strong
  - Ability to be evaluated: Weak

- Foundations in rigorous evidence: Fair

Sources:

GCF FP019 Project Proposal: *https://www.greenclimate.fund/documents/20182/574760/Funding_proposal_-_FP019_-_UNDP_-_Ecuador.pdf/e586b720-abc1-41e2-ac9d-dc6047ce77c7*

Puri, J., Nath, M., Bhatia, R., & Glew, L. (2016). *Examining the evidence base for forest conservation interventions* (3ie Evidence Gap Map Report 4). London, UK: International Initiative for Impact Evaluation (3ie). Retrieved from *http://www.3ieimpact.org/media/filer_public/2017/01/06/egm-4-forest-conservation.pdf*

Samii, C., Lisiecki, M., Kulkarni, P., Paler, L., & Chavis, L. (2015). *Effects of payment for environmental services (PES) on deforestation and poverty in low- and middle-income countries: A systematic review* (3ie Grantee Final Review). London, UK: International Initiative for Impact Evaluation (3ie). Retrieved from *http://www.3ieimpact.org/media/filer_public/2015/10/05/pes_on_deforestation_samii.pdf*

Snilstveit, B., Stevenson, J., Fenton Villar, P., Eyers, J., Harvey, C., Panfil, S., Puri, J., & McKinnon, M. (2016). *Land-use change and forestry programmes: Evidence on the effects of greenhouse gas emissions and food security* (3ie Evidence Gap Map Report 3). London, UK: International Initiative for Impact Evaluation (3ie). Retrieved from *http://www.3ieimpact.org/media/filer_public/2016/11/17/egm3-landuse-forest.pdf*

Memo 8

GCF FP026: Sustainable Landscapes in Eastern Madagascar

Programme objective:

The project "Sustainable Landscapes in Eastern Madagascar" aims to "implement sustainable landscape measures to enhance the resiliency of smallholders, reduce GHG emissions, and channel private finance into climate-smart investments in agriculture and renewable energy that transform livelihoods". The project contains both private- and public-sector interventions and aims to effect both climate mitigation and adaptation.

Background context:

Madagascar is one of the most climate-vulnerable regions in the world. It is home to "vast numbers of extremely vulnerable smallholders" and faces threats to biodiversity and challenges to GHG emissions reductions due to deforestation. At the same time, access to credit is limited in Madagascar, and there is no financing available for climate-related activities at scale. Foreign Direct Investment has also sharply decreased due to the political crisis in Madagascar from 2009 to 2013, and Madagascar scores poorly in the 2015 *Doing Business* classification. According to Conservation International, the project will take place in "the Ambositra – Vondrozo Forest Corridor (COFAV) and the Ankeniheny – Zahamena Corridor (CAZ) [...] two protected areas with the status of 'Protected Harmonious Landscape' and 'Natural Resources Reserve' respectively".

Interventions:

- Public sector: Working directly with farmers in the region's landscapes to develop resilient farming communities
  - Sustainable agriculture programme: "Identify climate-smart landscape measures that can improve the resilience of agricultural systems and the livelihoods of small farmers" and support the management of these activities
  - Forest management to reduce deforestation: Collaborate with community groups to implement "effective forest management"; update key planning documents to align with the Verified Carbon Standard
  - Climate risk awareness and adaptation measures: Training for professionals, curricula for schools and materials for community groups
  - Institutional capacity-building, including the capacity for financing future climate interventions (training modules, commune development plans): "developing climate-smart landscape modules, to be applied to training and policy development and to be shared during local and national workshops"; update commune (municipal) development plans to include climate change considerations
  - Creation of Climate Change Trust Fund to finance future adaptation and mitigation activities (after GCF funding ends, and using returns from the investment fund)
- Private sector: Establishment of the Climate Investment Fund
  - Profit Participation Loans to deploy financial support to communities, farmer organizations, and sustainable companies for the following activities:
  - Sustainable agriculture investments
  - Investments in low-emission energy generation and distribution: Priority to renewable energy, biomass and fuel efficiency projects
- Establishment of a green/climate bond: Madagascar will partner with the European Investment Bank to develop a green/climate bond that will channel a part of its issuance into this programme, and another part into other energy investments in European markets.

Theories of change:

- Strengthened adaptive capacity and reduced exposure to climate risks
  - Funds and training → sustainable agriculture programme established → farmers' yields face less risk due to extreme weather AND smallholders become more food secure
  - Climate Investment Fund established → fund invests in sustainable agriculture initiatives → farmers involved in those initiatives face less risk due to extreme weather AND the Fund makes returns it can reinvest into the Climate Change Trust Fund
- Strengthened awareness of climate threats and risk reduction processes
  - Training for professionals, community groups and school students on the threats of climate change and how to reduce risk → professionals, community groups and school students are more aware of the risks of climate change AND know what to do to reduce those risks → professionals, community groups and school students act on their knowledge surrounding these risks to reduce their actual risk to climate impacts
- Strengthened institutional and regulatory systems for climate-responsive planning and development
  - Climate-smart landscape modules created and presented at workshops and training → policymakers become more aware of techniques for climate-responsive planning → policymakers become more likely to use climate-responsive planning in their policy decisions
  - Climate-smart commune (municipal) development plans are updated to integrate climate change issues → municipalities integrate climate considerations into their decision-making → municipalities become more resilient to the impacts of climate change
- Increased number of low-emission power suppliers
  - The Climate Investment Fund is established → CIF invests in low-emission energy generation and distribution projects → increased access to energy for citizens AND reduced reliance on diesel power plants → reduced emissions from diesel plants AND reduced health impacts from diesel pollution AND improved quality of life through access to energy
- Improved management of land and forest or improved management contributing to emissions reduction
  - Collaboration with community groups to establish forest management techniques → community groups manage the forest in the area → forest is less susceptible to deforestation and degradation → less carbon is emitted from deforestation
  - Planning documents updated to align with the Verified Carbon Standard → land-use and forest programme coordinators change the programmes to better align with the Verified Carbon Standard → outcomes can be updated as to how much carbon the programmes sequester

Concerns:

- A major concern with this programme concerning its evaluability is a lack of specificity around the details of some programme elements. For example, the programme proposal elaborates very little on the specific activities under the Sustainable Agriculture Programme, a central intervention in the public-sector aspect of the project. The entities should consult the literature on similar programmes to understand which kinds of agriculture interventions could prove

most beneficial in terms of increasing climate resilience and then focus on those.

- The following indicators, from the outcomes framework, comprise the most elaborate description of the Sustainable Agriculture Programme in the project proposal: "Agricultural support programme: agriculture / livestock / fisheries: soil conservation practices, integrated management of water for irrigation, drinking water, agroforestry, cash crop: ginger, cloves, vanilla, coffee, improving animal production, beekeeping, ecotourism community, small-scale irrigation infrastructure by using local materials, integrated pest management, seed selection, establishment of savings groups." It does not tease out which of these specific interventions is intended to have what impacts.
- The project provides some baselines for its indicators, including rates of food insecurity, hectares of land already protected and a number of households that lose crops after climate shocks. These provide a good starting point for evaluation. However, the entities could work to aggregate more and more systematized baseline data.
- Spillover effects from one intervention are a major concern in the evaluation of the different programme components, as they will be operating simultaneously.
- The designers should also consider whether all interventions are necessary if one or two are found to be more effective than others in reducing climate risk. A factorial design can help discern the additive effects of the interventions, provided there is a sufficient sample size.

The potential for causal inference:

- The Sustainable Agriculture Programme seems to be the most promising intervention to be subject to a randomized evaluation. However, it is unclear from the project proposal how many farmers will be involved in the programme or their geographic distribution, so it is challenging to define whether randomization will be at the individual, household or community level. If the sample is large enough, a factorial design can assign different formulations of the programme to understand the effects of designing the programme in one way versus another.
- For those interventions surrounding capacity-building and climate-smart planning, process evaluations, qualitative methods or results-based management might be effective for understanding programme impacts.
- For the activities of the climate investment fund, time series can monitor the flows of capital and returns on investment.
- As the programme's causal links are not entirely clear and separate from one another, emergent causal models may help define the programme's theories of change.
- The forestry management programme can be assessed using spatial analysis of forest cover and so forth.

Evidence base/Similar programmes:

- A systematic review by Stewart et al. (2015) found that there is a lack of rigorous (randomized) evidence surrounding these types of interventions in the African smallholder context.
  - They did find, however, "some promise that agricultural input innovations, in particular, orange-fleshed sweet potato (OFSP), might have positive effects on smallholders' levels of food security".
  - They also found "some positive indications that training interventions might have beneficial effects on farming households' income".
  - The review's findings suggest that it

would be beneficial to conduct a randomized impact evaluation on the Sustainable Agriculture aspect of the programme.

- A systematic review by Samii, Lisiecki, Kulkarni, Paler and Chavis, (2015) found that there is not a rigorous evidence base surrounding the effects of Decentralized/Community Forest Management (CFM) on deforestation and poverty.
  - They found a mixed range of positive effects of CFM on forest cover.
  - They also found a range of positive effects of CFM on human welfare outcomes, with some evidence suggesting negative secondary effects for neighbouring communities. Overall, they concluded that this evidence was not strong enough for conclusions to be drawn.
  - This suggests that there is also more room for randomized evaluations to be conducted to measure the effects of the forest management interventions on deforestation, GHG emissions and livelihoods. However, it is unclear from the project proposal what sample sizes would be available in terms of community members involved in the programme.
- Bizikova, Waldick and Larkin (2017) outline more specific indicators that can be used in agricultural programmes to measure resilience. The examples fit under the themes of climate change, population, farmers/farmland production, market/economy, rural infrastructure and natural environment.
- Vollenweider (2015) created a set of indices that can be used to measure climate vulnerability and resilience, as follows:
  - "The *weather vulnerability index* is a measure of the expected poverty gap caused by an adverse weather shock and is designed to summarize weather sensitivity.
  - The *climate vulnerability index* is the average weather-induced poverty gap, given the expected distribution of all-weather shocks of different magnitudes over time.
  - The *weather resilience index* is the expected speed of recovery after a given weather shock.
  - The *climate-resilience index* is the average recovery time, given the expected distribution of weather shocks of different magnitudes."
- Vollenweider's (2015) indices suggest that income levels and household consumption should be considered in measures of resilience and vulnerability.

Notes on complexity:

- This programme appears to rank high in complexity. The project has eight interventions, spanning across forestry, agriculture, climate risk awareness, capacity-building, energy generation and investment, which could reinforce or detract from each other, or produce some other unintended secondary effects.
- Moreover, the measurement of climate resilience is not spatially or temporally simple. We do not have a clear indication of what weather impacts will look like in the future, and that will affect our ability to measure resilience within a reasonable time frame.
- It is unclear in the proposal whether the beneficiaries of the multiple interventions will be the same people. If this is the case, programme designers should be intentional with their assignment of different interventions to target groups for evaluation, to avoid confounding variables.
- Interventions: Six
- Stakeholder groups: Office of the Vice President, Tanzanian federal ministries, regional administration and local government, communities

- Sectors: Public health, agriculture, and water management
- Theories of change: Weak
  - Coherence: Weak
  - Ability to be evaluated: Fair
  - Foundations in rigorous evidence: Weak

Sources:

GCF FP026 Project Proposal: https://www.greenclimate.fund/documents/20182/574760/Funding_proposal_-_FP026_-_CI_and_EIB_-_Madagascar.pdf/2eaed41d-5142-4f2b-bfde-e8e663087658

Bizikova, L., Waldick, R., & Larkin, P. (2017). *Can we measure resilience? Reducing agriculture's vulnerability to climate change (*IISD Briefing Note). Winnipeg, Canada: International Institute for Sustainable Development. Retrieved from https://www.iisd.org/sites/default/files/publications/reducing-agriculture-vulnerability-climate-change.pdf

Samii, C., Lisiecki, M., Kulkarni, P., Paler, L., & Chavis, L. (2015). *Decentralised forest management for reducing deforestation and poverty in low- and middle-income countries* (3ie Systemic Review 16). London, UK: International Initiative for Impact Evaluation (3ie). Retrieved from http://www.3ieimpact.org/media/filer_public/2016/07/12/sr16-decentralisation-review.pdf

Stewart, R., Langer, L., Rebelo Da Silva, N., Muchiri, E., Zaranyika, H., Erasmus, Y., Randall, N., Rafferty, S., Korth, M. et al. (2015). *The effects of training, innovation and new technology on African smallholder farmers' wealth and food security* (3ie Systematic Review 19). London, UK: International Initiative for Impact Evaluation (3ie). Retrieved from http://www.3ieimpact.org/media/filer_public/2016/07/12/sr19-africa-smallholder-farming-review.pdf

Vollenweider, X. (2015). *Measuring climate resilience and vulnerability: A case study from Ethiopia: Final report*. Washington, D.C., USA: USAID. Retrieved from http://pdf.usaid.gov/pdf_docs/PA00M8KW.pdf

Memo 9

GCF FP035: Climate Information Services for Resilient Development in Vanuatu

Programme objective:

The project "Climate Information Services for Resilient Development in Vanuatu" aims to "standardise the use of science-based climate information" by expanding the use of Climate Information Services in tourism, agriculture, infrastructure, water management and fisheries. "Specific project goals include building technical capacity to harness and manage climate data, developing practical CIS tools, fostering their use and disseminating tailored climate information."

Background context:

Vanuatu is a small island developing state in the South Pacific that is particularly vulnerable to climate impacts by way of cyclones, sea level rise, drought and ocean acidification. The population of 270,000 is mainly supported by agriculture, with fishing, offshore financial services and tourism also contributing to the economy. Most residents do not have reliable access to potable water. Vanuatu is developing "climate-smart" policy frameworks to address climate impacts today and prepare for them in the future. It also has some existing climate information systems (CIS) infrastructure for meteorological and climatological observation.

Interventions:

USD 26.6 million; USD 23 million of which is a GCF grant

- Component 1: Capacity development – USD 3.37 million
  - Policy:
- Review existing Vanuatu Government policy and planning and identify where CIS can best be integrated
  - Training:
    + Deliver training and support for the application of CIS (workshops, handbooks)
    + Establish graduate/post-grad mentoring for climate science through scholarships
    + Training for Doppler radar operators
    + Establish a Vanuatu network of community-based CIS "champions" to oversee the use of CIS in vulnerable communities
  - Pilot:
    + Apply CIS to a case study in each of the sectors of interest
  - Support:
    + Provide CIS remote "help desk" for the government
- Component 2: User interface platform (focus on the **development** of CIS) – USD 1.01 million
  - Communication tools:
    + Develop and deliver new CIS communication products in each sector (updates, videos, factsheets, games, media)
    + Adapt existing and create new CIS decision-support system (DSS) processes and tools
- Component 3: Climate Information Services system (focus on the **delivery** of CIS) – USD 2.93 million
  - IT platforms:
    + Deliver all online CIS outputs including customized access to DSS processes (upgraded IT platform)
    + Develop a Vanuatu Climate Futures web portal
    + Develop and implement IT and communications platforms for sector-based multi-hazard "impact" climate early warning systems (CLEWS) (website, app, social media pages, cell phone, media)
    + Develop and deliver web-based, mobile-compatible DSS for the agricultural sector
  - Data records:
    + Update Vanuatu climate data records and visualization
  - Analysis:
    + Use Pacific CIS Cost-Benefit

Framework to undertake Socioeconomic Benefit analysis for Vanuatu

- Component 4: Observation and monitoring – USD 9.87 million
  - Data collection and updating:
    - Rescue and digitize high-quality daily/sub-daily data from archived paper records for key climate parameters
    - Collect new coastal (inshore) bathymetric and topographic data for high risk (hazard/vulnerability) climate "hotspots"
  - Weather and climate infrastructure:
    - Undertake the development and maintenance of existing weather and climate infrastructure
    - Installation of new automated weather stations where required for collecting core agro-meteorological data
    - Installation and commissioning of new Doppler radar system
- Component 5: Research, modelling and prediction – USD 5.75 million
  - Improve understanding of large-scale climate processes influencing variability and extreme events
  - Develop new and enhance existing multi-hazard (impact-based) CLEWS tailored for priority sectors
  - Prediction:
    - Improve the utility and functionality of existing seasonal climate impact forecasts
    - Develop and provide downscaled multi-decadal projections for temperature, rainfall, drought, tropical cyclones, sea level anomalies and coral bleaching risk
    - Develop tailored, application-ready climate projection data sets through the Vanuatu Climate Futures web tool
    - Develop (risk assessment-based) extreme sea level probabilities and coastal inundation impact hazard maps for "hotspots"
    - Undertake a hydrodynamic assessment of coral reef "health" and vulnerability to the slow-onset impacts of ocean warming and acidification
    - Develop and apply agro-met services utilizing climate information for climate-smart decision-making in the agricultural sector
- Component 6: Project management and development – USD 3.7 million
  - Managed by executing entities: Secretariat of the Pacific Regional Environment Programme (SPREP) and Vanuatu Ministry of Climate Change, Meteorology, Geo-Hazards, Energy, Environment and Disaster Management (VMGD)

Theories of change:

The project's theories of change are as follows:

- Component 1: Capacity development
  - Capacity support to review Vanuatu policy → priority policy areas identified → CIS policy integrated into existing planning and policy → CIS operates effectively within government institutions and frameworks
  - Funds and personnel for training activities → workshops and training materials delivered AND climate science scholarships established AND radar operators trained AND CIS community champions trained → community members and decision-makers better equipped to operate CIS systems
  - Funds and personnel for case-study pilots → climate information systems programmes applied in five sectors → programmes tested for their effectiveness → results effectively used to inform future decisions and

designs surrounding CIS

- Component 2: User interface platform (focus on the **development** of CIS)
  - Funds and personnel for communication systems → new CIS communications products are developed in each sector AND new CIS decision-support system tools are created → new products and tools are effectively disseminated and consumed by the public → public becomes more aware of available CIS
- Component 3: Climate Information Services system (focus on the **delivery** of CIS)
  - Funds and personnel for delivery of CIS and DSS → CIS outputs provided to beneficiaries → beneficiaries receive CIS and have a greater understanding of climate risk → beneficiaries act in their best interest based on the information gained from CIS → beneficiaries become more resilient to climate risk
  - Funds and personnel for IT and communications platforms → web portal created AND sector-based IT platforms created AND climate data records updated → beneficiaries engage with these platforms and have a greater understanding of climate risk → beneficiaries act in their best interest based on the information gained from CIS → beneficiaries become more resilient to climate risk
- Component 4: Observation and monitoring
  - Funds and personnel for data updating → paper archives digitized AND new coastal and topographic data collected → data systems for climate modelling improved
  - Funds for climate infrastructure → upgrade existing climate and weather infrastructure AND install new weather and radar systems → data systems for climate modelling improved
- Component 5: Research, modelling and prediction
  - Funds and personnel to improve climate research, modelling, and prediction → risk assessments conducted AND climate projections improved → understanding of climate risk improved → learnings communicated to government and beneficiaries → improved inputs used for climate planning and CIS
  - Funds for innovation in multi-hazard EWS → new EWS established AND existing systems updated → beneficiaries receive EWS and have a greater understanding of climate risk → beneficiaries act in their best interest based on the information gained from EWS → beneficiaries more resilient in the face of extreme weather events

Concerns:

- Baselines: Pages 17–21 of the project proposal provide baseline information on the sectors in which the project will be implemented. The estimates are largely qualitative, although some are quantitative, and all are informative, nonetheless. It would be additionally beneficial if they would provide some information on the quality and abundance of the baseline data. The Logic Framework uses a lack of clarity on data as justification for assuming that baselines are zero for some outputs, and for others it aims to establish baseline data from case studies. While the latter approach is reasonable, the former could lead to an inaccurate measurement of the programme's impacts.
- Behavioural aspects: While the various components of this project proposal are generally thoroughly explained, the proposal does not outline the specifics of how access to CIS and EWS will change the behaviour of beneficiaries receiving the services to reduce their vulnerability

to climate risks.
The behavioural challenge is an opportunity for experimentation and adaptive programme management through the different pilot programmes. Executing entities should use knowledge from the initial case studies to understand which interventions are most successful for spurring behaviour change and should expand the use of those interventions deemed most effective.

- Moreover, data on the behaviour of beneficiaries may also be challenging to collect in the context of a disaster scenario (specifically for EWS). Perhaps one way to facilitate this process would be to integrate the collection of response data into new CIS technologies. For example, a cellular-based EWS app could have a "mark as safe" feature, like the one on Facebook, that would enable users to indicate their safety or call for help.

The potential for causal inference:

- The programme aims to contribute to the following impacts:
  - Avoid lock-in of long-lived, climate-vulnerable infrastructure
  - Increase the generation and use of climate (and required associated) information in decision-making
  - Strengthen adaptive capacity and reduced exposure to climate risk
  - Strengthen awareness of climate threats and risk reduction processes
  - 86,910 direct and 173,820 indirect beneficiaries
  - Direct beneficiaries based on community climate centres multiplied by catchment size plus direct beneficiaries of EWS
  - Indirect beneficiaries based on 60 per cent of the population of Tuvalu that relies on the agricultural sector
- The programme aims to carry out "participatory 'end-to-end' case studies" of CIS initiatives in each of the priority sectors. These could be a good opportunity to pilot small impact evaluations for each of five interventions. A mixed-methods approach might be appropriate to gain insight into what is and is not working in the systems. For example, researchers could collect baseline and end line data for control and treatment groups, while also conducting qualitative interviews about beneficiaries' experiences using the CIS technologies. However, the feasibility of randomized evaluations of pilot projects will depend on the population sizes in each pilot project, because small sample sizes reduce the ability to detect a statistically significant effect.
- Executing entities can use web analytics to gain an initial understanding of the reach of interventions based on IT and information and communications technology. For example, key performance indicators such as page visits and conversion rates can provide a formative understanding of site usage overall, whereas predictive analytics such as A/B testing can help discern the details of which intervention setups are most effective at promoting usage. Note that this still does not address the aforementioned challenge with behavioural change, and randomized experiments might be the best way to assess that.
- Data collected on human welfare can be combined with that on weather and climate patterns to capture the conditional probabilities of programme outcomes: we must be sure that we are measuring outcomes given the occurrence of some climate event. If an EWS is not deployed during the time of evaluation, there is no way to assess its effectiveness properly.

Evidence base/Similar programmes:

- From a search of relevant databases, it appears that there is a paucity of evidence that tests EWS using counterfactual methods. Moreover, we could not find a comprehensive review of evidence relating to CIS and EWS. Thus, much

needs to be done in terms of understanding the full impacts of EWS and CIS on beneficiary populations, especially given the recognition of the need for a scale-up of EWS programmes highlighted by the UNFCCC and the GCF.

- However, Ibrahim and Kruczkiewicz (2016) conducted a review of EWS case studies carried out across development agencies. The authors highlight a number of internal and external barriers to successful EWS programmes, including insufficient scope and mainstreaming, poor execution and political influences.
- Moreover, Pulwarty and Sivakumar (2014) describe the need in EWS for collaboration between government departments and across scales, from the community to the national level.
- All that said, lessons on effective implementation can be learned from the literature on behavioural science and mobile health interventions.

Notes on complexity:

- This project gains its complexity in a few ways. First, it works across many sectors with many stakeholders involved. Second, the interventions rely upon behavioural change in response to information disseminated in a system. If people do not behave according to the recommendations of the CIS, for a variety of reasons, the results could be very different than intended. Use of the CIS may evolve towards the existence of a system that was not planned in the project proposal phase.
- Number of interventions: Five (or more)
- Stakeholder groups: Five
- Sectors: Public administration, information and communications technology, climate science, tourism, agriculture, fisheries, water, infrastructure
- Theories of change: Fair
  - Coherence: Strong
  - Ability to be evaluated: Weak
  - Foundations in rigorous evidence: Weak

Sources:

GCF FP035 Project Proposal: *https://www.greenclimate.fund/documents/20182/574760/Funding_proposal_-_FP035_-_SPREP_-_Vanuatu.pdf/59266edc-7e5b-4068-a1fe-d4cd3d7437e1*

Ibrahim, M., & Kruczkiewicz, A. (2016). *Learning from experience: a review of early warning systems.* Milton Keynes, UK: World Vision. Retrieved from *https://www.wvi.org/sites/default/files/WV_EWEA_Doc_FINAL_Web.pdf*

Pulwarty, R., & Sivakuman, M. (2014). Information systems in a changing climate: Early warnings and drought risk management. *Weather and Climate Extremes, 3*, 14–21. doi: *https://doi.org/10.1016/j.wace.2014.03.005*

Memo 10

GCF FP041: Simiyu Climate Resilience Project

Programme objective:

The "Simiyu Climate Resilience Project" aims to increase resilience to climate shocks and unstable water supply in the Simiyu Region of Tanzania by strengthening adaptation planning, water and sanitation services, and agricultural practices.

Background:

The Simiyu Region in Tanzania faces increased climate variability including precipitation extremes such as drought and heavy rainfall. Because the Simiyu River has become a seasonal (rather than permanent) river, the population must rely on Lake Victoria as a water source. However, most of both the rural and urban populations do not have access to clean drinking water. The region's economy is heavily reliant on agriculture, and more broadly much of the country is reliant on hydropower. Thus, it is vital that the region strengthen its resilience to climate shocks while improving access to clean water and sanitation. This programme aims to take a cross-sectoral, community-based approach to address these problems, to strengthen capacity for local decision-making and adaptation planning.

Interventions:

- Refine mechanisms for implementation of adaptation activities
  - The steering committee established for cross-sectoral adaptation planning
- Improve water supply infrastructure, agricultural practices and sanitation services
  - Water supply:
    + Install a water intake and treatment plant from Lake Victoria
      - Pump water to a command reservoir, which will flow to urban centres (routes that can be further expanded in the future)
    + Rehabilitate and expand water distribution networks in three towns
      - Provide secondary reservoirs and tanker filling stations
    + Public sanitation and hygiene:
      - Improve latrines, fecal sludge transport and sludge treatment plants
      - Subsidize construction material for individual household latrines
      - Establish sanitation facilities at schools, market places and bus stands
      - Create hygiene awareness campaigns (school "sanitation clubs", etc.)
      - Establish demonstration facilities like Urine Diversion De-Hydration Toilets and Double-Ventilated Improved Pit Latrines
    + Climate-smart agriculture:
      - Construct small dams for rainwater harvesting
      - Create small-scale irrigation systems (i.e. drip irrigation)
      - Provide climate-resilient seeds for horticulture, maize and rice
      - Expand forest areas under "Ngitili" management, a traditional form of land management aimed at supplying fuelwood
- Pursue a community-driven approach
  - Involve communities in decision-making in the choice of water, sanitation and agricultural infrastructure
- Capacity development
  - Train regional secretariat and local governments to effectively approach adaptation planning
  - Establish Farmer Field Schools to improve agricultural practices, especially among smallholder women

Theories of change:

- Water supply
  - Funds and materials to establish water intake and treatment plant → water from Lake Victoria is effectively treated and piped to urban centres → individuals living in urban centres have improved access to clean water → decreased susceptibility to waterborne illness, water price increases and water access variability
  - Funds and materials to establish and rehabilitate rural water distribution networks → water is distributed from three towns to surrounding villages → individuals living in rural areas have improved access to clean water → decreased susceptibility to waterborne illness, water price increases and water access variability AND improved access to water for agricultural irrigation → rural farmers have increased crop yield and increased resilience to climate variability
- Sanitation
  - Funds and materials to establish improved sanitation infrastructure AND subsidies for personal latrine construction materials → establish wastewater treatment plant, wastewater transport trucks and public toilets AND increase the number of personal toilets → communities and private households use newly established sanitation facilities → hygiene practices improve → reduced transmission of illness → reduced loss of life and livelihood
  - Funds and personnel for hygiene awareness programmes → hygiene awareness programmes established in schools and other community institutions → hygiene practices improve → reduced transmission of illness → reduced loss of life and livelihood
- Climate-smart agriculture
  - Funds and materials for irrigation infrastructure → establish rainwater collection dams AND communities choose and construct irrigation technologies → irrigation technology replaces rainwater as a primary water source for agriculture → higher crop yield AND agriculture less vulnerable to climate variability → improved livelihoods for farmers
  - Funds and personnel to establish Farmer's Field Schools (FFS) → farmers, including smallholder women, participate in FFS → participants gain knowledge and skills in improved agricultural practice, including climate-smart agriculture → higher crop yield AND agriculture less vulnerable to climate variability → improved livelihoods for farmers
- Adaptation planning and capacity development
  - Funds and personnel to facilitate engagement with communities → communities choose the specific water, sanitation and agricultural infrastructure that best fits community needs → suitable infrastructure is established in communities AND the capacity for community decision-making is strengthened → communities are better equipped to make future decisions regarding climate-smart and development planning
  - Funds and personnel to establish a steering committee and capacity training → adaptation planning steering committee established AND local authorities trained to implement adaptation planning effectively → adaptation planning is used more widely in government decision-making AND local authorities manage climate-smart projects more

effectively

Concerns:

- It is somewhat straightforward to expect that the water and sanitation initiatives will be beneficial for the health and livelihood of the project beneficiaries. This part of the project raises the question: What is the difference between a climate change intervention and a development intervention? The project proposal states that the water supply has become less reliable, which would imply that some people who once had access to a clean water supply no longer have it. If this is the claim being made, it would be beneficial to provide some additional baseline data to support it.
- While the inclusion of community-based decision-making as a central feature of this project is laudable, its effectiveness relies upon the assumption that communities will choose the interventions (technologies, farming techniques) most useful to the majority of community members. Without testing this assumption, community decision-making could reflect social structures that advantage the more powerful members of the community. Thus, project implementers should prioritize equitable decision-making at the community level.
- The project proposal appears to have consulted background studies to establish baselines and an assessment of the region's needs.
- As outlined by Waddington and White (2014), FFS may not be an effective or cost-effective intervention for improving agricultural outcomes. However, it appears that programme impacts can vary depending on facilitators, pedagogical methods, size and intended outcomes. Thus, a well-designed FFS programme, that addresses some of the pitfalls noted in Waddington and White, could confer more benefit than average.
- The proposal mentions that female-headed smallholder households benefit above average from FFS. Evidence to support this claim would be beneficial.

The potential for causal inference:

- The agricultural programmes are those most suitable for a randomized evaluation. The irrigation and FFS programmes could be rolled out in a cluster-randomized manner as a treatment and control group. Randomization would occur at the community level.
  - The four treatment arms could work as follows:

	Receives FFS	Does not receive FFS
Receives irrigation technology	Receives irrigation & FFS	Receives irrigation but not FFS
Does not receive irrigation technology	Receives FFS but not irrigation	Receives neither FFS nor irrigation

  - Farmers can be surveyed before and after the programme to understand the programmes' impacts on livelihood.
- The urban sanitation and water programmes could be measured in pre-post surveys related to health because they would likely need to be introduced all at the same time. However, they could be measured through instrumental variables if the proper proxy variables are identified.
- Interventions for capacity-building and community participation can be measured using qualitative methods, including interviews, focus groups and surveys. Qualitative methods may be especially useful at the community level, where participation by community members may reveal points of tension or inefficiency in the programme.

Evidence base/Similar programmes:

- There exists a broad literature base to measure the effectiveness of water and

sanitation interventions. Generally, they tend to improve the health of programme recipients and reduce deaths from diarrhoea.
  - In a systematic review, Ejemot-Nwadiaro, Ehiri, Arikpo, Meremikwu and Critchley (2015) found moderate quality evidence that hand-washing and hygiene education programmes reduce the prevalence of diarrhoea in rural and poor communities.
  - In a systematic review, Clasen et al. (2010) found that improvements to the disposal of human waste strongly decrease the prevalence of diarrhoea (though they note that more randomized trials would be welcome).
  - A third systematic review, by Dangour et al. (2013), indicated that water and sanitation interventions slightly improve child nutrition in developing countries.
  - However, Clasen et al. (2015) found "no studies evaluating reliable piped-in water supplies delivered to households", which suggests that this programme could potentially contribute to the evidence base on water infrastructure interventions (presuming the water supply interventions aim to pipe the water into houses).
- A systematic review by Stewart et al. (2015) found that there is a lack of rigorous (randomized) evidence surrounding these types of interventions in the African smallholder context.
- There is also an abundance of literature on the effects of agricultural technology (including irrigation) on farmer outcomes such as income, nutrition and crop yields. Generally, agricultural technology helps improve yields and thus incomes. However, Rosenstock et al. (2016) point out that there has been no systematic approach to analyzing evidence on the effectiveness of interventions for climate-smart agriculture, and therefore they have defined a protocol for that systematic review to be carried out.
- Duflo and Pande (2007) found in an instrumental variables study in India that the construction of dams was beneficial for agricultural yields and rural poverty reduction in villages downstream of the dams but led to an increase in rural poverty for the communities in which the dams were directly built. This suggests that dams can be useful for increasing the stability of water sources in the face of shocks but can still have adverse effects on the communities closest to them.
- A systematic review summary report on FFS by Waddington and White (2014) found the following:
  - Most FFS were targeted at farmers who were better off than others; in those with pro-poor targeting, targeting methods were not always successful.
  - Many FFS programmes struggle to find appropriate facilitators for the programmes.
  - Small pilot FFS programmes generally confer a benefit to farmers through improved agricultural outcomes and profit but generally do not have an effect once scaled at the national level.
  - There was no significant knowledge diffusion between FFS participants and their non-participant neighbours.
  - FFS projects are generally not very cost-effective.
  - There is still a lack of quality randomized evidence for FFS at scale. We could benefit from a cluster-randomized evaluation of FFS.

Notes on complexity:

- This project exhibits a medium amount of complexity. While it has a fairly large number of interventions, they are all drawn together by the common thread of improving water and sanitation access for

daily life and agriculture in the face of increasing climate variability.

- We might expect that **either** the clean water and sanitation **or** the agriculture programmes alone might improve outcomes for life and livelihood. However, we do not know how much additional change the combined interventions will make over one alone. Thus, it might make sense to attempt to isolate the effects of the different interventions, which may prove experimentally difficult.
- Increasing climate variability might alter the effectiveness of the programme, as we are not able to observe the effects of this programme in the absence of the increasing damage done by climate change.
- Number of interventions: Six
- Stakeholder groups: Office of the Vice-President, Tanzanian federal ministries, regional administration and local government, communities
- Sectors: Water, agriculture, public administration
- Theories of change: Fair
  - Coherence: Strong
  - Ability to be evaluated: Fair
  - Foundations in rigorous evidence: Fair

Sources:

GCF FP041 Project Proposal: *https://www.greenclimate.fund/documents/20182/574760/Funding_proposal_-_FP041_-_KfW_-_Tanzania.pdf/309167bf-ab3f-40cd-a72f-67274a0a8f16*

Clasen, T., Alexander, K. T., Sinclair, D., Boisson, S., Peletz, R., Chang, H. H., Majorin, F., & Cairncross, S. (2015). Interventions to improve water quality for preventing diarrhoea. *Cochrane Database of Systematic Reviews 2015* (10). doi: 10.1002/14651858.CD004794.pub3

Clasen, T., Bostoen, K., Schmidt, W., Boisson, S., Fung, I., Jenkins, M. W., Scott, B., Sugden, S., & Cairncross, S. (2010). Interventions to improve disposal of human excreta for preventing diarrhoea. *Cochrane Database of Systematic Reviews 2010* (6). doi: 10.1002/14651858.CD007180.pub2

Dangour, A. D., Watson, L., Cumming, O., Boisson, S., Che, Y., Velleman, Y., Cavill, S., Allen, E., & Uauy, R. (2013). Interventions to improve water quality and supply, sanitation and hygiene practices, and their effects on the nutritional status of children. *The Cochrane Library 2013*, (8). Retrieved from *https://www.sswm.info/sites/default/files/reference_attachments/DANGOUR%20et%20al%202013%20Interventions%20to%20Improve%20Water%20Quality%20and%20Supply,%20Sanitation%20and%20Hygiene%20Practices,%20and%20Their%20Effects%20on%20the%20Nutritional%20Status%20of%20Children.pdf*

Duflo, E., & Pande, R. (2007). Dams. Quarterly *Journal of Economics*, *May 2007*, 601–646. Retrieved from *https://scholar.harvard.edu/files/rpande/files/dams_0.pdf*

Ejemot-Nwadiaro, R. I., Ehiri, J. E., Arikpo, D., Meremikwu, M. M., & Critchley, J. A. (2015). *Hand washing promotion for preventing diarrhoea.* Cochrane Database of Systematic Reviews 2015 (9). doi: 10.1002/14651858.CD004265.pub3

Rosenstock, T., Lamanna, C., Chesterman, S., Bell, P., Arslan, A., Richards, M., Rioux, J., Akinleye, A., Champalle, C., Cheng, Z., Corner-Dolloff, C., Dohn, J., English, W., Eyrich, A., Girvetz, E., Kerr, A., Lizarazo, M., Madalinska, A., McFatridge, S., Morris, K., Namoi, N., Poultouchidou, A., Ravina da Silva, M., Rayess, S., Strom, H., Tully, K., & Zhou, W. (2016). *The scientific basis of climate-smart agriculture: A systemic review protocol* (Working Paper No. 138). Copenhagen, Denmark: CGIAR Research Programme on Climate Change, Agriculture, and Food Security. Retrieved from *https://cgspace.cgiar.org/rest/bitstreams/66359/retrieve*

Stewart, R., Langer, L., Rebelo Da Silva, N., Muchiri, E., Zaranyika, H., Erasmus, Y., Randall, N., Rafferty, S., Korth, M. et al. (2015). *The effects of training,*

innovation and new technology on African smallholder farmers' wealth and food security (3ie Systematic Review 19). London, UK: International Initiative for Impact Evaluation (3ie). Retrieved from *http://www.3ieimpact.org/media/filer_public/2016/07/12/sr19-africa-smallholder-farming-review.pdf*

Waddington, H., and White, H. (2014). *Farmer field schools: From agricultural extension to adult education* (3ie Systematic Review Summary 1). London, UK: International Initiative for Impact Evaluation (3ie). Retrieved from *http://www.3ieimpact.org/media/filer_public/2014/08/07/srs1_ffs_revise_060814_final_web.pdf*

ANNEX 2. FULL COMPLEXITY RUBRIC

Table 4. Full complexity rubric with inputs and scores

Project Name Shortcut	FP	Number of Inter-ventions	Score	Target Outcome	Score	No. of Stakeholder Groups	Score	No. of GCF Impacts Described	Score	No. of Sectors	Score	Theory of Change	Score	Over-all Comp-lexity Score	Overall Complex-ity Rating
Resilience of Wetlands in Peru	1	5	2	Both	3	9	3	2	1	3	1	Fair	2	12	Medium
Resilient Infrastructure: Bangladesh	4	3	1	Adaptation	2	5	2	2	1	2	1	Weak	3	10	Medium
Ecosystem-based Adaptation in Gambia	11	3	1	Adaptation	2	6	2	3	2	3	1	Fair	2	10	Medium
Coastal Resilience in Viet Nam	13	3	1	Both	3	7	3	4	2	3	1	Fair	2	12	Medium
Solar Energy in Chile	17	2	1	Mitigation	1	3	1	2	1	1	1	Strong	1	6	Low
GLOF Risk Reduction in Pakistan	18	6	2	Adaptation	2	5	2	2	1	6	3	Fair	2	12	Medium
Reduce Deforestation Emissions in Ecuador	19	9	4	Mitigation	1	7	3	1	1	5	3	Fair	2	14	High
Sustainable Landscapes in Eastern Madagascar	26	7	3	Both	3	7	3	5	3	6	3	Weak	3	18	High

Project Name Shortcut	FP	Number of Inter-ventions	Score	Target Outcome	Score	No. of Stakeholder Groups	Score	No. of GCF Impacts Described	Score	No. of Sectors	Score	Theory of Change	Score	Over-all Comp-lexity Score	Overall Complex-ity Rating
Climate Information Services in Vanuatu	35	5	2	Adaptation	2	5	2	4	2	8	3	Weak	3	14	High
Resilient Development in Tanzania	41	6	2	Adaptation	2	4	2	4	2	3	1	Fair	2	11	Medium

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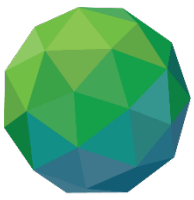

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