Bridge Collaborative Practitioner's Guide

Principles and Guidance for Cross-sector Action Planning and Evidence Evaluation

BRIDGE COLLABORATIVE

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The Bridge Collaborative is a partnership spearheaded by The Nature Conservancy, PATH, the International Food Policy Research Institute and Duke University, with contributions from over 150 academics, program implementers and policy makers representing 90 organizations from around the globe. We envision health, development and environment communities jointly solving today's complex, interconnected challenges. We are sparking action to develop a shared evidence base for solutions that bridge inclusive development and environmental sustainability. Through this paradigm shift, we aim to achieve cross sectoral outcomes with higher impact, increase efficiencies and drive greater sustainability.

BRIDGECOLLABORATIVE

The Bridge Collaborative was created to catalyze problem solving across the health, development and environment sectors. Inspired by the Human Genome Project's ability to transform culture quickly in service of research and human advancement, the Bridge Collaborative was created as a global coalition designed for rapid action. The Nature Conservancy, PATH, the International Food Policy Research Institute (IFPRI) and Duke University founded the Bridge Collaborative in 2016 with the aim to shatter disciplinary silos so that health, development and environment professionals regularly collaborate to create the evidence and opportunities to solve the greatest challenges facing people and the world we share. Challenges like climate change, food security, nutrition, pollution, water security, poverty alleviation and many others are rooted in and impact these multiple sectors.

The long-term objectives of the Collaborative are thus to 1) develop more aligned agendas among the health, development and environment communities in order to collaboratively solve today's major planetary challenges; 2) enable organizations to use aligned planning and evidence assessment methods, making evidence more interoperable and transferrable; and 3) catalyze synthesis of evidence across sectors, speeding identification of solutions that have potential to yield multiple benefits.

The Bridge Collaborative aims to advance these efforts through a globally representative group of researchers and practitioners across the broad realms of health, development and environment. Many current Collaborative members lead or engage in existing networks and cross-sector efforts, providing an opportunity to learn from, expand on and amplify these initiatives. Through a rapid co-creation process, the Collaborative has generated principles and actionable guidance for using results chains and evaluating evidence in research design and action planning across sectors. Bridge Collaborative members worked in six working groups, using topical challenges as a reference point while developing and testing the general principles and guidance. Recommendations reported here were generated while considering the topical challenges of climate change, sustainable food and nutrition, sanitation and water security, and clean air, but are likely to be applicable to other major global challenges such as refugee crises, desertification, and emerging infectious diseases.

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THE BRIDGE COLLABORATIVE FOUNDING PARTNERS

Duke University • International Food Policy Research Institute (IFPRI) • The Nature Conservancy • PATH

175 Collaborative Members • 90 Organizations • 23 Countries

Definitions

Assumption: A proposition that is accepted as true in order to provide a basis for logical reasoning.

Conceptual Model: A representation of the elements or conditions of a system, their connectivity, and the relationships among and between them. We understand some communities prefer the term framework for this use.

Drivers: Any natural or human-induced factor that directly or indirectly causes a change in an element or condition of a system.

Evidence: The available body of verifiable facts or verifiable, relevant information from any sector or discipline indicating that a hypothesis (or assumption) can be supported, considered valid, or refuted. We take a broad and inclusive definition of evidence and accept information from the following sources, which we define for use in this context:

- **Expert knowledge:** The judgement of those with specialized knowledge obtained through training or experience. This includes local knowledge, traditional knowledge, and subject matter expertise.
- **Measurement results:** Information gained from any measurement which may or may not be part of a study.
- **Models:** A description or representation of an object or system. Models can be conceptual, mathematical, physical, mental or computational. Models can be used in conjunction with quantitative or qualitative studies, theory, or expert knowledge.
- **Qualitative studies:** Studies based on inference through a thorough understanding of a case(s) under study, but unable to characterize an absolute numerical relationship between parts of a system.
- **Quantitative studies:** Studies based on inference through numerical data and analysis that describe the relationship between parts of a system. Quantitative studies may be experimental, quasi-experimental or observational.
- **Theory:** A scientifically accepted general principle or body of principles offered to explain phenomena.

Hypothesis: A proposed explanation, based on observation or other indicating evidence, used as a starting point for further investigation.

Intervention: An action taken to achieve a desired impact. We use the term broadly to include activities, projects, programs, policies or any other scale or type of action that an individual or organization could take to improve a situation.

Impact: The intended, positive effect(s) of an intervention. We understand that some communities prefer the term outcome for this use.

Results Chain: A visual representation of the logic and theory by which an intervention leads to positive and negative consequences. Results chains are typically constructed of nodes (drivers and/or consequences) and links (lines or arrows representing hypotheses about how a change in one node causes a change in another node in the system). Other similar terms include: logic model, theory of change, influence diagram, means-end diagram, causal chain, impact pathway, and results framework. See Figures 1-2 for simplified, hypothetical results chain examples.

Sector: An area of the economy or society in which businesses or organizations share the same or related products, services, or practices. We use sector to refer to the broad set of actors involved in major domains of advancement and practice such as health, development and environment. We understand there are other uses of this term, including to differentiate between private entities (corporations) and public entities (governments). We define these sectors broadly, such that the health sector encompasses all actors (e.g. research institutes and universities; insurance, pharmaceutical and other companies; public health workers and organizations; funders; etc.) working on any aspect of health. The environment sector encompasses all actors (e.g. non-profit organizations, research institutes and universities, funders, law firms, regulators, natural resource management firms, etc.) working on any aspect of the environment (conservation, pollution, sustainability, etc). And the development sector encompasses all actors (e.g. multilateral development banks, foundations, bilateral development agencies, non-profits, private development firms, etc) working on any aspect of human development (e.g. education, gender equity, agriculture, housing, security, economic development, infrastructure, sanitation, etc).

Situation Analysis: A description of the current status of a system including consideration of key connections between biophysical, social and economic elements, functions and institutions. Methods that may be used to conduct situation analyses include root cause analysis, Strength/Weaknesses/Opportunities/Threats (SWOT) analysis, causal loop diagrams, problem tree analysis and conceptual models. Diagrams may be used in situation analysis, and when they are, differ from results chains as they reflect the current state of the system, while results chains reflect expected changes resulting from an intervention.

Unintended Consequences: Unexpected positive or negative changes in a system caused by an intervention.

Introduction

The health, development and environment sectors increasingly realize that they cannot achieve their respective goals by acting in isolation. Yet, as they pivot to act collectively, they face challenges in finding and interpreting evidence on sectoral interrelationships, and thus in developing effective evidence-based responses. Each sector already uses some form of evidence-based research, design and action planning, but methods vary and ideas about the strength of evidence differ, creating stumbling blocks in the way of cross-sector impact. A new initiative, called the Bridge Collaborative, set out to spark cross-sector problem solving by developing common approaches that the three sectors could agree to and use. Specifically, the Collaborative has focused on two linked areas of practice that could unlock cross sector collaboration – results chains and the evaluation of supporting evidence. Through this process, the Collaborative has provided a platform for dialogue and collaboration among professionals from across these sectors, allowing for face-to-face interaction and discussion to build professional networks.

This document captures a set of principles identified and used by the Collaborative, along with a detailed set of guidance for creating comparable results chains across sectors and evaluating evidence from multiple disciplines in common terms. These principles and guidance reflect novel contributions from the Bridge Collaborative as well as restatements of existing recommendations that resonated among health, development and environment researchers and practitioners. Both conventional (single-sector) and cross-sector problem solving may be aided by these principles and guidance, though they are seen by the Collaborative to be particularly useful for cross-sector collaboration. Further application and testing will reveal how and how much they contribute to efficiency and impact.


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Principles

1 Use evidence to inform decisions. By learning from evidence of how systems function and what has and has not worked, decision makers can make faster progress, cut costs, and avoid failures and backtracking.

2 Act now and learn by doing. Acknowledge that progress can be made now even while there is not complete understanding, evidence, or political or social alignment across sectors. Encourage flexibility and intentional learning along the way to improve actions and impact.

3 Seek and respect other perspectives. Believe and act as if goals in one sector may be met more effectively, efficiently or sustainably by embracing ideas, interventions, approaches or concepts from other sectors.

4 Be intentional about inclusion. Use tools designed to explicitly include and empower under-represented groups. When new sectors are included in traditionally single-sector discussions, these same tools can prove useful.

5 Strive to do no harm. Seek out and circumvent potential harmful outcomes, strive for positive outcomes in one sector for a certain group that do not come at the expense of negative outcomes in other sectors, other groups, or future generations. When trade-offs do occur, make efforts to minimize and mitigate negative outcomes.

6 Share information openly and transparently. Share data, frameworks and concepts quickly, openly and transparently while respecting anonymity and privacy. Doing so will facilitate improved trust, collaboration and faster progress.

Guidance for Cross-Sector Action Planning and Evidence Evaluation

Create the Team

1. Include input from people representing diverse disciplines, expertise, career stages, roles and perspectives.
2. Allow sufficient time and resources for multi-sector teams to be formed.
3. Design an inclusive process.

Define and Analyze the Situation and Set Goals

4. Take a systems view to provide a broader understanding of what the true scope of the challenge and interactions within the system may be.
5. Consider multiple scales in space, time and levels of governance.
6. Discuss decision criteria for how to manage potential tradeoffs.
7. Consider evidence from outside the focal sector or discipline.

Analyze Possible Interventions or Hypotheses Using Results Chains

8. Decide on spatial and temporal scales for results chain development.
9. Draw results chains that are comparable or can be combined across sectors.
10. Clearly state assumptions for each link in the chain, enabling other sector experts to understand causal reasoning.
11. Seek expert input on interpretation of effect sizes.
12. Consider additional outcomes, unintended consequences (positive and negative), and additional drivers.
13. Match the burden of evidence review to the risk of 'getting it wrong'.
14. Draw on all relevant types of evidence from all relevant sectors to evaluate strength of confidence for links in the chain.
15. Assess and reflect strength of confidence in evidence for links in chain by applying the provided rubric to available evidence.

Choose Interventions and Select Impacts, Metrics and Monitoring Plan

16. Interpret the strength of evidence based on the decision context and decision maker(s).
17. Compare and contrast possible interventions based on feasibility, anticipated cost-effectiveness, sustainability and equity.
18. Use results chains to develop and focus on priority metrics that capture key cross-sector connections efficiently.

Implement

19. Identify the most effective actor(s) for each intervention.

Monitor, Evaluate and Adapt

20. Create and make use of opportunities to learn about effectiveness or needed improvement in cross-sector efforts.

Principles

The Bridge Collaborative identified and followed six principles in practice and found them useful for framing work across sectors. The principles largely promote mindsets and actions that help foster trust, a critical element for success when bringing new parties together. They draw heavily from existing recommendations for integrated development[1,2,3,4,5] and other efforts to build collaborations at the nexus of several disciplines or fields of practice.

Use evidence to inform decisions. By learning from evidence of how systems function and what has and has not worked, decision makers can make faster progress, cut costs, and avoid failures and backtracking. The health, development and environment sectors have long recognized the value of evidence-based decision making. With the emerging 'post-truth' mentality, it is worth emphasizing the benefits of evidence-based decisions.

Act now and learn by doing. We acknowledge that progress can, indeed must be made now even while there is not complete understanding, evidence, or political or social alignment across sectors. Flexible, intentional learning can improve actions and impact. This latter point forms the basis of adaptive management and evidence-based management, approaches championed extensively in environmental management, development and health to learn through action.

Seek and respect other perspectives. Many barriers to multi-sectoral action will be reduced over time if we believe and act as if goals in one sector may be met more cost effectively, efficiently or sustainably by embracing ideas, interventions, approaches or concepts from other sectors. For example, consider a case where residents in a community are susceptible to disease due to malnutrition and lack of access to clean water. While health providers may reasonably resort to medicines to treat diseases and prevent mortality, their integration of development and environment interventions to secure nutritious food and clean water could enable multiple effective and sustainable advances. Similarly, an intervention that may not be cost effective from a single sector perspective may become so once other perspectives are included. For example, repairing damaged irrigation infrastructure may not be cost-effective with regards to agricultural benefits, but may become so if the repairs also provide energy, health and safety benefits. The experiences of the Bridge Collaborative suggest that even brief (30 min – 1 day) opportunities for experts from different sectors to meet and problem solve can lead to rapid transformation in problem framing, strategic planning and evidence use.

Be intentional about inclusion. A further, and more common extension of perspective seeking is to intentionally include potentially relevant, under-represented groups in research and practice from the planning stage forward. Encourage use of established tools for inclusive engagement. New sector representatives may also benefit from the use of these tools in cross-sector engagements. Guidance and tools for increasing inclusion are well established in practices used by health,[6] development[7,8] and environment[9,10,11] sectors.

Strive to do no harm. Best practice encourages researchers, policy makers and practitioners to seek out and circumvent potential harmful outcomes and strive for positive outcomes that do not come at the expense of other sectors, groups, or future generations. When trade-offs are plausible, efforts must be made to minimize and mitigate negative outcomes. Cross-sectoral efforts that fail to prevent or mitigate negative outcomes are likely to be ineffective at balancing multiple objectives and short-lived. Tools and approaches for identifying tradeoffs and synergies are available,[12,13] and could be applied more widely.

Share information openly and transparently. Lack of openness and transparency across sectors may lead to mistrust, misunderstandings, increased transaction costs, ineffective collaboration, overlooked options, missed opportunities, duplicative efforts, and short-lived partnerships.[14] We encourage all to share data, frameworks and concepts quickly, openly and transparently, while respecting anonymity and privacy.

Guidance

CROSS-SECTOR RESEARCH AND ACTION PLANNING

Many publications call for cross-sector collaboration and identify current barriers to its advance. Few give operational guidance on how to move through the challenges of conducting evidence-based planning across sectors. We provide initial, practical guidance to address some of these challenges here, with a strong emphasis on the creation of results chains and evidence evaluation.

The health, development and environment communities all use some form of strategic planning and implementation processes that generally have steps such as:

- Create the team
- Define and analyze the situation and set goals
- Analyze possible interventions or develop research hypotheses using results chains
- Choose interventions (or research questions) and select impacts, metrics and monitoring plan
- Implement
- Monitor, evaluate and adapt (or adjust or refute hypotheses)

Extensive guidance exists within sectors and disciplines for how to carry out these steps and they are often applied in a highly iterative process. Successful evidence-based work across sectors will require inclusive and appropriate engagement of diverse and relevant stakeholders at each step in this kind of process. The health, development and environment sectors all commonly emphasize this need and provide guidance and tools for successful stakeholder engagement. We summarize some of these and other tools and methods commonly applied at each general step in the Appendix: Toolkit for Research and Practice. Our emphasis here is on the use of these common steps across sectors. While many elements of single-sector approaches are necessary and applicable for cross-sector engagement, they are not sufficient.

HOW CROSS-SECTOR ENGAGEMENT CAN HELP

Once a team is created, some form of situation analysis is typically conducted. In this process, the scope of the work is set, and key drivers and linkages in the focal system are identified. This step sets the stage for consideration of possible strategies to solve challenges within the scope or hypotheses for research, so it is a key point at which to expand the view. Adding other sector views or evidence at this stage can help identify other drivers, identify which drivers are strongest, reveal links across temporal or spatial scales in the system, etc.

Once the situation is generally understood, the team considers possible interventions. This is the step where potential solutions are sourced and compared, and/or hypotheses are generated. Results chains are a common tool that is used in various ways across health, development and environment planning and research at this stage. Simply creating a results chain with multiple sector viewpoints involved can help reveal connections and interactions across sectors. This may lead to new collaborations or partner seeking.

Consider a hypothetical case (Fig. 1a) where an environmental group is working with a timber company to conduct sustainable, mechanical thinning as a way to reduce fire intensity in a local forest. Fire intensity in this case has increased over time, changing the fire regime, making it difficult for a local tree species of concern to thrive. Mechanical thinning is being considered as an intervention that can restore the fire regime the tree species is adapted to. In the same area, health workers are combatting high rates of respiratory disease and are considering the use of respiratory inhalers to ease the respiratory disease burden in local populations. Yet another group of actors, a local renewable energy organization working in the same community, is planning to introduce micro solar subsidies to encourage adoption of solar energy as a way to increase local energy security. Each of these interventions is being considered from a single-sector viewpoint to address a single-sector problem.

If we expand the view and extend the results chains to impacts these interventions may have in other sectors, the view changes substantially (Fig. 1b). Instead of three disconnected interventions, we see that all three interventions could be viable solutions for reducing respiratory disease prevalence. We also see that the micro solar subsidy and mechanical thinning may be viable ways to reach the intended environmental change for the tree population of concern. This is obviously a highly simplified case, but one that demonstrates how improving the ability of research and practitioner teams to see beyond single-sector views can open opportunities for new interventions, and identify possible positive and negative unintended consequences of sector-based interventions.

Figure 1. Simplified cases of single-sector (a) and cross-sector (b) results chains. In this generalized case, three interventions generally developed from a single sector viewpoint (a) are indeed three alternative interventions for a health outcome, and two alternative interventions for an environment outcome (b). Exploring cross-sector results chains such as these (b) can help identify more potential solutions to today's interconnected global challenges. PM2.5 = fine particulate matter pollution of great concern for respiratory health. Solid lines indicate positive relationships, dotted lines indicate negative relationships.

Figure 1A

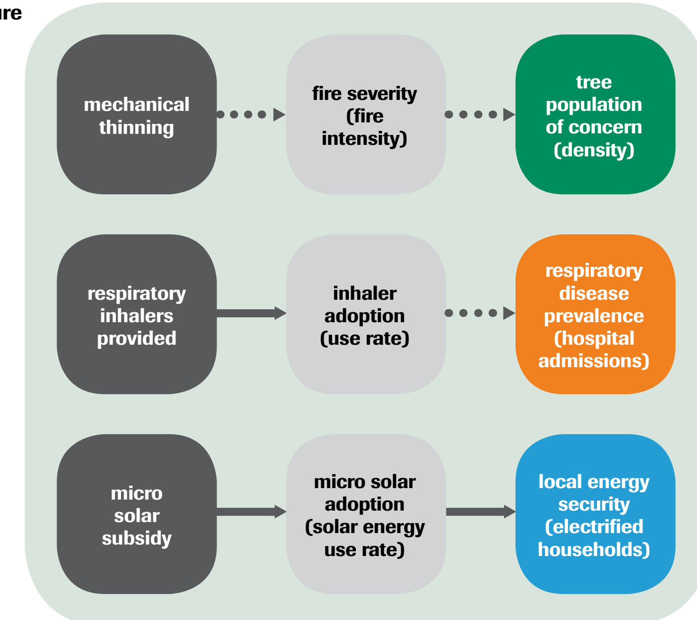
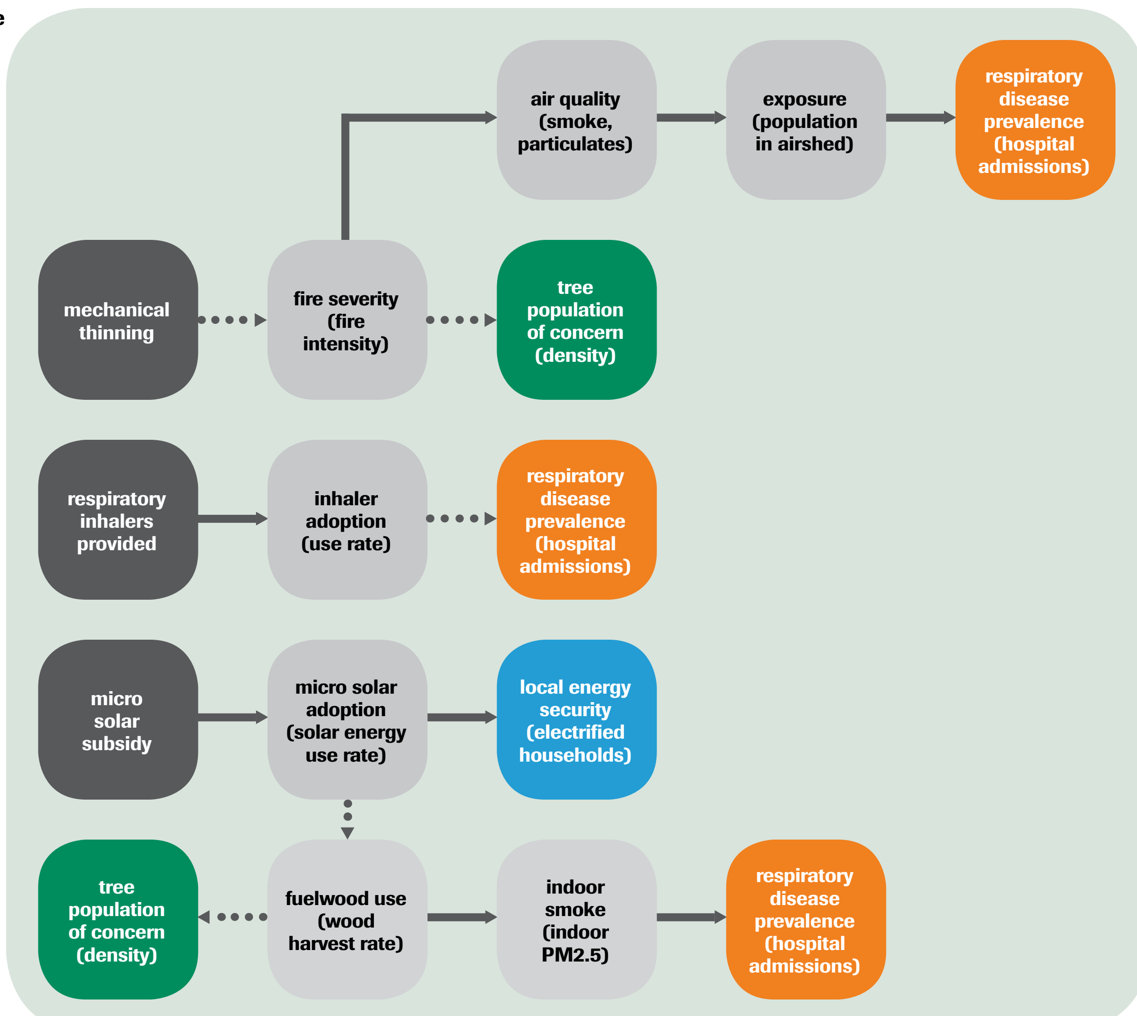


Figure 1B



In addition, results chains can be used as the basis for evidence synthesis. Each link in a chain reflects a hypothesis that can be tested. Evaluating evidence for multiple links in a results chain can 1) help reveal links where we have high confidence in the expected change and 2) reveal links with lower confidence. The latter may motivate identification of additional interventions that may be needed to mitigate risk, reduction of investment until linkages are clarified, or increased monitoring and evaluation that enables learning. As results chains reflect causal relationships within a system, they may also form the basis for mathematical models that can be used to estimate the likely changes in a system due to an intervention.

RECOMMENDATIONS

Each sector has multiple guidebooks and recommendations for best practice in strategic planning and research design. Most existing recommendations are relevant to cross-sector work, but they are not sufficient to assist teams in working through the unique challenges of cross-sector engagements. We do not summarize all existing guidebooks and recommendations here, but we do emphasize common best practices from health, development and environment communities that we think are especially helpful in cross sector collaborations. *These are noted in italics below.* In addition, we have developed new recommendations to fill the gaps left by existing literature and guidance.

It will take time for practices to change so that cross-sector connections can be considered at every step in strategic planning and research design. In an effort to meet people where they are and make early advances, we focused the majority of our efforts on recommendations for the results chain step as a key entry point to initiate change. Results chains are tightly linked to actions on the ground and provide ready opportunities for health, development and environment sectors to make immediate adjustments. Looking ahead, situation analyses are another transformational entry point for cross sector thinking. Expansion of the situation analysis would help people see the full scope of challenges more easily, consider alternative diagnoses of problems to be addressed, and identify a broader suite of possible interventions. We give some initial recommendations for the use of evidence for cross-sector situation analysis but did not address this step fully. We welcome and encourage further efforts to develop guidance for the use of shared evidence base for situation analysis. Overall, we offer 20 recommendations to advance the development and use of a cross-sector evidence base.

CREATE THE TEAM

1. Include input from people representing diverse disciplines, expertise, career stages, roles and perspectives.

Representation from diverse roles can affirm leadership commitment and engender trust and investment from others. In cross-sector efforts, it can be especially important to engage decision-makers from other sectors early, and throughout the process. Diverse input can be gained through direct team membership, advising, peer review and other modes (see Recommendation 3). Recognizing that teams will not always be able to engage a wide range of expertise, the remaining recommendations can be applied by single sector or cross sector teams.

2. Allow sufficient time and resources for multi-sector teams to be formed.

Take the time and make the effort to get a general understanding of the concepts underpinning the challenges that brought the cross-sector team together, recognizing that each sector may have its own jargon and language and may use different terms when referring to the same concept, or may assign a different meaning to the same word. Cross-sector work may require team members to advocate for their own engagement or adoption of outputs with peers or superiors, or require uncomfortable personal or interpersonal efforts. Many facilitation tools can aid this process. Provide meaningful incentives (e.g. management accountability, funding support, salary increase, professional opportunity or recognition, power in decision process) to encourage people to take on the real and perceived challenges of cross-sector action.

3. Design an inclusive process.

This recommendation aligns closely with Principle 4: be intentional about inclusion. It is repeated here because designing an inclusive process should start at the outset of a project. Inclusion of traditionally underrepresented groups or sectors at the foundational stages of project design can make a project more efficient and effective by illuminating new ideas, strategies, approaches, potential pitfalls, and partnerships. Inclusive processes should also be built into multiple stages of the design and implementation of a project so that diverse perspectives provide meaningful input throughout the adaptive management cycle. Inclusion should not be built into a project for inclusion's sake; it should be part of the process to truly add value and insight and balance potential tradeoffs.

DEFINE AND ANALYZE THE SITUATION AND SET GOALS

4. Take a systems view to provide a broader understanding of what the true scope of the challenge and interactions within the system may be.

This is the stage when cross-sector linkages first emerge and reveal how projects can be more effective, or mistakenly fail. A systems view reveals key connections between biophysical, social and economic elements, functions and institutions. Increasingly, the necessity of taking a systems view and approach has been recognized in various fields of policy and corporate practices. For instance, the development community is moving toward more comprehensive—or systems level—thinking as it looks at issues of poverty, hunger, and malnutrition.[15] International development organizations such as UNDP, the World Bank, USAID, Global Affairs Canada, and Japan International Cooperation Agency have shifted to systems-based concepts,[16] holistic, and integrated approaches[17] to the design, delivery and evaluation of development programs.

Methods that may be used include situation analysis, cross-sectoral conceptual frameworks, root cause analysis, causal loop diagrams, Strengths/ Weaknesses/ Opportunities/Threats (SWOT) analysis, problem tree analysis, and conceptual models. See the Definitions section, and Figure 2 to clarify how situation analyses differ from results chains. When systems frameworks exist, referencing them at this point can help expand and clarify the scope and goals of the effort.

Consider feedback loops and unintended consequences at this stage, as they commonly act across socially or economically defined sector boundaries and so are commonly missed in single-sector situation analyses. Reveal these linkages by thinking about unlikely but plausible outcomes provided by each sector's perspective.

5. Consider multiple scales in space, time and levels of governance.

Effective cross-sectoral problem solving requires acknowledging that challenges tend to permeate multiple scales in space (global, regional, local, household and intrahousehold levels), time (daily, annual, decadal, millennial time scales) and levels of governance (community, county, state, national, etc). Interventions and processes at one scale affect and are affected by challenges, processes and interventions at other scales. Taking a systems view may capture relevant connections across scales, but intentional exploration of scale may reveal additional important linkages.

6. Discuss decision criteria for how to manage potential tradeoffs.

Win-win outcomes are desirable, but not always possible. When interventions traditionally intended to create one impact present possible tradeoffs with other impacts or changes in the system, it is useful to have decision criteria set early in the process (e.g. do no harm to any groups involved, maximize benefit, minimize regret).

7. Consider evidence from outside the focal sector or discipline.

Evidence is often used to inform a situation analysis. Looking for evidence of linkages in the system from new sources outside typical sector resources can reveal additional linkages, help understand which drivers are most influential, and reveal which linkages are best or least understood. Full treatment of evidence application to situation analysis was outside the scope of our work, but offers a rich entry point for future exploration.

ANALYZE POSSIBLE INTERVENTIONS OR HYPOTHESES USING RESULTS CHAINS

8. Decide on spatial and temporal scales for results chain development.

Different sectors commonly use interventions that act over different temporal and spatial scales. Be explicit about which scales are being included. Without discussion and agreement, results chain development can progress quite far with different sector representatives holding very different assumptions about spatial and temporal scales, leading to later misunderstandings, incompatibilities or disagreements.

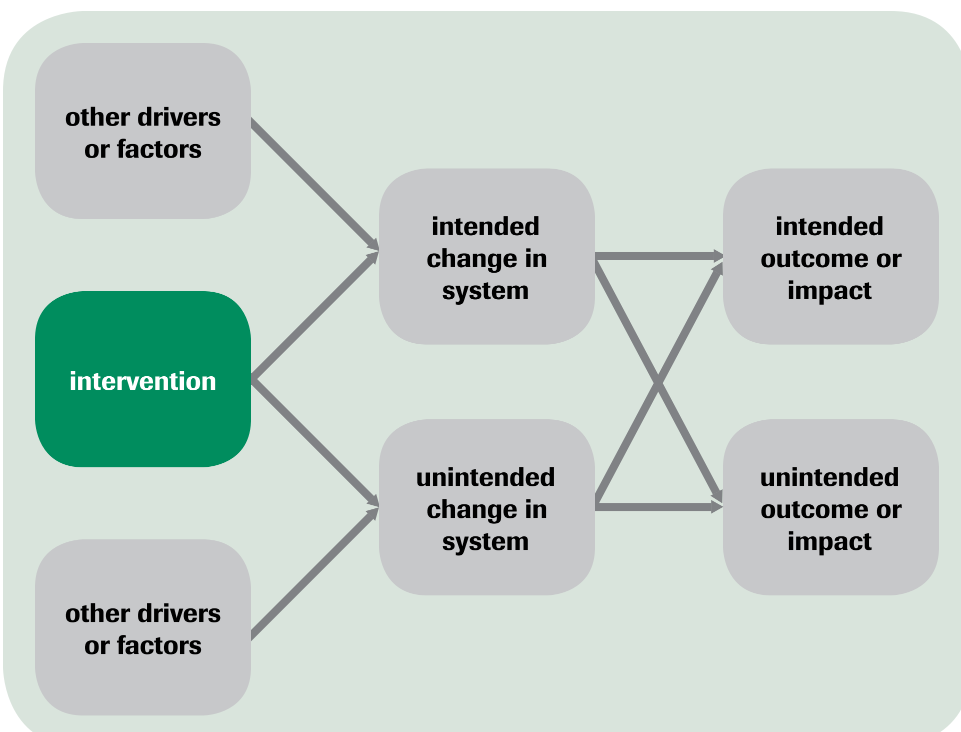
9. Draw results chains that are comparable or can be combined across sectors.

Different sectors and disciplines construct results chains differently. Following these simple specifications will allow chains created by different sectors and disciplines to be more consistent and interoperable.

Basic Recommendations for Comparable Results Chains

- Arrows point from cause to effect for each link.
- Arrows can graphically represent effect size and/or whether effect is positive or negative.
- Arrows can graphically reflect expected time scale of change.
- Each arrow reflects only one hypothesized and testable causal relationship.
- Nodes capture drivers and/or consequences.
- Nodes do *not* capture the direction of change.
- Nodes do *not* represent actors, stakeholders, or context without being associated with a driver or consequence.
- Impacts included in the chain are measurable or observable.

Figure 2. **Generalized view of a results chain that follows the basic elements of Recommendation 9.**



In Figure 3, we see results chains for a simplified, hypothetical rural solar technology intervention that reflect one of the common mistakes of cross-sector results chain creation. In Figure 3a, the nodes relating to the solar intervention and expected, positive impact (household access to energy) are specific and measurable. However, when researchers or practitioners are extending their chains to include impacts, outcomes or other factors outside their area of expertise, "leap of faith" links are common. In this example, forest health was added on as a possible co-benefit of changing the household energy source from charcoal to solar, thus reducing harvest pressure on nearby forests. Some forest-related impact may exist in this case, but forest health itself is too vague a notion to allow observation or measurement, or to enable evidence searches to help summarize current confidence in the likelihood of that impact. It is similarly too vague to help environmental experts understand how their knowledge or actions may be relevant to the intervention being proposed.

Similarly, in Figure 2b we see general nodes for elements of the energy sector introduced. Generalizations of economic drivers and/or social outcomes (e.g. market drivers and local communities) may happen as more environmentally-experienced groups aim to extend their view of an intervention and its impacts. Figure 3b specifies more clearly the potential impacts of a solar light subsidy on local forests, but fails to specify market drivers and household impacts sufficiently.

Figure 3. Hypothetical results chains showing one common mistake of cross-sector examples and how it can be overcome by following Recommendation 9. Consider an example where a solar light subsidy is a possible intervention to increase local solar energy usage. In (a), forest health is included as a possible co-benefit, introducing a node that is too vague as to be measured or observed. In (b), forest health is further specified to measurable elements such as local forest small diameter tree density, but additional elements of the energy pathway are shown as vague nodes (market drivers; local communities). In (c) all nodes are specified clearly enough to allow measurement or observation, to facilitate efforts to understand each link or to assess confidence in each link. Solid lines indicate positive relationships, dotted lines indicate negative relationships.

Figure 3A

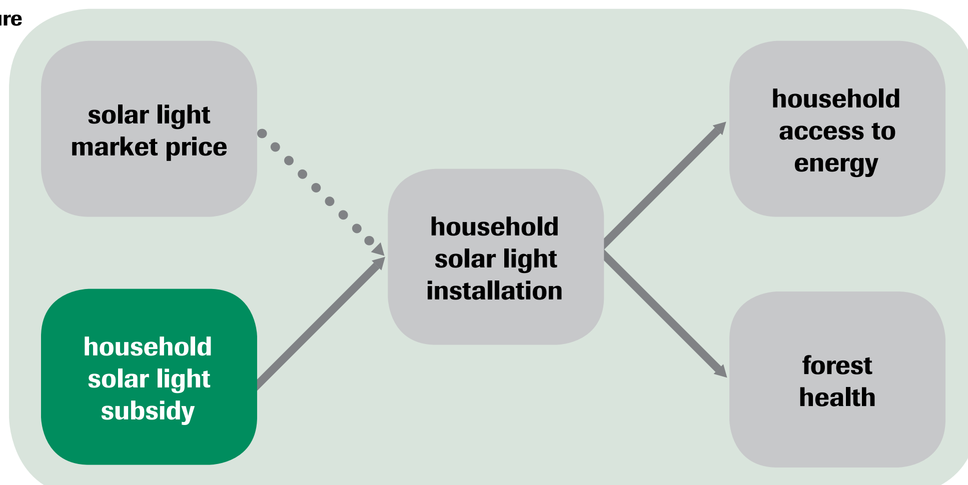


Figure 3B

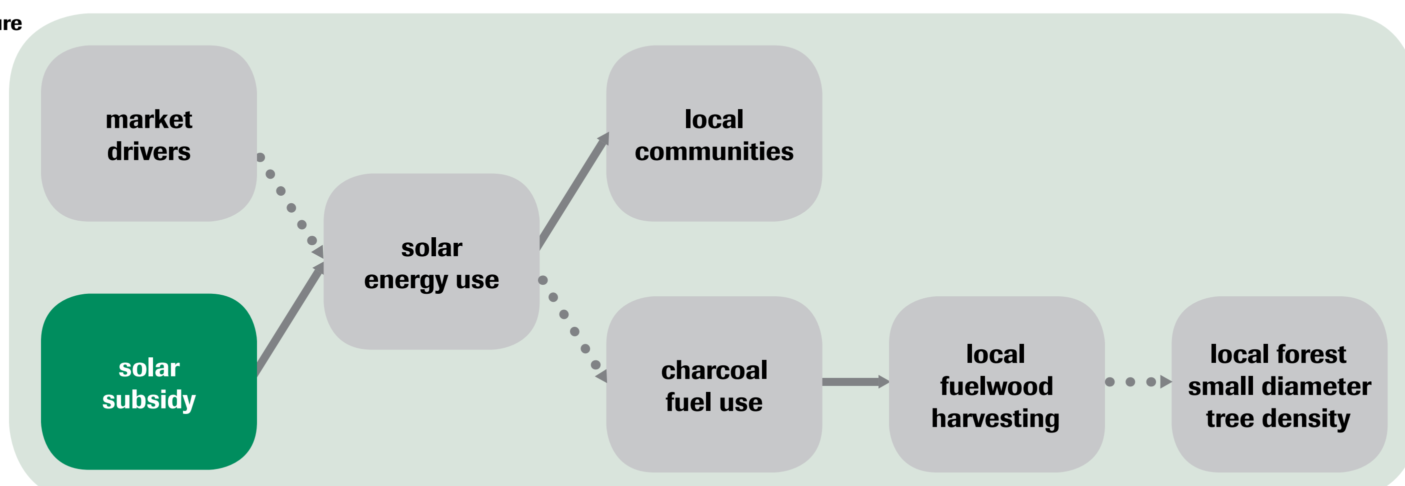
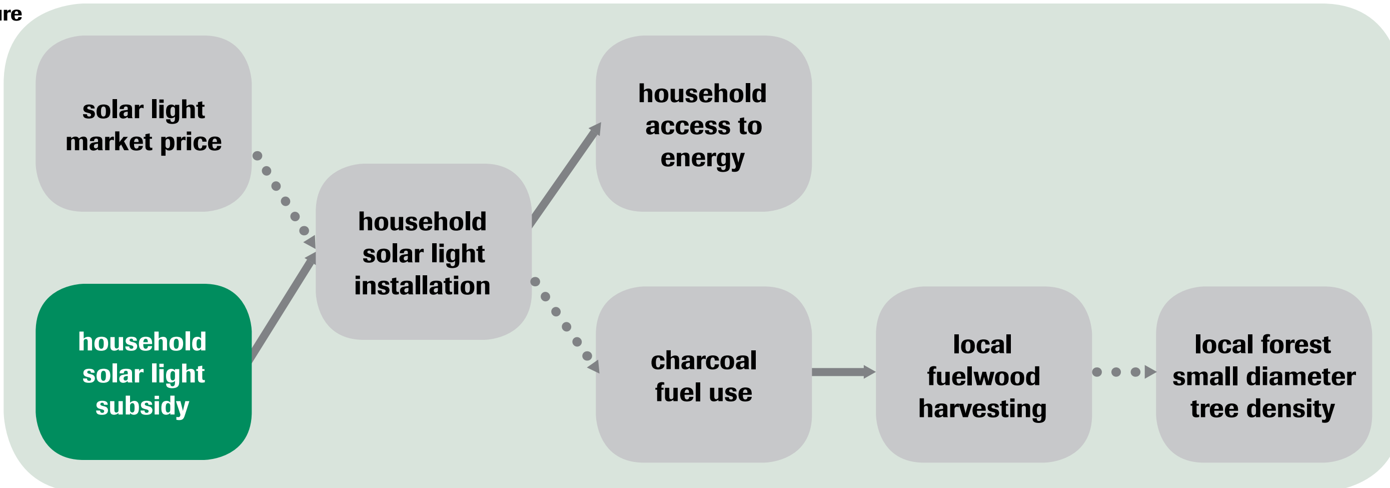


Figure 3C



Several of the specific elements of Recommendation 9 aim to move teams past these stumbling blocks to clearly specified chains that can be tested and understood by experts in other sectors.

- Each link reflects only one hypothesized and testable causal relationship.

To test this element, construct an if-then statement related to each link, and determine if multiple statements are needed to describe the link. If they are, break up the link into multiple links to match those statements. Another useful way to test this element of a results chain is to think through whether the hypothesis reflected by each link could be tested through an experiment or other means. In our hypothetical example, Figure 3a and 3b demonstrate this recommendation as forest health (Fig. 3a) is further specified into a change in local fuelwood harvesting and finally to a change in the density of small diameter trees in local forests (Fig. 3b).

In some cases, it may be useful to construct chains with links that do reflect more than one expected causal relationship (multiple steps in a larger process) when complexity underlying the link is expressed elsewhere (e.g. in a complex, dynamic model), evidence for specific links has been explored and found to be lacking (see Fig. 4, 5 pesticide-related health risks) or when it is necessary to simplify communication with some stakeholders or decision makers.

- Nodes do not represent actors, stakeholders, settings or context without being associated with a driver or consequence.

There is a common tendency for groups attempting to expand their single-sector views to make nodes in chains that represent a population (e.g. women, indigenous communities, elderly people) without specifying what about that population is expected to change. For example, in exercises with various groups to beta test earlier versions of this guidance, some teams added nodes such as "local communities," "human well-being," or "poverty" to their chains. We see this in our hypothetical example (Fig. 3b) with the identification of local communities in the results chains. Such a vague node does not give enough information as to be useful in a planning or research context. When developing cross-sector results chains, review chains for any nodes that specify a general population, actor, stakeholder or setting (e.g. tropical forest, urban) and refine the node to include the aspect of the population or place that is expected to change (e.g. indigenous community employment rate; tropical forest fire frequency). In Fig. 3a and 3c, household access to energy is identified as the aspect of the local population that is most likely to respond to a household solar light subsidy.

- Impacts included in the chain are measurable or observable.

Thinking about how a node would be measured or observed in practice can help reveal whether the node is too vague, or can be clarified further. In the solar technology example, measuring market drivers (Fig. 3b) would be quite a challenge as that node captures many possible drivers. Identifying the particular driver of interest (e.g. Fig 3a, c) will help ensure that any evidence exploration or program monitoring or evaluation are well-targeted to the most relevant market driver for the case.

The Future of Evidence

The cases we provide in this section represent a subset of the issue areas that have gained some attention from cross-sectoral teams. Other areas that have been explored and documented include population, health and environment; zoonoses and the environment (e.g. Zika virus, Ebola virus); and the many connections addressed by integrated development. There are many other global challenges that bring together multiple sectors, but have been less well served by cross-sectoral evidence use. Here, we highlight a few of these challenges currently under exploration by members of the Bridge Collaborative.

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SANITATION, HEALTH AND BIODIVERSITY

Around half of the world's population lacks access to sufficient sanitation.[18] Sewage and wastewater from open defecation, insufficient wastewater treatment and combined sewer overflows present a major global threat to freshwater biodiversity.[19] Child undernutrition, the major underlying cause of death among children under 5 years of age, is largely attributable to insufficient sanitation. This fact highlights the need to find new sanitation solutions that can reach millions of people and hundreds of thousands of river kilometers worldwide. Most evidence of "what works" has focused on household behavior (e.g. hand washing) or infrastructure (e.g. latrines, treatment facilities) solutions. Do these solutions benefit nature as well? Can nature be part of the solution for people? Where and how can development, health and environment sectors work together most efficiently to solve this challenge? A joint working group between the Bridge Collaborative and the Science for Nature & People Partnership (SNAPP) is evaluating existing evidence from water and sanitation health, freshwater ecology, green infrastructure, nutrition and engineering to begin to answer these questions.

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COOKING FOR FORESTS, RESPIRATORY HEALTH AND NUTRITION

There is a well-established link between household energy, forests and respiratory health. Around 3 billion people cook and heat their homes using open fires and simple stoves burning biomass (wood, animal dung and crop waste) and coal.[20] That creates a lot of smoke, now tied to nearly 4 million deaths a year. Transitioning households off of fuelwood to a clean, renewable energy source would dramatically improve health, contribute to a more stable climate, and allow forests in some places to rebound. Lurking around the edges of this picture is a new link–changing the fuel people use to cook may be changing what they cook, with unknown outcomes for nutrition. How strong is this link? What alternative fuels are best for forests, nutrition, breathing and energy? A working group led by Bridge Collaborative members from PATH and the Global Alliance for Clean Cookstoves is using this guidance to look across sectors and clarify what we already do and don't know about this complex nexus.

REFUGEE ACTION FOR PEOPLE AND THE PLANET

Human displacement around the globe has reached unprecedented levels. Displaced people now spend on average 10 years away from their country of origin, emphasizing how the protracted nature of this issue blurs the line between a crisis and a long term development challenge.[21] Host countries struggle to provide sufficient food and basic services as international aid falls short of the need. Real-time environmental collapse in conflict zones can fuel desperation, and the choice to join insurgencies. What are the ways forward for refugee and host community near term needs? What are their best prospects for a viable future? What mix of humanitarian, development and environmental solutions can erode the root causes of conflict, meet needs today and pave a hopeful path forward? Bridge Collaborative members from the Center for Global Development, FHI 360 and The Nature Conservancy are experimenting with a way to bring pop-up capacity to humanitarian teams, using results chains to expand thinking and explore a wider set of solutions to the refugee challenge.

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Case

HOW DO PESTICIDE TAXES AND HABITAT SUBSIDIES COMPARE FOR HEALTH RISKS, INCOME AND THE ENVIRONMENT?

Insect pest problems are among the main causes of crop yield losses in global agriculture as pests reduce crop yields and farmer income, and sometimes challenge local food security. Chemical pesticides are commonly applied to lessen the impacts of these insect pests on crops, but their use can drive environmental harms and create human health risks. Given these multiple connections, pest management provides a good example of an issue that is relevant to health, development and environment communities.

Stylized results chains (Fig. 4, 5) show a simplified view of how two policy interventions for encouraging different pest management options may cause multiple impacts. Is it better to use a market instrument (a pesticide tax) to reduce pesticide use, or let nature reduce the need for pesticides in the first place (through a habitat subsidy)? Which approach is better for farmer's income, health and food security? What about consumers, and the risks they face from pesticide-laden foods? Less pesticide means less pollution, so are both options equally good for the environment? These are difficult questions to answer if we only take one sector's viewpoint and evidence into consideration. Compatible results chains can bring together multiple views and allow consideration of health, income, and pollution impacts at once.

Pesticide taxes are increasingly prominent in European agriculture, with policies in place in Belgium, Denmark, Finland, France, Italy, the Netherlands, Norway, Sweden, Canada (British Columbia) and the United States (Louisiana). For example, in Denmark, an initial 3 percent tax rate was applied, and the tax was refined over

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Figure 4. Simplified results chain for multiple pesticide tax impacts. Arrows indicate positive (solid) or negative (dotted) relationships.

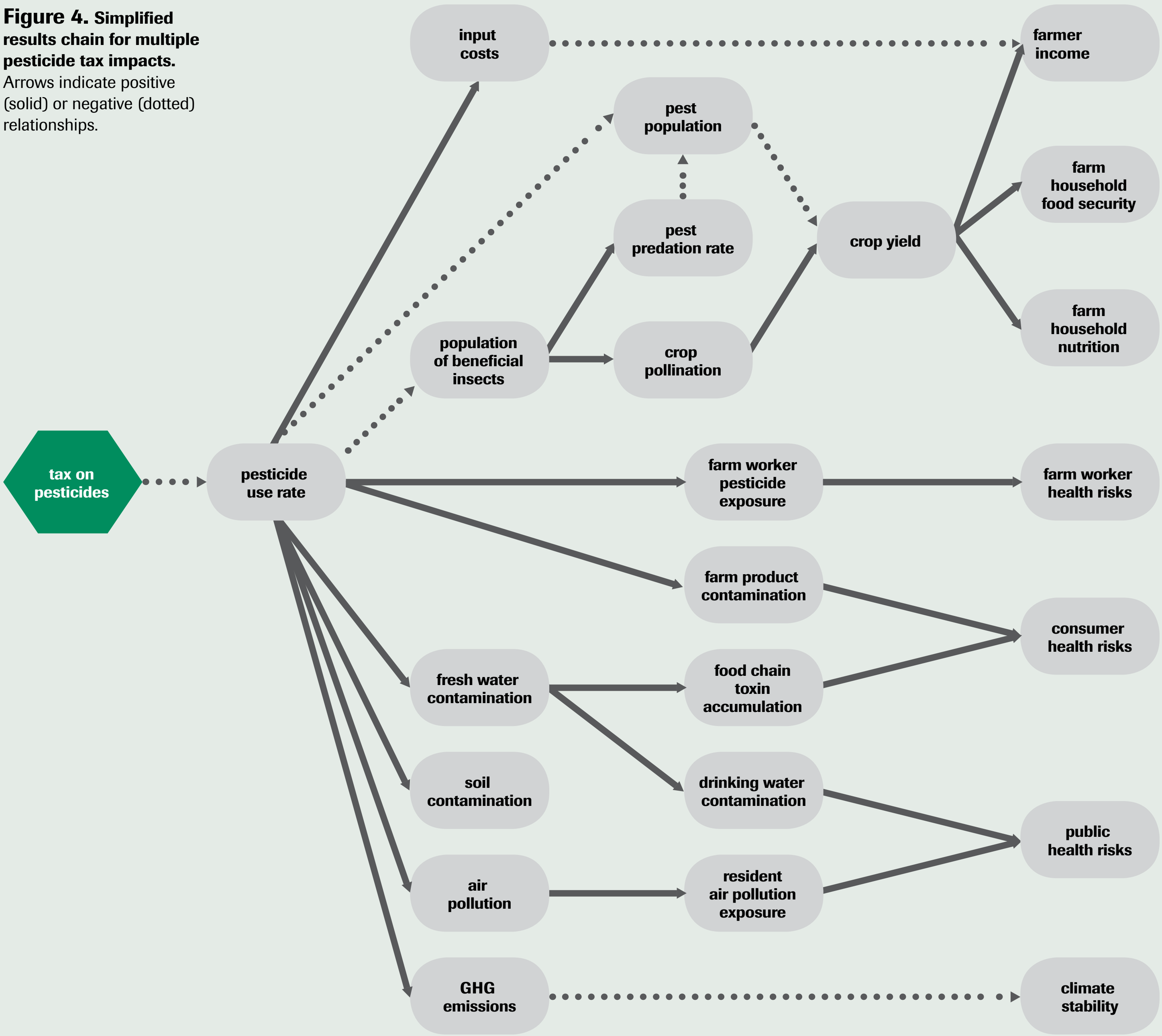
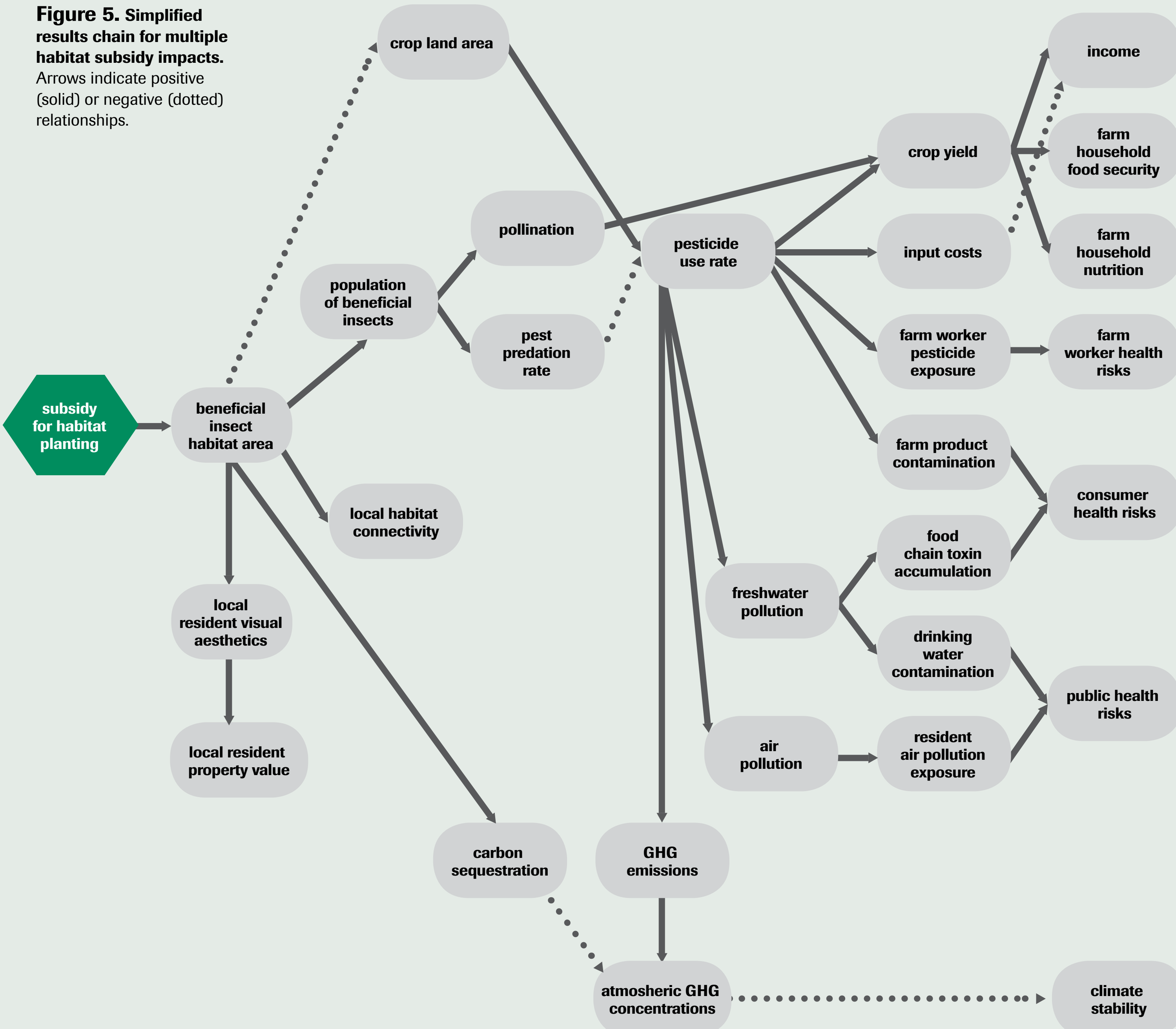


Figure 5. **Simplified results chain for multiple habitat subsidy impacts.** Arrows indicate positive (solid) or negative (dotted) relationships.



time with differentiated tax rates accounting for variable impacts of different pesticides on the environment. Pesticide taxes have multiple impacts on society and the environment, and here we highlight a few main elements (Fig. 4). In brief, the pesticide tax increases the cost of pesticides, reducing their use. The effect of reduced pesticide use on crop yields is determined by the relative strength of two dynamic, countervailing effects: the benefit to crops from increasing beneficial insect populations and harm to crops by release of pests from chemical control. Reduced pesticide use may limit environmental impacts including air, water and soil contamination as well as greenhouse gas (GHG) emissions. These environmental changes, while an end in themselves, may lead to further benefits to consumer, farm worker and public health.

Subsidies for habitat planting in agricultural landscapes provide an alternative intervention for reducing pesticide use. This intervention encourages the planting or conservation of natural habitat around fields. Such habitat subsidies are provided by national and local governments in some countries, for example by Farm Bill provisions in the United States, and by the European Union Common Agricultural Policy. Habitat areas in agricultural landscapes may reduce pesticide use by harboring insect predators and parasitoids that drive down crop pest populations, reducing the need for chemical applications (Fig. 5). While this intervention has the same expected impacts from reducing pesticide use, it introduces several impact pathways that the pesticide tax does not. Habitat area constructed or protected may also harbor helpful pollinator that increase yields of insect-pollinated crops. Habitat may also sequester carbon, adding to the climate stabilization benefits of reducing pesticide use. Adding habitat patches to the landscape can improve local habitat connectivity which may benefit local biodiversity or other species of concern. Further, the presence of habitat on the landscape may be enjoyed by local residents, raising property values. However, not all additional impacts of the habitat subsidy approach are positive from a farmer viewpoint. Farmers may have to give up productive field areas to plant or protect sufficient habitat, reducing the cropped area and as such, limiting yields and revenue. This reduction in revenue may be offset by the habitat subsidy itself, depending on the value of the subsidy and the amount of crop area foregone for habitat. More details on these cases and their assumptions can be found in other resources.[22,23,24]

These chains follow the Bridge Collaborative basic recommendations for creating comparable results chains (see Recommendation 9). While the simplified views of these interventions do not present an obvious 'winner,' they do demonstrate the utility of a common basis from which to compare the pros and cons of each approach across multiple types of impact. The specificity of the nodes (each measurable or observable), clarifies that each intervention may affect several components of the environment (air, water, soil, climate) and present health risks to three different populations through separate exposure pathways (e.g. farm workers through direct contact; consumers through crop consumption or through fish or other aquatic species consumption; general public through air or water pollution). While we would ideally resolve health risks further, they vary dramatically (e.g. multiple cancers, diabetes, neurodegenerative diseases, birth defects, reproductive disorders) based on the particular pesticide in use and the context for application. Health, development and environment impacts are shown in one comparable frame, and further exploration of effect sizes and strength of evidence would provide an even richer view of how these interventions compare and how well current evidence supports hypotheses about the many potential impacts.

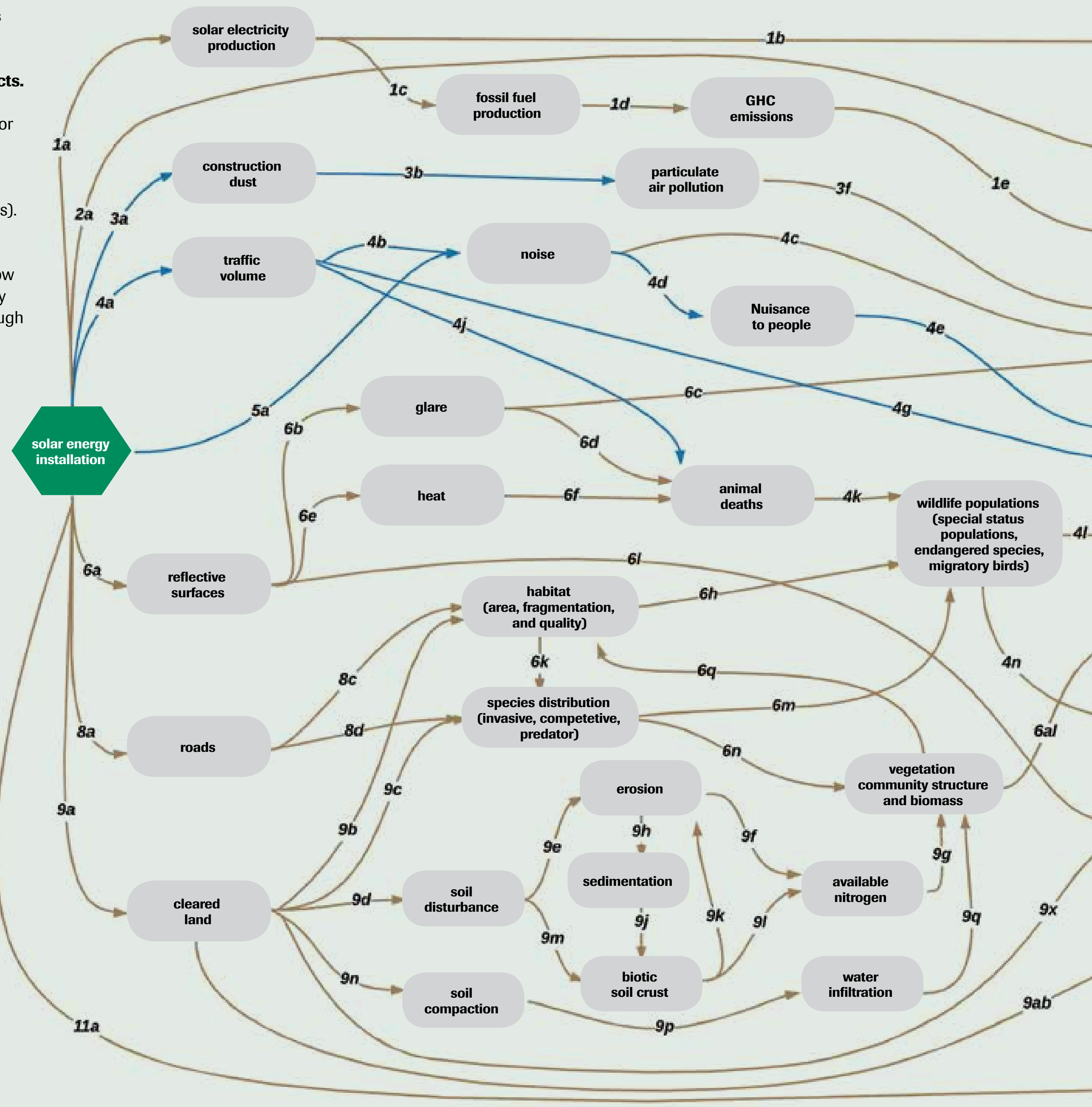
Case

HOW CAN THE US BUREAU OF LAND MANAGEMENT PLAN FOR SOLAR ENERGY, HEALTH AND NATURE?

The United States Bureau of Land Management (BLM) manages large amounts of land in the southwestern US that are ideal for solar energy production, and utility-scale solar energy projects have proliferated on these lands in recent years. Solar projects are typically driven by energy production objectives, and BLM is interested in a more systematic framework to ensure that climate, health and environmental impacts of energy choices on federal lands are fully considered.

Duke University and BLM staff are collaborating to develop a generalized results chain that could be used as a reference point for BLM's energy decisions on lands across the southwestern United States. An amended version of that general chain is shown here (Fig. 6). The intent of developing such a chain is for managers and consultants working on environmental impact statements to use the general model as a starting point

Figure 6. Results chain for multiple solar energy development impacts. Some impacts are expected to persist for short periods (blue arrows) while others are expected to last longer (brown arrows). Evidence associated with the hypothesis underlying each arrow is collated in a library and referenced through the labels on each arrow.



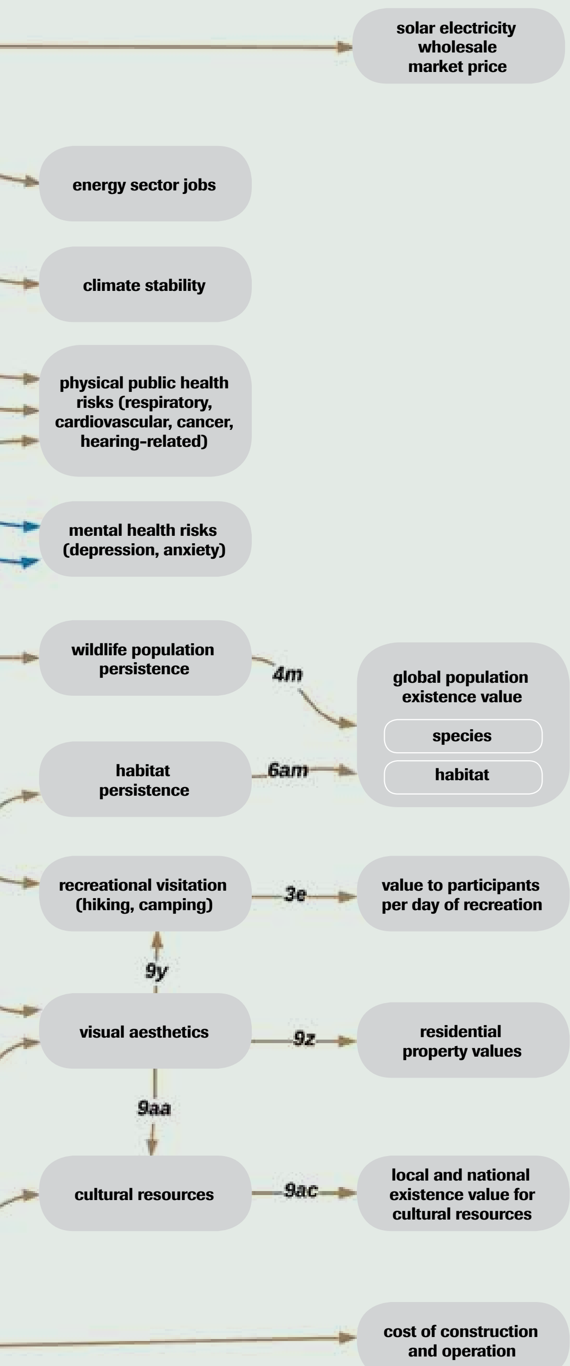
short-term impact

long-term impact

and then adapt it to their needs using local information and expertise. Many of the relationships shown can be positive or negative, depending on the place and context. To clearly document and communicate the hypotheses associated with each link, the results chain is tied to a library of hypotheses and associated evidence from diverse sources across health, energy, ecology, climate and economics sources (through the numbered arrows in Fig. 6). The general model and evidence library supporting it can be found in Warnell et al.[25]

When considering likely outcomes from an intervention, it can be useful to distinguish between temporary impacts, which occur in the short term but do not continue once a driver (for example, construction) is removed, and long-term impacts, which cause changes in the system that persist even after short-term drivers are discontinued. In this example, short-term impacts such as installation impacts on dust and traffic (blue arrows) are differentiated from long-term impacts such as health risks and habitat changes (brown arrows).

Bridge Collaborative members at Duke University are developing other generalized results chain models in other contexts: salt marsh restoration's multiple impacts for national application by the US National Estuarine Research Reserves and fertilizer management strategy implications for the Canadian Fertilizer Institute.



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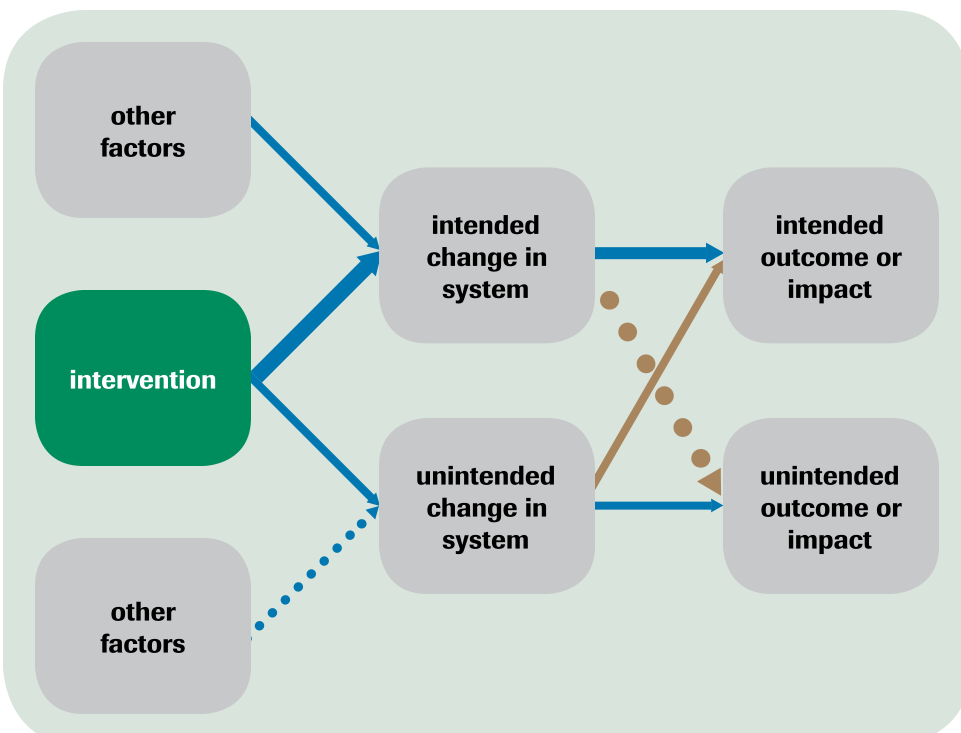
When additional information is available about the effect size or direction of change reflected in a results chain, this information can be added visually so others can easily interpret which changes in the depicted system are likely to be large, and how the system is likely to respond. For example, Figure 7 shows how the size of arrows in a chain can be used to show smaller (Fig. 7, thinner arrows) or larger (Fig. 7, thicker arrows) effect sizes. Many changes in socio-ecological systems are not linear, making it inappropriate to depict a simple positive or negative relationship. When information is known about the functional form of a relationship that is nonlinear, this can be expressed in text accompanying the results chain.

In addition, it may be useful to visually represent differences in time scales of expected changes. In some cases, unintended impacts (positive or negative) are slower to respond than intended impacts. These differences can be shown visually in a results chain, if doing so is useful for interpretation or decision-making. For example, Figures 6 and 7 use blue arrows to indicate faster responding elements of the chain and brown arrows to indicate more slowly responding elements. Use of such visual cues should come with a clear differentiation between fast and slow, for example noting what the difference in time frame reflects.

These two elements of Recommendation 9 prompt consideration of these features when information is available to support them:

- Links can graphically represent effect size and/or whether effect is positive or negative. When known, additional information about the magnitude, details and form of effects can be expressed in supporting text.
- Links can graphically reflect expected time scale of change. Consider reflecting time scales of change that vary dramatically across sectors or that differ from important decision time frames.

Figure 7. Generic example of the additional visual features that can be used in cross-sector results chains. Here, arrows reflect an increase (solid arrow) or decrease (dotted arrow) in the endpoint node and arrow weight indicates effect size (heavier arrows show larger effect sizes, lighter arrows show weaker effect sizes). Arrow color represents the relative time frame of response as fast (blue) or slow (brown).



10. Clearly state assumptions for each link in the chain, enabling other sector experts to understand causal reasoning.

The assumptions underlying links in results chains may be obvious or intuitive to those operating within a sector, but are likely to differ widely across sectors. Explicitly naming the logic connections underlying the links helps to highlight these differences. One sector's assumption may be another sector's challenge to solve. Recommendation 9 suggests making certain that each link in a chain reflects a testable hypothesis. This recommendation goes further, suggesting each assumption associated with each link in a chain be written down clearly.

11. Seek expert input on interpretation of effect sizes.

The magnitude of various causal relationships or effect sizes can be hard for non-experts to interpret. For example, a 1 percent change in an element or function can be meaningless in some cases and transformational in others. When teams cannot include all relevant experts as team members, expert review of interpretation of effect sizes should be sought.

12. Consider additional outcomes, unintended consequences (positive and negative), and additional drivers.

Many unintended consequences occur because a narrow view was taken in initial exploration of a system or intervention. Considering both positive and negative unintended consequences at this stage can reveal connections to other key sectors' impacts or risks. Reviewing considerations of scale, feedbacks and the situation analysis can help reveal possible unintended consequences. Considering these factors can help identify areas where additional interventions will be helpful or necessary. This is a process point where consultation with knowledge holders from other sectors can be very informative.

13. Match the burden of evidence review to the risk of 'getting it wrong'. Higher risk actions relate to those that are:

- *Highly uncertain (low confidence)* AND
- *Associated with high financial risk* OR
- *Associated with high reputational risk* OR
- *Associated with irreversible, extreme changes (such as mortality or extinction)* OR
- *Linked to many subsequent outcomes*

Evidence review can be done quickly through a survey of several relevant experts, or a larger investment of time and resources can be used to support cursory to extensive reviews of all available evidence. We recommend matching the investment in evidence review to the risk associated with the hypothesis being tested. Within a given results chains, there is likely to be a diversity of links with varying levels of associated risk. If a cursory review of evidence shows that link may have low confidence, but the link does not meet any of the other criteria here, a deeper evidence evaluation may not be warranted. If, however, a link does represent a relationship of high financial consequence, high reputational risk, irreversible effect or is a key node central to many subsequent links, a more extensive evidence evaluation is warranted to establish the level of confidence. This recommendation holds regardless of the target audience's tolerance for risk (see Recommendation 16).

14. Draw on all relevant types of evidence from all relevant sectors to evaluate strength of confidence for links in the chain. We consider evidence to include many forms of information (see definitions for an explanation of each):

- Quantitative studies
- Qualitative studies
- Theory
- Model results
- Expert knowledge
- Measurement results

Reviewing evidence to resolve linkages, and clarify hypotheses and assumptions can improve results chains.

However, sectors and disciplines do not fully agree on the types of information that can be considered as evidence for this use. For example, the medical field historically preferred randomized control trials,[26] while other efforts in the health,[27] development and environment[28,29] sectors include other types of evidence. Views in the medical field are expanding. For example, Cochrane Reviews now allow inclusion of non-randomised studies, economic data and equity considerations,[30] while methods for additional evidence types are under development. The Bridge Collaborative recommends drawing on all relevant types of evidence from all relevant sectors, recognizing the need for cross-sector problem solving to be inclusive. Other groups have advocated for such a broad definition of evidence. Attaining access to available evidence will require searches from multiple disciplines, sectors and sources that may be helped by looking across multiple language sources and expanding keyword lists and expert networks.

15. Assess and reflect strength of confidence in evidence for links in chain by applying the provided rubric to available evidence.

Once available evidence has been collected, stating the confidence in the hypotheses reflected by each link or in an overall results chain can be useful in several ways. First, reviewing evidence can improve the chain, often further resolving linkages and clarifying hypotheses and assumptions. Looking at the confidence in a chain can inform risk assessment (where are areas of uncertainty and high risk?) and decisions about whether and how to proceed with an intervention. For example, we may have very low confidence in a few links in a chain. If those links are high risk (because they are very important to a key stakeholder, or associated with high costs, etc), we may choose not to proceed with an action. Alternatively, we may identify additional interventions to mitigate those risks, or invest in monitoring and evaluation to increase our confidence and understanding.

We introduce a shared evidence evaluation rubric because each sector currently has multiple rubrics for evaluating evidence. For consistent interpretation of evidence from multiple sectors, a common rubric is needed. The Bridge Collaborative has developed a rubric with elements of confidence that are common and agreeable across communities. This rubric follows closely the confidence frameworks of the IPCC,[31] IPBES,[32] and the US National Climate Assessment.[33] However, these existing rubrics are not fully consistent with each other and are not systematically applied to the development of results chains in all sectors.

The proposed rubric includes four confidence levels (Table 1). We introduce four levels rather than three for two reasons. First, research shows a human cognitive bias towards a middle category when three options are provided. This tendency is referred to as "middle bias" or the "center-stage effect".[34,35,36] The presence of four categories can help mitigate against this effect. In addition, the four levels introduce additional information and nuance that would be lost with three categories. While the language differentiating the levels may seem vague (e.g. several types of evidence versus. a few types of evidence), initial testing of the rubric by Bridge Collaborative members indicated that these designations were useful once a specific set of evidence was in hand for evaluation. Further testing of the rubric will reveal whether improvements are needed.

In this rubric, high confidence in the hypothesis underlying a link can be stated when multiple types of evidence (e.g. randomized control trials, model results and qualitative focus group results) support the assumption; results are consistent across sources, types of evidence and contexts; methods used across evidence types are well documented and accepted by the relevant field(s); and available evidence is highly applicable to the study or practice context. All four criteria must be met for a high confidence statement to be applied.

The same criteria define the other confidence levels with decreasing diversity of evidence types, consistency of results, establishment of methods and applicability from moderate to low confidence (Table 1). In the rare instances where there is no evidence available, that condition can be stated and no confidence given to the assumption. When using this rubric, document the rationale for the confidence level chosen.

Table 1

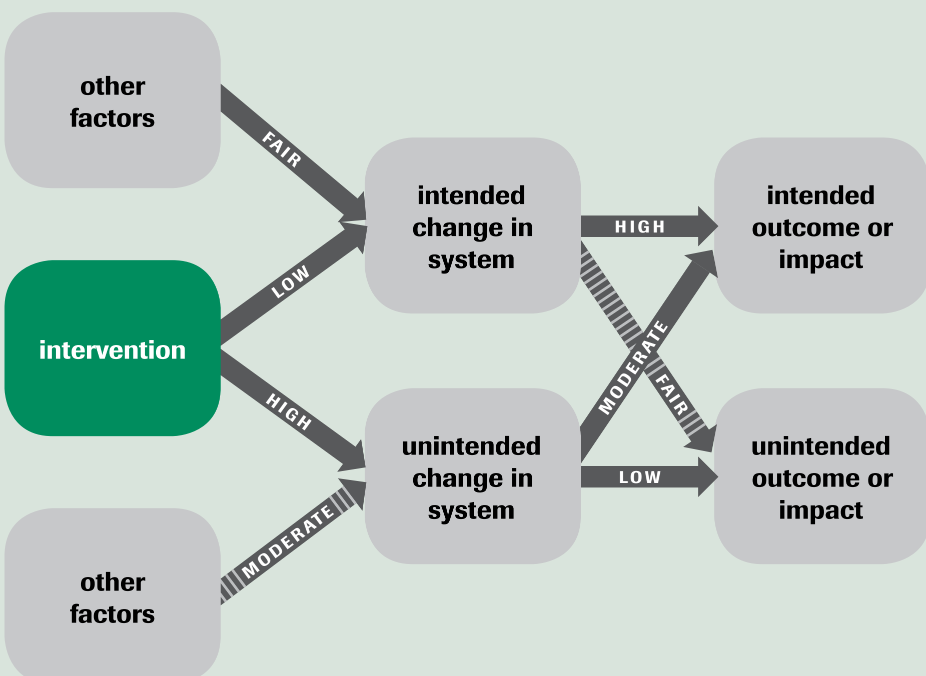
Confidence Level	Criteria: Types of Evidence	Consistency of results	Methods	Applicability
High	**multiple**	**AND consistent across sources, types of evidence and contexts**	**AND well documented and accepted**	**AND high**
Moderate	**several**	**some consistency**	**not fully accepted, some documentation**	**some**
Fair	**a few**	**limited consistency**	**emerging, limited documentation**	**limited**
Low	**limited, extrapolations**	**inconsistent**	**poor documentation or untested**	**limited to none**

Unified evidence evaluation rubric for identifying confidence in results chain assumptions across health, development and environmental evidence. Applicability refers to the similarity in ecological, social, political, economic or other relevant conditions between those represented in the available evidence and those in the case to which the evidence is being applied. Consistency refers to the agreement across findings in a body of evidence, not the lack of variability in observed relationships. We define accepted methods as those that have been peer reviewed and broadly supported by a community of practice.

This rubric would advance the use of evidence across sectors most rapidly if it could be applied by experts and non-experts consistently. In a preliminary test of the rubric, a small group of Bridge Collaborative members were given case examples and a set of peer-reviewed publications from outside their sector of expertise to evaluate using the rubric. We used three cases related to transportation development from each of the three different sector entry points. A development case explored how rural road development can increase access to markets, leading to increased rural household income. An environment case explored how urban transportation development planning can influence biodiversity habitat connectivity in urban settings. Finally, a health case explored how urban transportation planning can influence elder health through access to services and localized air pollution impacts on respiratory disease. Each case had an associated set of peer reviewed papers (a narrow set of evidence that was easily accessible for this test). Each case was presented to a set of non-experts for evaluation (health experts received the environment case; environment experts received the development case and development experts received the health case). For each case, the same set of papers was evaluated with the rubric by sector experts. In this simplified, cursory test, experts and non-experts arrived at the same confidence statements. Much further testing and refinement is needed to understand how useful this rubric can be when applied by sector experts or non-experts in different contexts.

When this rubric has been used, it may be helpful to represent the strength of confidence identified for each link in a results chain. As this rubric is newly developed, we are in the process of the first applications of the rubric to real cases. Figure 8 shows one way that the confidence in each link could be shown visually in a generic results chain.

Figure 8. **In this generic example, text associated with arrows indicate the level of confidence, given available evidence. Arrows indicate positive (solid) or negative (hashed) relationships.**



Application of this rubric will allow researchers and practitioners within and across sectors to share findings of ‘what works’ and what does not on a consistent basis of what constitutes strong evidence. For example, researchers using an evidence based results chains to explore the ability of forest management interventions to reduce risk of exposure to malaria, heat stress or respiratory disease could express the confidence in their findings in terms that medical practitioners, public health officials or ministers of health would understand and accept. Similarly, results chains constructed following this guidance could aid the myriad actors currently searching for solutions to complex challenges like climate adaptation. In particular, they would allow examination of a much broader set of interventions using a common basis for assessing effectiveness of efforts aiming to improve multiple outcomes from food security to flood risk reduction, nutrition, gender equity or ecosystem resilience.

CHOOSE INTERVENTIONS AND SELECT IMPACTS, METRICS AND MONITORING PLAN

16. Interpret the relevance of confidence (strength of evidence) based on the decision context and decision maker(s).

Different strengths of evidence may be desired depending on the risk tolerance of the decision-maker(s) and on the use of the information. For example, a team designing a single, small, low risk project may have a higher tolerance for uncertainty and risk than a team setting a national standard or defending a case in a court of law. Different decision makers also have different tolerances for risk. For example, a venture capitalist interested in the search for revolutionary new ideas may have a high tolerance for risk, while a large, multilateral lender or government agency may have a lower risk tolerance. As such, the consideration of confidence statements when selecting interventions could lead to different decisions in different contexts. For example, a venture capitalist may intentionally choose to invest in a high risk, potential high return intervention while a more conservative investor would avoid the same intervention.

17. Compare and contrast possible interventions based on

- *Feasibility considerations such as time, social constraints, degree of complexity*
- *Anticipated cost-effectiveness*
- *Sustainability*
- *Equity*

18. Use results chains to develop and focus on priority metrics that capture key cross-sector connections efficiently.

Cross-sector problem solving can cause an explosion of metrics when each sector brings long lists of metrics to the process. Rather than taking all metrics from all sectors, the results chain can help identify which linkages across sectors are critical and least understood, providing good candidates for monitoring and evaluation. Priority metrics could include those that reflect influential links to priority sector outcomes, high risk links with low confidence, and/or links that connect to unintended consequences (positive co benefits and negative risks). Use cross-sector exploration of metrics to find efficiencies for monitoring. Identify metrics that add valuable information for multiple sectors and determine which sector is best positioned to collect information on each metric.

For example, beta testing of this guidance by The Nature Conservancy in the Northern Rangelands of Kenya helped identify intersecting chains and allowed narrowing of the metric set. The program uses an intervention for sustainable grazing that requires more herders than traditional grazing. One outcome of this intervention is increased employment, which is also a local development objective. Similarly, the group found possible connections between the conservation intervention and health outcomes related to livestock product consumption. The conservation intervention results chain suggested that by improving local forage production for cattle, local supplies of milk and meat could also be increased, leading to possible improvements in nutrition, an objective of local health programs. The knowledge of these intersections helped stakeholders choose a reduced list of focal metrics that were of interest to multiple sectors, and made monitoring efforts more efficient. The exercise also helped stakeholders understand how their interests were connected.

IMPLEMENT

19. Identify the most effective actor(s) for each intervention.

To maximize the efficiency of working across sectors, it is important to leave room for groups to decide when collaboration may be superfluous rather than useful.[2] Identification of a fuller solution set from which to select the optimal set of interventions to address a complex problem requires representation from each sector. However, it may be feasible to implement a given solution solely within a single sector, depending on the particular intervention selected. Even when implementation can be done by one sector, coordination with other interventions being carried out by other sectors may be needed.

MONITOR, EVALUATE AND ADAPT

20. Create and make use of opportunities to learn about effectiveness or needed improvement in cross-sector efforts.

Many past efforts have aimed to integrate resources, projects and programs across health, development and environment, or subsets of these sectors. In some cases, the added value of cross-sector collaboration has been documented. For example, some population, health and environment programs have documented improved efficiencies from cross-sector programs.[37] However, many of the supposed cross-sector benefits are not yet well documented,[37] and as such, any new efforts that do include expanded cross-sector views could tailor monitoring and evaluation efforts to improve our overall understanding of if, when and how cross-sector collaboration adds value.

Applying the Guidance to Create Reference Results Chains

While we intend for this guidance to be useful by single sector and cross sector teams alike, it can be challenging for single sector teams to represent causal relationships outside their area of expertise. To aid in these situations, the Bridge Collaborative guidance could be applied to create a generalized set of results chains as a reference for practitioners.

Having such a reference library of chains would allow people to start with a familiar intervention and see what unintended impacts (positive and negative) might be plausible. For example, one could look up malaria bed net distribution as an intervention, and learn that in addition to the intended outcome of reduced exposure to mosquitos and reduced malaria transmittance rate, the distribution of bed nets could lead to the use of nets for fishing, leading to an unanticipated decline in local fisheries, and loss of local income and nutrition.[38]

Some efforts exist to compile results chains libraries, with the most advanced including syntheses of existing strength of evidence for links within generalized chains. For example, the International Rescue Committee supports an Outcomes and Evidence Framework as an online, freely accessible resource summarizing strength of evidence for common humanitarian and development interventions and their associated outcomes. Conservation Evidence, primarily led by faculty at the University of Cambridge, is another growing online resource evaluating evidence for effectiveness of conservation interventions for biodiversity and ecosystem service impacts. These are incredibly rich resources that demonstrate the utility and power of reference results chains and libraries. Yet, they could be further expanded to include cross-sector impacts and views.

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Appendix: Toolkit for Research and Practice

References for sector-specific or cross-sector general planning guidance

Ecoagriculture Guide for Partnerships http://ecoagriculture.org/publication/public-private-civic-partnerships-for-sustainable-landscapes/

FHI 360 Guidance on Integrated Development https://www.fhi360.org/resource/resource-package-integrated-development-learning-action

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The Consolidated Framework for Implementation Research (CFIR) http://cfirguide.org/index.html.

IPES (International Panel of Experts on Sustainable Food Systems), http://www.ipes-food.org/images/CoreDocs/IPES-Food_10_principles.pdf

Scientific and Technical Advisory Panel (STAP) for the Global Environment Facility (GEF) guidelines for designing projects in a rapidly changing world: http://www.stapgef.org/rapta-guidelines

SUN (Scaling Up Nutrition) http://scalingupnutrition.org/about-sun/the-vision-and-principles-of-sun/

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WLE (Water, Lands and Ecosystems - CGIAR) https://cgspace.cgiar.org/rest/bitstreams/55182/retrieve

REFERENCES FOR VARIOUS PLANNING AND RESEARCH PROCESS STAGES

Process Stage	Tools & Methods	Resources
Define and analyze the situation and set goals	Objectives hierarchy	Keeney, R. L. (2009). Value-focused thinking: A path to creative decisionmaking. Harvard University Press.
	Systems map/ diagram	FHI 360. Development Sector Adjacency Map (2016). https://www.fhi360.org/sites/default/files/media/documents/resource-id-adjacency-map.pdf USAID. Integrating Population, Health, and Environment Projects (2007). http://www.ehproject.org/pdf/phe/phe-usaid_programming_manual2007.pdf
	Root cause analysis/ mapping	MCC Root Cause Analysis Guidelines https://www.mcc.gov/resources/story/story-cdg-chapter-6-guidelines-for-root-cause-analysis
	Strengths/ weaknesses/ opportunities/ threats (SWOT) analysis	WRI http://pdf.wri.org/sustainability_swot_user_guide.pdf EPA https://cfpub.epa.gov/watertrain/moduleSingleFrame.cfm?parent_object_id=2338
	Problem tree analysis	Management for Development Foundation http://www.toolkitsportdevelopment.org/html/resources/91/910EE48E-350A-47FB-953B-374221B375CE/03%20Problem%20tree%20analysis.pdf ODI Problem Tree Toolkit https://www.odi.org/publications/5258-problem-tree-analysis Sustainable Sanitation and Water Management Problem Tree Analysis http://www.sswm.info/content/problem-tree-analysis FAO Problem Tree Tool http://www.fao.org/capacity-development/resources/practical-tools/capacity-assessment/problem-tree-tool/en/
	Systems model	Fulton EA, Boschetti F, Sporcic M, Jones T, Little LR, Dambacher JM, Gray R, Scott R, Gorton R. A multi-model approach to engaging stakeholder and modellers in complex environmental problems. Environmental Science & Policy. 2015; 48:44–56. doi:10.1016/j.envsci.2014.12.006
	DPSIR framework	Gabrielsen P, Bosch P. Environmental indicators: typology and use in reporting. EEA, Copenhagen. 2003.
	Context analysis	UNDP Context Analysis Guidance Note http://www.undp.org/content/dam/undp/library/Democratic%20Governance/OGC/UNDP_Institutional%20and%20Context%20Analysis.pdf World Food Program Integrated Context Analysis http://documents.wfp.org/stellent/groups/public/documents/communications/wfp264472.pdf
	Stakeholder map	The net-map toolhttps://netmap.wordpress.com/about/ Public-private-civic partnerships for sustainable landscapes https://www.idhsustainabletrade.com/uploaded/2017/03/Public-Private-Civic-Partnerships-for-Sustainable-Landscapes-Practical-Guide-for-Conveners_webVrs.pdf

Process Stage	Tools & Methods	Resources
Define and analyze the situation and set goals (cont'd.)	Stakeholder engagement processes	UNDP. Multi-stakeholder engagement processes: a UNDP capacity development resource. United Nations Development Program. 2006. http://www.undp.org/content/undp/en/home/librarypage/capacity-building/accountability/multi-stakeholder-engagement-processes.html
	Situation analysis diagram	The Nature Conservancy. Conservation by Design 2.0 (2016). https://www.conservationgateway.org/ConservationPlanning/cbd/Documents/CbD2.0_Guidance%20Doc_Version%201.pdf
	Evidence gap maps	3ie. Evidence Gap Maps (2016). http://www.3ieimpact.org/en/evidence/gap-maps/ Evidence maps and evidence gaps: evidence review mapping as a method for collating and appraising evidence reviews to inform research and policy https://environmentalevidencejournal.biomedcentral.com/articles/10.1186/s13750-017-0096-9
	Evidence grading schemes	IPCC, IPBES, Conservation Evidence, Center for Environmental Evidence, Eco-Evidence Analysis, GRADE, Environmental GRADE, ConQual, Hierarchy of evidence for qualitative health research, Evidence Assessment Tool for Ecosystem Services and Conservation Studies, USDA Nutrition Evidence Library Evaluation Criteria, Platinum Standard for Evidence Based Assessment, System for Grading Qualitative Evidence.
Analyze possible interventions or develop research hypotheses using results chains	Conceptual model/ diagram	Oglethorpe, Honzak, and Margoulis. Healthy People, Healthy Ecosystems (2008). http://assets.worldwildlife.org/publications/370/files/original/Healthy_People__Healthy_Ecosystems_A_Manual_on_Integrating_Health_and_Family_Planning_into_Conservation_Projects.pdf
	Logic model/ diagram	Kellogg foundation. Logic Model Development Guide (2004). http://www.bttop.org/sites/default/files/public/W.K.%20Kellogg%20LogicModel.pdf
	Results chain	The Nature Conservancy. Conservation by Design 2.0 (2016). https://www.conservationgateway.org/ConservationPlanning/cbd/Documents/CbD2.0_Guidance%20Doc_Version%201.pdf Donor Committee for Enterprise Development (2015). http://www.enterprise-development.org/wp-content/uploads/1_Implementation_Guidelines_Results_Chains_Apr_2015.pdf USAID. Using Results Chains to Depict Theories of Change in USAID Biodiversity Programming (2016). http://pdf.usaid.gov/pdf_docs/PA00M8MW.pdf The Open Standards. Results Chains References (links to many sources). http://cmp-openstandards.org/guidance_topics/results-chains/ World Health Organization. The Results Chain (Infographic). http://www.who.int/about/resources_planning/WHO_GPW12_results_chain.pdf Foundations of Success http://www.fosonline.org/wordpress/wp-content/uploads/2010/08/FOS_Results_Chain_Guide_2007-05.pdf

Process Stage	Tools & Methods	Resources
Analyze possible interventions or develop research hypotheses using results chains (cont'd.)	Log frame	http://www.betterevaluation.org/en/evaluation-options/logframe
	Adaptation pathways	Wise RM, Fazey I, Stafford Smith M, Park SE, Eakin HC, Archer Van Garderen ERM, Campbell B. Reconceptualising adaptation to climate change as part of pathways of change and response. Global Environmental Change. , 2014; 28:325–336. doi:10.1016/j.gloenvcha.2013.12.002 Butler JRA, Suadnya W, Yanuartati Y, Meharg S, Wise RM, Sutaryono Y, Duggan K. Priming adaptation pathways through adaptive co-management: Design and evaluation for developing countries. Climate Risk Management. 2016; 12:1–16. doi:10.1016/j.crm.2016.01.001
	Theory of change	USAID. Using Results Chains to Depict Theories of Change in USAID Biodiversity Programming (2016). http://pdf.usaid.gov/pdf_docs/PA00M8MW.pdf Innovations for Poverty Action. Guiding Your Program to Build a Theory of Change (2016). http://www.poverty-action.org/sites/default/files/publications/Goldilocks-Deep-Dive-Guiding-Your-Program-to-Build-Theory-of-Change_2.pdf Woodhill, J. 2014. Understanding Theory of Change
	Results framework	World Bank. Results Framework and M&E Guidance Note (2013). http://siteresources.worldbank.org/PROJECTS/Resources/40940-1365611011935/Guidance_Note_Results_and_M&E.pdf
	Evidence gap maps	IPCC, IPBES, Conservation Evidence, Center for Environmental Evidence, Eco-Evidence Analysis, GRADE, Environmental GRADE, IRC iOEF, ConQual, Hierarchy of Evidence for Qualitative Health Research, Evidence Assessment Tool for Ecosystem Services and Conservation Studies, USDA Nutrition Evidence Library Evaluation Criteria, Platinum Standard for Evidence Based Assessment, System for Grading Qualitative Evidence
Choose interventions (or research questions) and select impacts, metrics & monitoring plan	Multi-attribute value functions	Keeney, R. L. (2009). Value-focused thinking: A path to creative decisionmaking. Harvard University Press.

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