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Climate Related Game Changers

Enhancing Adaptation Program Impact to Address Climate Game Changers.

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List of Acronyms

COP 22	Conference of Parties, 22nd Session
CGIAR	Consultative Group on International Agricultural Research
SDGs	Sustainable Development Goals
UNEP	United Nations Environment Programme
FAO	United Nations Food and Agriculture Organization
IPCC	United Nations Intergovernmental Panel on Climate Change
AR6	United Nations Intergovernmental Panel on Climate Change Sixth Assessment Report
USAID	Unites States Agency for International Development
WMO	World Meteorological Organization

Enhancing Climate Adaptation Program Impact to Address Game Changers

The United Nations Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6) makes clear that the impacts of climate change on lives and livelihoods in many areas of the world are both more immediate and, barring large efforts at adaptation and mitigation, likely to be more pronounced than estimated in previous reports.[1] Evidence suggests that significantly more resources will be needed in mitigation and that immediate and sustained investment in adaptation is necessary to prevent the worst development outcomes.[2] Many communities are already experiencing "game changing" situations. For the purposes of this report, a climate game changer is defined as a situation in which a community currently faces or will face within the next two decades substantial and sustained stress from climate change that will result in significant impacts on lives and livelihoods.

Flows of climate finance have been insufficient in amount and efficiency to address the magnitude of the challenges confronting developing countries. Climate assistance to developing countries was $79.6 billion in 2019,[3] with only about fourteen percent of public climate finance allocated for adaptation.[4] The United Nations estimates that up to $300 billion annually will be needed for adaptation in developing countries by 2030, in addition to climate change mitigation efforts.[5]

To adequately address climate game changers, a shift in adaptation funding prioritization and implementation, along with an increase in amount, will be necessary. The AR6 Working Group II report, focusing on impacts, adaptation, and vulnerability to climate change, finds that "[m]ost observed adaptation is fragmented, small in scale, incremental, sector-specific, designed to respond to current impacts or near-term risks," that this has come at the expense of transformational, systems-level adaptation, and that finance amounts are significantly below what is needed to address the scale of the challenge.[6]

The immediacy of climate impacts coupled with the need for broad-based change underscores the importance of the approach adopted in the United States Agency for International Development (USAID) Climate Strategy 2022-2030 to pursue both targeted direct action and systems change with regard to climate change adaptation and mitigation.[7] The lack of consensus in the international community regarding measurement and definitions has created the opportunity for an agency such as USAID to play a global

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[1] H.-O. Pörtner, et al, eds., "Climate Change 2022: Impacts, Adaptation, and Vulnerability," *IPCC Intergovernmental Panel on Climate Change (IPCC) Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press. In Press, 2022).

[2] United Nations, "The trillion dollar climate finance challenge (and opportunity)," *UN News* (June 27, 2021).

[3] United Nations Environment Programme, *Adaptation Gap Report 2021: The Gathering Storm – Adapting to climate change in a post-pandemic world* (UNEP 2021).

[4] Climate Policy Initiative, *Global Landscape of Climate Finance* (2021).

[55] United Nations Environment Programme. *Adaptation Gap Report 2021: The Gathering Storm – Adapting to climate change in a post-pandemic world* (UNEP 2021).

[6] Pörtner, et al, eds., "Climate Change 2022."

[7] United States Agency for International Development, *USAID Climate Strategy 2022-2030* (USAID Washington, D.C., 2022).

leadership role in crafting comparable metrics, methods, and models for estimating broad impacts of adaptation efforts and informing prioritization of adaptation programs across multiple countries and sectors.

The findings in this report do not represent new science; they present an analysis that seeks to cut through the vast quantity of existing research and provide concrete, broad-impact actions to consider for enhancing the impact of climate programs. Researchers examined literature related to six climate stressors that can create "game changing" situations for lives and livelihoods: precipitation changes, temperature changes, storms, sea-level rise, soil quality, and desertification. The six stressors were chosen in consultation with USAID. The goal of this report is to conduct sufficient review of the literature to draw generalizable conclusions that can inform development programming. The focus on six stressors allows sufficient breadth to draw conclusions but is not meant to be exhaustive. Additionally, while each of these stressors can create game changing situations, not all manifestations of these stressors will create conditions that rise to a game changing level. Conclusions are drawn from an extensive literature review and from workshops with climate-development experts.

Results of the literature were analyzed against existing USAID public documents in order to augment what is already known rather than repeat existing findings.[8] The analysis showed that USAID documents have a strong underpinning of the current state of the literature on climate stress. Regional and country climate risk profiles developed by USAID, while they would benefit from including new information from the IPCC AR6 report and related documents, currently show a clear understanding of climate risks by region.

The finding that stands out most forcefully from a review of academic, organization, and policy publications across all six climate stressors is the anecdotal and disjointed nature of evidence regarding when and how different types of climate development interventions produce positive impacts. The research team set out to identify generalizable findings regarding the impacts of the six climate stressors on human lives and livelihoods, particularly with regard to social, economic, and political game changing impacts, and with a focus on filling gaps in knowledge, connecting across findings, and identifying cascading effects. Instead, the research found that the literature lacks synthesis, generalizability, and agreement on basic concepts, including how to measure impact of climate adaptation. These gaps in knowledge are hampering the ability of development agencies worldwide (both transnational and domestic) to maximize impact with climate financing. This is not particular to game changing situations, but the need to change course and fill knowledge gaps is more urgent in these cases.

This report identifies three key areas of knowledge gaps that are inhibiting climate-related development programming and suggests innovative ways forward based on current research. First, the ability to prioritize adaptation programs will require new types of transdisciplinary modeling of society-wide (cascading) impacts informed by high quality data and metrics. Second, effective systems-wide programming will need to incorporate innovation in implementation, including incorporating and testing innovations suggested by behavioral science to scale out high impact/low investment programs to hundreds of millions of individuals and households who will be the frontline implementers of climate strategy. Third, game changing situations will create migration, much of it internal, that will impact development well beyond areas of immediate climate impact. The ability to plan for and respond to internal migration will depend on producing better data and predictions regarding human mobility so that

[8] The research team reviewed all USAID Regional Climate Risk Profiles available at https://www.climatelinks.org/climate-risk-management/regional-country-risk-profiles.

programming can account for predicted movements and the related stress on social, economic, and political systems.

This report details findings in the literature related to these gaps and identifies potential future pathways to inform programming. The broad analysis is followed by a case study of smallholder farmers, a sector already experiencing game changing conditions and one that is affected by all six of the climate stressors studied. The case study examines how these three broader findings apply in this sector. The identified gaps in the current state of research are relevant across game changers. Overcoming them will be instrumental for developing strong programmatic responses, particularly at the systemic level.

Methods

This report represents an analysis of existing findings; it does not represent new science. Research included a broad literature review focusing on keywords including and related to the six climate stressors (precipitation changes, temperature changes, storms, sea-level rise, soil quality, and desertification) as well as an in-depth review of relevant organization websites and top journals. The initial search yielded 2,467 academic articles and 677 reports from outside academic journals. Articles were filtered to retain those that focus on development outcomes, focus on developing countries, and meet acceptable standards for methodological quality. The final set of 181 articles was coded for game changers, impacts, and potential policy solutions, along with additional information — such as time frame and geographical area — that helped categorize the analysis. A PRISMA chart showing this process is included in Appendix A. The research team additionally reviewed publicly available reports from USAID related to climate change, focusing on Regional Climate Risk Profiles.[9]

The team conducted a series of meetings with an interdisciplinary set of ten experts based in Chile, Germany, India, Malawi, and the United States; a list of participants is included in Appendix B. Both the literature review and the expert consultations pointed to significant gaps in research and analysis that are highlighted throughout this report. When the initial review and expert consultations failed to identify broad agreement on new findings not already in use by USAID, a further targeted literature search was conducted on the cross-cutting themes regarding modeling, metrics, and data; migration data and modeling; and behavioral economics. This search verified that the lack of consensus we noted in the literature is a real issue and not due to features of our search pattern. Our work was augmented by workshops and regular consultations with USAID experts, which provided valuable insights and helped determine useful directions for research and report structure. A list of USAID experts who engaged with the research team during the drafting of this report is included in Appendix C.

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[9] Available at https://www.climatelinks.org/climate-risk-management/regional-country-risk-profiles.

Background

The IPCC AR6 report demonstrates that anthropogenic climate change has created impacts that will inevitably lead to game changing situations, some of which are already occurring. These cannot be avoided by mitigation efforts, although increased mitigation of climate change will decrease negative future impacts.[10] The United Nations Environment Programme (UNEP) reports annually on the gap in adaptation financing — the difference between funding already flowing to developing countries and funding needed to meet adaptation needs. The organization estimates that up to $300 billion in annual adaptation financing will be needed by 2030, while 2019 saw a combined total of $79.6 billion in aid finance for climate change mitigation and adaptation flow to developing countries, with the majority allocated for mitigation.[11] Developing countries and international organizations regularly call for increased funding for adaptation, which will be necessary to meet the growing needs of developing countries already feeling the impacts of climate change. These impacts will continue for some time, even under the most ambitious mitigation scenarios.

Resilience to climate impacts will increase and adaptation will be facilitated by general development,[12] conflict mitigation,[13] and by strengthening infrastructure for transportation, water and sanitation, health, and education.[14] For example, the most important step that can be taken in some locations to combat the rising challenges of increased spread of diseases related to climate change may be a general strengthening of the healthcare sector and improved sanitation and water infrastructure.[15] The fact that general development improvements will be important for coping with climate change — and in some cases may be the most important factors — is assumed and not elaborated in the report, as it would repeat knowledge already broadly shared within USAID.

The importance of general development for building adaptation capacity can make it difficult to disentangle funding for adaptation from other funding, or general development projects from adaptation projects. The improved data collection, modeling, and analysis recommended in this report could facilitate measuring "adaptation impacts" (i.e., outcomes) rather than "adaptation funding" (i.e., inputs). Adaptation programming will not always achieve greatest impact by focusing funding on narrowly defined projects that "count" as adaptation at the expense of broad development. The UNEP Adaptation Gap Report finds that "basic development sectors such as health, education and others such as disaster prevention and preparedness, and other social infrastructure and services, received negligible amounts of adaptation

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[10] Pörtner, et al, eds., "Climate Change 2022."

[11] UNEP, "Adaptation Gap Report 2021."

[12] D. Dodman, and D. Satterthwaite, "Institutional Capacity, Climate Change Adaptation and the Urban Poor," *IDS Bulletin* (2009): 39, 67–74.

[13] United States Agency for International Development, *Climate Change and Conflict: An Annex to the USAID Climate-Resilient Development Framework* (2015).

[14] G. Howard, R. Calow, and J. Bartram. "Climate Change and Water and Sanitation: Likely Impacts and Emerging Trends for Action," *Annual Review of Environment and Resources* 41 (2016): 41, 253–276.

[15] Centers for Disease Control and Prevention, *Water, Sanitation, and Hygiene (WASH) in Healthcare Facilities*, National Center for Emerging and Zoonotic Infectious Diseases (NCEZID), Division of Foodborne, Waterborne, and Environmental Diseases at CDC, 2020, https://www.cdc.gov/healthywater/global/healthcare-facilities/overview.html.

spending" from bilateral aid donors despite their importance for country-level adaptation.[16] While these broad sector needs do not negate the need for project-specific adaptation funding, they do represent a potential avenue for increasing resilience through adaptation funding.

Effective and participatory governance, similar to general development, is likely to have a multiplier effect on adaptation abilities and inclusiveness.[17] Programs that enhance governance capacity can have positive spillovers for climate adaptation efforts.[18] Good governance is not always necessary for an adaptation program to have positive impacts. In some cases, working directly with individual stakeholders or community leaders can provide an effective way of operating even if overall governance metrics are low.[19] Scaling out programs that directly train end users and programs that fund municipalities are possible examples of ways to increase effectiveness when national governance quality is poor. Developing local capacity on climate adaptation and development can have positive spillover effects on local governance, which could eventually have scalable impacts on governance quality within a country.[20] However, it will almost certainly be easier to scale up programs when governance quality is high. When governance is poor, innovations in scaling out directly to additional frontline beneficiaries may prove more effective.

The focus of this report is on "game changers" within the next twenty years, where even the more ambitious mitigation scenarios will not prevent significant negative impacts.[21] This leads to an emphasis on adaptation over mitigation. This should not be interpreted as a finding that adaptation is a more important development focus than mitigation; to avoid the worst impacts of climate change on development outcomes in the

Sidebar: Excerpt regarding Paris Agreement funds from UNEP Adaptation Gap Report (2021, p. 47)

"Funds serving the Paris Agreement, as well as some bilaterally supported climate funds, publish performance data that are often based on portfolio-wide standard indicators, such as the number of beneficiaries. As [of] June 2020, the [Least Developed Countries Fund] has reached more than 16.2 million direct beneficiaries and trained 508,000 people, while the [Special Climate Change Fund] has reached over 6.4 million direct beneficiaries and trained 80,000 people (GEF 2021). As [of] 31 December 2020, [Green Climate Fund]-funded adaptation projects were reported to have reached a total of 49 million direct and indirect beneficiaries (GCF 2021). Through its projects approved before 30 June 2021, [Adaptation Fund] is expecting to reach 10 million direct beneficiaries (AF 2021). While this type of data indicates a fund's reach and level of activity, ***it does not provide information about the actual outcomes of adaptation – i.e., to what extent the beneficiaries have become more resilient and against what level of climate risk***" (emphasis added).

[16] UNEP, "Adaptation Gap Report 2021."

[17] H. Leonardsson, et al, "Achieving peaceful climate change adaptation through transformative governance," *World Development* (2021): 147, 105656.

[18] L. Susskind and A. Kim, "Building local capacity to adapt to climate change," *Climate Policy* (2022): 22, 593-606.

[19] George Ingram, "Locally driven development: Overcoming the obstacles," *Brookings Global Working Paper* (Washington 2022) 173.

[20] C, Termeer, A. Dewulf, H. van Rijswick, and A. van Buuren, "The Regional Governance of Climate Adaptation: A Framework for Developing Legitimate, Effective, and Resilient Governance Arrangements." *Climate L.* (2011): 2,159.

[21] V. Clement, et al. *Groundswell Part 2: Acting on Internal Climate Migration* (2021). https://openknowledge.worldbank.org/handle/10986/36248.

future, strong performance on ambitious global mitigation goals is essential.[22]

Prioritization and Learning: Models, Metrics, and Data

The focus of development finance on small-scale adaptation programs has left significant knowledge gaps regarding the design, implementation, and impact of aid programs meant to provide systems-level solutions to address both direct impacts and society-wide cascading effects associated with climate change. The ten experts interviewed for this report (Appendix B) agreed that the current state of models, metrics, and data is insufficient for effective learning and decision-making regarding climate adaptation, particularly at a systems level. There is broad agreement that global funding for adaptation is not sufficient to meet needs and that even with increased funding, learning and prioritization will be essential to improve efficient use of resources.

The literature review of the six climate stressors that can become "game changers" revealed extremely disjointed findings. When studies are methodologically sound (and there is high variation on this), they are often localized with no obvious method for drawing generalizable or scalable conclusions. This led to a subsequent literature search that was able to verify this narrow focus of studies as a weakness of the field. This section is a result of that analysis, documenting these shortcomings and suggesting pathways forward.

A principal goal of adaptation programs is to reduce the risk associated with climate impacts. Across each of the climate stressors researched for this study, assessment of effectiveness for adaptation programs fails to measure society-wide impacts of risk reduction associated with programming. Measuring impact of a program requires quantifying both climate risk and program outcomes at the societal level, allowing impact to be assessed relative to risk reduction achieved through adaptation. Climate stressors result in game changing situations when climate risk is high. These situations have negative consequences when adaptation insufficiently reduces the realized or anticipated impacts associated with these risks. Re-orienting climate adaptation funding decisions to account for risk reduction will be essential for generating the long-term, transformative systems change identified as one of two strategic objectives in USAID's Climate Strategy. It will help prioritize funding to avoid the worst outcomes in game changing situations.

Experts studying climate change adaptation point out that adaptation assessment lags behind the study of climate change mitigation in metrics, methodologies, and comparability across time and space.[23] The Moroccan presidency of the 22nd session of the Conference of the Parties (COP 22) to the United Nations Framework Convention on Climate Change in 2016 drew particular attention to the need to develop meaningful and comparable metrics to measure success of adaptation programs.[24] In the years since, little progress has been made in identifying such measures. Measuring impact in mitigation programs has benefitted from both an established baseline (e.g., relative to emissions in a particular year) and an

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[22] Nasa Global Climate Change. "Climate Change Adaptation and Mitigation." *Climate Change: Vital Signs of the Planet.* (undated) https://climate.nasa.gov/solutions/adaptation-mitigation.

[23] J.D. Ford and L. Berrang-Ford, "The 4Cs of adaptation tracking: consistency, comparability, comprehensiveness, coherency," *Mitigation and Adaptation Strategies for Global Change* (2016): 21, 839-859. https://doi.org/10.1007/s11027-014-9627-7.

[24] See http://sdg.iisd.org/news/cop-22-presidency-holds-conference-on-adaptation-metrics/.

agreed and comparable measurement of outcomes (CO_2 equivalents). No easily identifiable baseline or performance metric exists in the climate adaptation space.[25] The varied nature of adaptation makes uniformity both unlikely and undesirable for measurement. However, agreed processes for estimating impact that incorporate modeling of risk reduction or harm avoidance will allow more informed decision-making and greater comparability of outcomes.

Frameworks for studying adaptation often rely on evaluation at the project, local, or sectoral level, and may apply context-specific approaches that hinder comparison and understanding of national-level impacts.[26] The 2021 UNEP Adaptation Gap Report notes that monitoring and evaluation of adaptation projects focuses on easily measurable short-term outputs such as people supported or assets improved, rather than emphasizing changes to vulnerability or risks, and observes that indicators used by Paris Agreement funds also use outputs as key indicators (see sidebar).[27] The report argues that:

"A stakeholder-informed understanding of current and expected climate hazards and vulnerability in the respective location, how they affect the population and who is most at risk, is critically important for adaptation planning."[28]

For example, the value of protecting a certain measured length of coastline from sea-level rise must vary based on the level of climate risk to the area and the size of its population, among other factors. Despite the importance of risk reduction in evaluating impact, a recent global review of 1,682 academic articles on adaptation found that only 3.4 percent contained formal assessment of risk reduction after implementation.[29]

Effectively estimating society-wide impacts requires local, project-specific metrics as well as the ability to estimate risk reduction that may extend beyond the timeframe and geographic boundaries covered by usual assessment methods. Box 1 provides an example demonstrating both the importance of measuring local outputs and the necessity of considering broader risk reduction when evaluating impact.

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[25] L. Christiansen, G. Martinez, and P. Naswa, eds., *Adaptation metrics: perspectives on measuring, aggregating, and comparing adaptation results.* UNEP DTU Partnership, (Copenhagen 2018). https://resilientcities2018.iclei.org/wp-content/uploads/UDP_Perspectives-Adaptation-Metrics-WEB.pdf.

[26] T. Leiter, et al., *Adaptation metrics: current landscape and evolving practices*, (Rotterdam and Washington, D.C. 2019). Available online at www.gca.org.

[27] UNEP, "Adaptation Gap Report 2021."

[28] UNEP, "Adaptation Gap Report 2021."

[29] L. Berrang-Ford, et al., "A systematic global stock take of evidence on human adaptation to climate change," *Nature Climate Change*. (2021):11, 989-1000. https://doi-org.proxy.lib.duke.edu/10.1038/s41558-021-01170-y.

Box 1: One intervention, multiple potential impacts

Local area "A" has a fairly sizable population of smallholder farmers, and crops in the area have been struggling due to changes in soil quality as a result of higher temperatures, changing precipitation patterns, and sub-optimal tillage practices. Without intervention, it is likely that farmers and their families will see an increase in food insecurity, which has already been trending upward. An aid-financed program works with farmers to introduce climate-smart agriculture techniques and crop yields increase as a result, allowing farmers to remain food secure on their lands. Most farmers remain on their farms.

Potential counterfactuals if intervention had not occurred and crop yields remained low:

Scenario 1: Many farmers decide to leave their farms, moving to informal settlements on the edge of the only nearby city where infrastructure is weak, water and sanitation services are poor, and the health and education systems are already under strain. There are very few jobs in the formal economy. The arrival of migrants increases strain on these systems, inequality grows, political unrest rises, and there is an uptick in violence. Migrants live in precarious circumstances and the pre-existing state of infrastructure, services, and the labor market results in urbanization that is not accompanied by economic growth.

Scenario 2: Experiencing severe food insecurity, many farmers would choose to migrate if they could. Lacking sufficient resources, they become trapped, reliant on humanitarian relief for food and seldom receiving enough to provide an adequate diet for their families.

Scenario 3: Many farmers decide to leave their farmers, heading to any of four different urban areas in the country. The cities are not wealthy, but infrastructure and services are generally of decent quality. The economy is growing and there is room for new entrants into the labor force. Although available jobs are relatively low-skilled, the wages provide a living slightly above subsistence level. As has been true in many times and places, this urbanization is accompanied by increased economic growth. Eventually, the farmer achieves a higher income in the city than on the farm.

The farmers in the example in Box 1 all experience the same local impact from the development program: soil quality increases and crop yields rise, and many farmers decide to remain on their farms. The direct benefit is measured by the value of increased crop yields, which is life-changing for the farm household, and perhaps by the number of farmers helped. Understanding the local impact is important. Knowing whether or not the program leads to improved yields is a learning opportunity that can provide insights for these farmers, the development agency, and similar farming communities.

With the same measured local impact, the total impact on the farm household and on society depends crucially on the counterfactual "business as usual" scenario against which success is measured, i.e., on a measurement of harm/risk avoidance and cascading societal impacts. In Scenario 1 the costs to farmers and society are high, and negative effects on the urban area have an impact on a large number of people. Scenario 2 also has significant costs, although they are more concentrated in the farming community. Scenario 3 is the least costly to both the farmers and society. In that scenario, while farmers may wish they had a viable opportunity to stay on their lands, they do have outside options that do not include severe food insecurity or exposure to significant levels of violence. The economy benefits from urbanization, as has been true of the development paths of many countries in the past. The benefit to the farmer of avoiding Scenario 1 or 2 is higher than the benefit to the farmer of avoiding Scenario 3, and the society-wide benefit of avoiding Scenario 1 is much higher than avoiding Scenario 3 (which might yield a net-positive society-wide impact).

Box 1 presents a highly stylized hypothetical example to illustrate the point: the full value of a particular intervention requires understanding the avoided costs to society that would have occurred absent the intervention. Estimating these ex-ante can provide insights for planning, while measuring them ex-post provides opportunities for updating and learning.

In an actual development situation, probabilities will be attached to the likelihood of success for the intervention, the likelihood of repeated crop failure (based on climate models), the likelihood of migration, the destination of migration, and each of the societal impacts. Modeling can incorporate multiple scenarios with different probabilities and/or estimated values for climate impacts, local results, and broader outcomes, allowing for comparison across policy options based on broad impacts. Higher weights can be placed in models on outcomes for poor or marginalized communities, allowing the impacts on these groups to be explicitly incorporated into decision-making.

Transdisciplinary expertise, coupled with country-specific knowledge, will be necessary to model climate impacts and societal outcomes. Experts have suggested specific modeling techniques for measuring the broad impacts of adaptation programs, but limited use in policy settings means significant uncertainty remains regarding their effectiveness.[30] There are no universally agreed metrics for measuring adaptation outcomes and the complexities that vary by location suggest that it may be more meaningful to have an agreed process for measuring impact rather than striving for universal metrics.[31] With any approach adopted, testing and modification will be needed to fully understand the best models to employ in various situations.

High quality models require investment in data gathering to measure baseline climate risks and value outcomes of risk avoidance at various levels (e.g., household, community, country). The World Meteorological Organization (WMO) notes gaps in surface reporting from climate monitoring stations in Africa, the South-West Pacific, South America, and Antarctica and reporting of upper-air observations is particularly poor from Africa, attributed to the high cost of operating such systems.[32] Expert interviews for this report also revealed concern that in parts of Africa, climate observation stations suffer from gaps because they are not sufficiently automated and updated with current technology. Technology transfer and investment in updated infrastructure would facilitate measurement of climate risks and the development of early warning systems. Experts also pointed to the need for investment in local-level data collection at sufficient frequency to facilitate assessment of risks and program impact. Innovation in using new technologies to generate data, such as mobile-phone based household surveys, could potentially be

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[30] For discussion of potential models see, R. Ebrey, M. Ruiter, W. Botzen, et al., *Study on adaptation modeling. Comprehensive desk review: climate adaptation models and tools* (European Commission, Directorate-General for Climate Action Publications Office, 2021). https://data.europa.eu/doi/10.2834/280156 and Kondrup, et al, eds. *Climate Adaptation Modelling,* Springer Climate (2022), https://doi.org/10.1007/978-3-030-86211-4.

[31] L. Christiansen, G. Martinez, and P. Naswa, (eds.). *Adaptation metrics: perspectives on measuring, aggregating and comparing adaptation results,* UNEP DTU Partnership (Copenhagen, 2018). https://resilientcities2018.iclei.org/wp-content/uploads/UDP_Perspectives-Adaptation-Metrics-WEB.pdf.

[32] World Meteorological Organization (WMO), *State of Climate Services: Risk Information And Early Warning Systems,* WMO (Geneva, 2020). https://library.wmo.int/index.php?lvl=notice_display&id=21777#.Yyd75LTMI2w.

used to enhance assessment of adaptation programs.[33] Data collected with demographic details would facilitate assessment of climate risk and program impact for vulnerable populations.

Investment in data collection and modeling to capture both direct impacts and broad measures of risk reduction could place USAID at the forefront of global efforts to develop metrics and methods to identify the full impact of adaptation programs. Useful modeling will account for baseline climate risks, their effects on social, economic, and political outcomes, and the difference between those values at a society-wide/macro level under "business and usual" and "adaptation" scenarios. Effective research teams would include natural and social scientists with macro-level modeling skills, working in tandem with stakeholders/community leaders with strong local knowledge. Leadership in this area would also position USAID well for prioritizing programming and assessing performance to achieve the systems change objective laid out in the USAID Climate Strategy.

Scaling out Implementation

The USAID Climate Strategy highlights the goals of targeted direct action and systems change. In multiple sectors, successful implementation of the climate strategy will require not only the simultaneous pursuit but also the combination of these goals: systems change will depend on the success of scaling out targeted direct action to hundreds of millions of individuals and households, making them direct implementers of change that will aggregate to a systems level. While this is qualitatively not new, an unprecedented and rapid scaling out of adaptation programs at the individual level over the next 10-20 years will be necessary to avoid game changing increases in food insecurity and losses of livelihoods, homes, and lives. It is not just that more funding is needed; expertise and information will need to be shared more widely and rapidly than is traditional in the practice of development. Innovation in scaling out directly to frontline implementers (often households or small communities) will be particularly important in areas where poor governance will impede the effectiveness of scaling up.

New processes are needed to get information into the hands of household-level decision-makers, and to do so in a way that centers locally-specific knowledge to improve reach and effectiveness. For example, national governments that wish to decrease internal migration to overcrowded megacities and encourage movement toward areas that can better absorb population growth need effective ways to communicate with potential migrants, both to understand their needs and to disseminate information on migration destinations. Policymakers promoting adaptation to climate change among small-scale fisheries and aquaculture communities need to understand individual and collective decision-making in these communities and adapt messaging to these contexts. Scientists and development practitioners working with smallholder farmers can reach vastly more farmers by understanding promising methods of information diffusion and knowledge training in localities. Local officials employing early warning systems for storms will benefit from techniques that improve trust in messaging to avoid delays in preparing for hazardous conditions.

Agent-based models that incorporate knowledge from behavioral sciences show promise for better understanding learning, communication, and diffusion in climate programming that will ultimately rely on the actions of individual decision-makers to achieve systems level change. Recognition of the importance

[33] UNEP, "Adaptation Gap Report 2021." https://www.unep.org/resources/adaptation-gap-report-2021; see online Annex 5.B.

of behavioral economics and psychology in policymaking, particularly regarding individual decision-making and peer learning, has grown in recent years.[34] Implications for using practices informed by behavioral analysis was the theme of the World Bank's 2015 World Development Report.[35] The report highlighted the importance of planning that incorporates the ways in which people think — including automatic thinking, social thinking, and thinking with culturally informed mental models — in order to increase the effectiveness of development programs.[36]

Scholars acknowledge the potential for behavioral science to bring about low investment/high impact results, but also caution that harnessing the benefits of behavioral analysis tools requires local knowledge, and measuring the impact of behavioral investments means examining long-term effects on actual changes in individual behavior.[37] There is significant agreement that insights from behavioral science can improve the effectiveness and scale of climate development programs, but insufficient evidence regarding the impact of different types of interventions under varying local contexts.

Current development programs are not adequately assessing the impact of naturally occurring knowledge cascades or the effectiveness of programs designed to enhance knowledge dissemination. For example, a program working directly with smallholder farmers to increase soil quality and crop yields in Central America shows positive results of the interventions through on-farm evaluation of the farms included in the program.[38] The program also incorporated training-the-trainers and farmer-to-farmer learning events. Studying the impact of these knowledge transfer programs and the processes of knowledge cascades in the communities could potentially lead to significant increases in benefits per dollar spent. There will be no one-size-fits all answer to knowledge dissemination, as locally effective techniques will vary based on circumstances and the common forms of learning within a community. Incorporating evaluations of knowledge dissemination into direct programming can facilitate scaling out and provide good return on investment for the funds spent on such evaluation.

USAID can play a leading role in incorporating behavioral science findings in climate-related development programs and evaluating strategies to better understand which interventions work best and under what circumstances. Do the individuals in a community learn better in group settings or through individual peer-to-peer training? Which social networks work best for knowledge diffusion and under what conditions? How can messaging be framed to have the highest impact for a local population? What types of technology or social media improve individual adoption rates for climate adaptation or mitigation practices? Gathering evidence through surveys and focus groups before, during, and after program implementation will improve programming and provide needed data on implementation that can be further tested in other localities to

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[34] C. Sunstein, *Behavioral Science and Public Policy (Elements in Public Economics)* (Cambridge: Cambridge University Press, 2020), doi:10.1017/9781108973144. Eldar Shafir, ed., *The Behavioral Foundations of Public Policy (*Princeton: Princeton University Press, 2022).

[35] World Bank *World Development Report 2015: Mind, Society, and Behavior* (Washington, D.C., 2015).

[36] James Walsh and Karla Hoff, "Bringing Behavioral Economics to Development," *Brookings Future Development* (May 19, 2015).

[37] Kulani Abendroth-Dias, "The problem and appeal of behavioural science in international development," *Apolitical* (May 4, 2020).

[38] M.-S. Turmel, K. Rosenow, A. Schmidt, E. Aburto Sanchez, and P. Hicks. "Scaling Water Smart Agriculture to Improve the Productivity and Resilience of Rainfed Smallholder Production Systems in Mesoamerica," In J. Barron, ed, *Strengthening resilience in rainfed agricultural systems through agricultural water management: a review on current state and ways ahead*, *The State of Food and Agriculture 2020 Background Report* for FAO (2020).

build robust knowledge regarding multiple scaling out techniques and the circumstances under which they perform best.

Climate Stress and Human Mobility

The six climate stressors studied for this report — precipitation changes, temperature changes, storms, sea-level rise, soil quality, and desertification — are each associated with a likely increase in migration. This impact will be particularly pronounced in game changing situations where lives and livelihoods are at risk. The World Bank has estimated that 216 million people could migrate, mostly within their own countries, by 2050.[39] Experts project that without migration, up to one-third of the world's population could live in conditions currently found only in places such as the Sahara by 2070, with mean average experienced temperatures 7.5°C above preindustrial levels (2.3 times the mean global temperature increase) based on both climate models and expected population growth by region.[40] This will disproportionately occur in areas where poverty is currently high.[41]

Human mobility is only one manifestation of climate impacts, but it is one that can have cascading effects in both the origin and destination communities. Migration is generally recognized as a potentially important means for improving individual or household well-being or for adapting to adverse events. It can have positive impacts on both sending and receiving areas. However, when migration is sudden and/or large-scale, or when populations are immobile due to existing poverty or shocks, it can create stress on local social, economic, and political systems.[42]

Understanding the timing, origin, and destination of migration, the potential for populations to become trapped by immobility, and the likely impacts of migration on sending and receiving locations, is important both for quantifying the overall impact of climate programming and for planning development interventions for affected communities. Experts have not been able to quantify at scale which populations are most likely to move, for what reasons, and where they are likely to go. There are three sources of uncertainty or variability that currently make it difficult to estimate the societal impacts of migration-related to climate change: uncertainty regarding internal migration estimates, uncertainty of the likely impacts of climate change on migration, and context-specific variability of the impact of migration on origin and destination areas. Modeling the links between climate, migration, and development outcomes will be essential for quantifying climate risks, measuring program impacts, and responding to current and projected migration patterns.

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[39] Viviane Clement, Kanta Kumari Rigaud, Alex de Sherbinin, Bryan Jones, et al. *Groundswell Part 2 : Acting on Internal Climate Migration* (Washington, D.C., World Bank, 2021). https://openknowledge.worldbank.org/handle/10986/36248 License: CC BY 3.0 IGO.

[40] C. Xu, T.A. Kohler, T.M. Lenton, J.C. Svenning, and M. Scheffer. *Future of the human climate niche*, Proceedings of the National Academy of Sciences (May 26, 2020),117(21):11350-11355. doi: 10.1073/pnas.1910114117. Epub 2020 May 4.

[41] C. Xu "Future," 2020.

[42] The White House, "*Report on the Impact of Climate Change on Migration*" (October 2021).

Climate-related migration often involves movement to cities, contributing to already growing rates of urbanization in many regions.[43] Cities in Africa, for instance, are projected to add nearly 1 billion people by 2050.[44] Urbanization has historically been a key factor in promoting economic growth, but key challenges face today's growing cities. Migrants to cities are often in vulnerable positions, and are likely to live in informal settlements which lack access to adequate services and leave them open to exploitation.[45] The United Nations estimates that urban growth is outpacing adequate housing, with more than 1 billion people worldwide living in informal settlements.[46] The World Bank estimates that 90 percent of urban expansion in developing countries is in hazard-prone areas, arguing that intensive policy coordination and investment is necessary to build cities that are inclusive, healthy, resilient, and sustainable.[47]

Urbanization is linked to growing inequality, with UN Habitat estimating that income inequality has increased since 1980 for more than two-thirds of the worlds' urban population.[48] In fragile contexts, rapid urbanization increases socio-political tensions and the risk of political unrest or conflict.[49] Scholars have demonstrated how food insecurity linked to drought led to internal migration in Syria, which in turn led to increases in protest activity in receiving communities and contributed to violent conflict.[50] When internal migration places stress on urban areas it can lead to further migration, including international migration.[51]

Governments and the international development community cannot adequately prepare for or respond to internal migration pressures without data and modeling on where people are moving from and where they are likely to settle. Data on internal migration in developing countries are not collected frequently enough or with high enough accuracy to be used for planning.[52] There is general agreement that climate

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[43] William Roderick et. al. "Cities, Climate and Migration: The role of cities at the climate-migration nexus," *C40 Cities report* (2020). https://www.c40knowledgehub.org/s/article/Cities-Climate-and-Migration-The-role-of-cities-at-the-climate-migration-nexus?language=en_US.

[44] Organisation for Economic Co-operation and Development/ Sahel and West Africa Club, "Africa's Urbanisation Dynamics 2020: Africapolis, Mapping a New Urban Geography," *West African Studies* (OECD Publishing: Paris, 2020). https://doi.org/10.1787/b6bccb81-en.

[45] Global Mayors Action Agenda on Climate and Migration (2021). https://www.mayorsmigrationcouncil.org/c40-mmc-action-agenda.

[46] https://unstats.un.org/sdgs/report/2019/goal-11/.

[47] See https://www.worldbank.org/en/topic/urbandevelopment/overview.

[48] Christine Knudsen, Eduardo Moreno, Ben Arimah, Raymond Otieno, and Ololade Ogunsany, "World Cities Report 2020: The Value of Sustainable Urbanization," *UN Habitat* (2020). https://unhabitat.org/sites/default/files/2020/10/wcr_2020_report.pdf.

[49] https://www.usip.org/publications/2022/06/climate-change-migration-and-risk-conflict-growing-urban-centers.

[50] Konstantin Ash and Nick Obradovich, "Climatic Stress, Internal Migration, and Syrian Civil War Onset," *Journal of Conflict Resolution* (2020): 64: 1: 3-31.

[51] Luca Marchiori, Jean-François Maystadt, and Ingmar Schumacher, "The impact of weather anomalies on migration in sub-Saharan Africa," *Journal of Environmental Economics and Management* (2020): 63(3): 355-374. https://doi.org/10.1016/j.jeem.2012.02.001.

[52] A. Sîrbu, et al. "Human migration: the big data perspective," *International Journal of Data Science and Analytics* (2021): 11: 341–360, https://doi.org/10.1007/s41060-020-00213-5.

change will fuel increased migration, but not on the exact nature of this relationship.[53] Lack of (near) current data on internal migration hampers the ability to model future scenarios and to study current and likely future impacts of climate change on migration.

Countries like Bangladesh are looking for innovative plans to manage climate-related internal migration. An estimated 2,000 people per day are moving to Dhaka, many coming from coastal areas where sea-level rise and storms are destroying livelihoods and homes.[54] Many new arrivals join the more than forty percent of residents living in poor conditions in informal settlements in the city, which lack basic water and sanitation services and can be located in environmentally hazardous areas that have resulted from unplanned urban sprawl.[55] This climate-related movement to large urban areas has been documented in multiple countries and regions, with people at times moving to an area that is at high risk for negative climate impacts in the near future. City governments lack information on how climate change will affect migration into their area, hampering their ability to plan.[56]

Urban climate finance for adaptation and resiliency is estimated at only about nine percent of project-level urban climate finance, with the other 91 percent focused on mitigation.[57] The impact of current and future resources will be enhanced by knowledge gained from modeling the links between climate impacts and migration, as well as likely demographic trends regarding migrant destinations, to help guide funding decisions. Better data and modeling can also support movements to incentivize internal migration to secondary cities and towns and away from megacities with large informal settlements.[58]

Researchers are exploring the potential to use data on mobile phone traffic to obtain more frequent and accurate measures of human mobility within countries[59] and even to examine when migrants are more likely to move to informal settlements.[60] These techniques are early and have so far focused on individual countries or cities but show promise for wider use. To better understand and predict the link between climate and migration, it is necessary to simultaneously model climate impacts and human migration response. Big data and machine learning may prove useful in this regard, but their use for these purposes is still in its infancy.[61]

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[53] Michel Beine and Lionel Jeusette, "A Meta-Analysis of the Literature on Climate Change and Migration," *IZA Discussion Paper* No. 12639, and Šedová, Barbora, Lucia Cizmaziova and Athene Cook, "A meta-analysis of climate migration literature." *CEPA Discussion Paper No. 29* (University of Potsdam, 2021).

[54] See "Creating a safe and thriving future for climate migrants," November 17, 2021.

[55] See "World Leaders Must Prepare for the Climate Migration Challenge," Mayors Migration Council, December 17, 2021.

[56] S.K. Rosengärtner, A.M. De Sherbinin, and R. Stojanov, "Supporting the agency of cities as climate migration destinations," *International Migration* (2022): 00, 1–18. Available from: https://doi.org/10.1111/imig.13024.

[57] Cities Climate Finance Leadership Alliance. "2021 State of Cities Climate Finance," (2021).

[58] Alam, Sarder Shafiqul, et al., *Building Climate-Resilient, Migrant-Friendly Cities and Towns*, International Centre for Climate Change and Development (2018).

[59] S. Lai, et al. "Exploring the use of mobile phone data for national migration statistics," *Palgrave Commun* (2019) 5, 34, https://doi.org/10.1057/s41599-019-0242-9.

[60] R. Lavelle-Hill, et al. "Using mobile money data and call detail records to explore the risks of urban migration in Tanzania," *EPJ Data Sci.* (2022) 11, 28, https://doi.org/10.1140/epjds/s13688-022-00340-y.

[61] Parth Khare, Samuel Huckstep, and Reva Resstack, *What Satellite Data Can (And Can't) Tell Us About Climate-Affected Migration*, Center for Global Development (2022), https://www.cgdev.org/blog/what-satellite-data-can-and-cant-tell-us-about-climate-affected-migration.

It is likely outside the purview of USAID to be at the forefront of migration modeling, but investment by the United States government in research studies that can model the intersection of climate impacts and human mobility would provide important insights regarding current and future migration trends. These could help guide adaptation programming both to avoid unnecessary migration through adaptation in place and to help destination areas adapt for population growth. A direct step that USAID could take would be incorporating surveys regarding migration intentions before, during, and after programming to understand the impact of programming on migration decision-making.

Mayors across the world are uniting to draw attention to the impact of climate change on cities, including the impact of climate-related migration to cities.[62] Where possible, USAID can work directly with mayors to understand the needs of their cities, fund locally led programs, and work to improve investment in infrastructure and programs that will improve resilience both to climate change and to increased migration. When working with national governments on systems-wide solutions, USAID can strive to include the voices of local leaders in sending and receiving communities to increase their voices in national-level policymaking that can benefit development.

Case Study: Smallholder Farmers

There are estimated to be at least 510 million farms worldwide operating less than 2 hectares of land.[63] In low and lower-middle income countries, these smallholder farmers account for 80 percent of farms and 30 percent to 40 percent of land, compared to high-income countries where smallholder farmers account for less than 5 percent of land.[64] Women make up more than 40 percent of the agricultural workforce in developing countries, although they lack the resources to produce crop yields at the same rate as men.[65]

Smallholder farmers are affected by each of the climate stressors studied for this report. Rising temperatures, changes in precipitation patterns, and an increase in extreme events such as droughts and storms are currently affecting soil quality, agricultural production, and food security.[66] Heat stress, rising evaporation rates, increased length of dry spells, higher frequency of drought, changes in timing of annual rainfall, heavy rainfall events causing landslides and flooding, increasing pests, and sea level rise all contribute to increasing stress on farming systems and threaten the livelihoods of smallholder farmers, often members of marginalized communities and/or already living in precarious situations. Agriculture was mentioned by experts interviewed for this report as the sector most in need of strong and immediate climate adaptation programming. While some challenges faced by smallholder farmers may be unique to

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[62] R. William et al. "Cities, Climate and Migration: The role of cities at the climate-migration nexus," *C40 Cities report*. (2021).: https://www.c40knowledgehub.org/s/article/Cities-Climate-and-Migration-The-role-of-cities-at-the-climate-migration-nexus?language=en_US.

[63] Sarah K. Lowder, Marco V. Sánchez, and Raffaele Bertini, "Which farms feed the world and has farmland become more concentrated?" *World Development* 142 (June 2021).

[64] Lowder, "Which farms feed the world?"

[65] Food and Agriculture Organization. *The State of Food and Agriculture 2010–11. Women in agriculture. Closing the gender gap for development (2011)*. Available at www.fao.org/3/a-i2050e.pdf).

[66] B. Mbow, et al., "Food Security," *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*, IPCC (2020).

this sector, it is also a useful area for demonstrating the issues raised in this report, which are broadly applicable beyond agriculture.

Many agricultural areas are at a tipping point, where "game changing" impacts to livelihoods are already occurring. Others will reach this point within the next 20 years. A 2021 study modeling crop yields for the important cereals maize, rice, soybeans, and wheat shows impacts on yields that are significantly more negative and sooner for the first three crops than in previous modeling; while wheat shows some net positive gains in higher latitudes, the tropics overall experience worse outcomes for the cereal yields studied.[67] Study authors find that major shifts in global crop productivity will occur in the next 20 years, much sooner than previously expected, and they emphasize the short lead time for confronting challenges in food system adaptation. They conclude:

"The degree to which even high mitigation climate change scenarios are projected to push global farming outside of its historical regimes suggests that current food production systems will soon face fundamentally changed risk profiles. Despite prevailing uncertainties, these ensemble projections spotlight the need for targeted food system adaptation and risk management across the main producer regions in the coming decades."[68]

Smallholder farmers (those cultivating less than 2 hectares) account for an estimated 84 percent of farms worldwide, controlling only 12 percent of agricultural land but producing 35 percent of global food supply.[69] The IPCC AR6 report predicts, with high confidence, that smallholder farmers are and will be more susceptible than large-scale producers to the impacts of climate change, a result related to policy, political voice, and market access as well as to direct climate effects.[70] Problems faced by smallholder farmers are less likely to be addressed by the private marketplace, and adoption of new crops or techniques are facilitated through policies, such as the provision of agricultural extension services, and use of farmers' social networks.[71]

Despite the impact of climate change on smallholder farmers, and their importance to global food systems, they are not well-represented in important conversations regarding the effects of climate change on agriculture.[72] Climate finance targeting smallholder farmers was estimated at only 1.7 percent of tracked climate finance in 2017-2018.[73] Experts argue that this is well below the amount needed and that failure

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[67] Jonas Jägermeyr, Christoph Müller, Alex C. Ruane, Joshua Elliott, et al., "Climate Impacts on Global Agriculture Emerge Earlier in New Generation of Climate and Crop Models," *Nature Food* (2021) 2 (11): 873–85. https://doi.org/10.1038/s43016-021-00400-y.

[68] Jägermeyr, "Climate Impacts."

[69] Sarah K. Lowder, Marco V. Sánchez, and Raffaele Bertini, "Which farms feed the world and has farmland become more concentrated?" *World Development* (June 2021) 142.

[70] R. Bezner Kerr, T. Hasegawa, R. Lasco, I. Bhatt, et al., "Food, Fibre, and Other Ecosystem Products," *Climate Change 2022: Impacts, Adaptation, and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge University Press, In Press 2022).

[71] M. Acevedo, K. Pixley, N. Zinyengere, et al., "A scoping review of adoption of climate-resilient crops by small-scale producers in low- and middle-income countries," *Natural Plants* (2020) 6, 1231–1241.

[72] https://www.devex.com/news/small-farmers-say-they-re-overlooked-in-climate-talks-101567.

[73] Damniela Chiriac and Baysa Naran, "Examining the Climate Finance Gap for Small-Scale Agriculture," *Climate Policy Initiative report* (2020).

to increase funding to smallholder farmers could lead to large increases in food insecurity, mass migration, social unrest, and conflict.[74]

Rainfed agriculture is used in approximately 80 percent of cropland, particularly by smallholder farmers.[75] In developing countries, the majority of agriculture is rainfed, with 95 percent of food production in Africa relying on rainfed agriculture.[76] Climate change is increasing water stress in a wide range of developing countries. Water use efficiency will need to increase in both rainfed and irrigated cropland to meet the growing demand for food coupled with the impacts of changing climate. Applications of Integrated Water Resource Management can help balance the needs of farmers with other uses for finite water supplies.[77]

Society-wide Effects

The United Nations Food and Agriculture Organization (FAO) estimates that more than 3 billion people live in agricultural areas with high or very high water shortages.[78] Projected decreases in crop yields and shifting regions of suitability for multiple crops in areas experiencing stress due to changes in heat or water will have implications for food security that reach beyond farm households and affect food systems. The nutritional value of some staple crops is also expected to decrease under more adverse growing conditions.[79] Food insecurity and inadequate nutrition have negative impacts on health and educational outcomes. Rural-to-urban migration is rising rapidly in some areas, including across much of Africa, and will put strains on urban systems ill-equipped to cope with the influx of people.

Studies of the impact of climate adaptation programming for smallholder farmers are often localized, examining changes in crop yields or farmer incomes. The full impact of these programs on development outcomes would be measured by capturing the risk avoided through adaptation, comparing a "business as usual" scenario to the "adaptation" scenario. This would account for broader impacts of a program on societal food security, water management, migration, urban systems, and political unrest, among other areas. Studies of program effectiveness rarely account for cascading effects or attempt to measure program impacts on migration intentions or political discontent; surveys and modeling could be implemented as part of programming to determine these broader effects of climate development programming.

The COVID-19 pandemic and Russia's invasion of Ukraine in 2022 were shocks that highlighted how key vulnerabilities in one sector or region can have cascading effects on multiple sectors across national, regional, and global scales. Climate change is an ongoing shock that will also have effects well beyond the directly affected areas and sectors. Attention to cascading effects of adaptation programming can inform prioritization based on impact and can facilitate study and comparison across countries and contexts.

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[74] Comments by Jyotsna Puri, Associate Vice-President of IFAD, in "More climate finance in support of small-scale farmers is urgently needed, warns IFAD at Stockholm+50," June 2, 2022.

[75] *The State of Food and Agriculture 2020. Overcoming water challenges in agriculture*, FAO (Rome, 2020). https://doi.org/10.4060/cb1447en.

[76] L. Abrams, *Unlocking the potential of enhanced rainfed agriculture. Report no. 39*, SIWI (Stockholm, 2021).

[77] See https://www.unep.org/explore-topics/disasters-conflicts/where-we-work/sudan/what-integrated-water-resources-management.

[78] FAO, "The State of Food and Agriculture," (2020).

[79] Jägermeyr, "Climate Impacts," (2021).

Building out scenario planning exercises to inform program selection and implementation could yield increased society-wide impact for adaptation funding.

Scaling Out: Challenges and Promising Approaches

Systems change in agriculture requires scaling out to reach many small-scale producers. Significant advances have been made in climate-smart agricultural technology and practices, yet dissemination across millions of smallholder farmers in developing countries has been slow and remains small compared to the scale of the challenge.[80] Innovations in scaling out to increase both knowledge transfer and uptake of new approaches will be essential to achieving impact at the necessary scale.

There are promising implementation approaches to incorporate lessons from behavioral sciences to scale out advances in agriculture for increased impact, but they are not being widely used or tested. The climate smart villages project, implemented by the Consultative Group on International Agricultural Research (CGIAR), is rolling out climate-smart agriculture across more than 30 villages in 19 countries in East Africa, West Africa, Central America, South America, South Asia, and Southeast Asia, all in areas considered to be at high risk to climate change.[81] This is a highly participatory approach, based on underlying connections with local communities, that provides support for farmers transitioning to climate resilient agriculture tailored to the local conditions (current and projected for the future).[82] Participation is scaled out through mechanisms such as farmer-to-farmer learning through field days and exchange visits, agricultural extension services, and use of communication technology such as radio programming and mobile phone communications.[83] A similar program has financed the adoption and study of water-smart agriculture techniques in the Central American Dry Corridor, showing improvement in soil fertility, rainwater productivity, and crop yields over even short time horizons; it also improved resilience on plots using these techniques during the 2018 drought.[84] In each of these examples, current and future programming would benefit from incorporating evaluation of the knowledge diffusion techniques into overall program evaluation.

Climate-smart agriculture incorporates techniques such as minimal tilling, planting of cover crops, residue retention, and water management that can also contribute to climate change mitigation and efficient water use. Many villages where these programs have been introduced are in countries where overall quality of governance is ranked poorly,[85] such as Bangladesh, Burkina Faso, Ethiopia, and Guatemala. By working with local organizations and partnering with farmers and local communities to scale out, the programs have managed to have impact even under conditions of poor governance. It should be noted that scalability

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[80] Z, Cui, H. Zhang, X. Chen, et al., "Pursuing sustainable productivity with millions of smallholder farmers," *Nature* (2018) 555, 363–366. https://doi.org/10.1038/nature25785.

[81] https://ccafs.cgiar.org/climate-smart-villages.

[82] P.K. Aggarwal, et al. "The climate-smart village approach: framework of an integrative strategy for scaling up adaptation options in agriculture," *Ecology and Society* (2018) 23(1):14. https://doi.org/10.5751/ES-09844-230114.

[83] Aggarwal, "The climate-smart village approach," (2018).

[84] M.-S. Turmel, K. Rosenow, A. Schmidt, E. Aburto Sanchez, and P. Hicks, "Scaling Water Smart Agriculture to Improve the Productivity and Resilience of Rainfed Smallholder Production Systems in Mesoamerica" In, Barron, J. (ed). *Strengthening resilience in rainfed agricultural systems through agricultural water management: a review on current state and ways ahead*, *The State of Food and Agriculture 2020 Background Report* for FAO (2020).

[85] World Bank. Worldwide Governance Indicator (2021). https://info.worldbank.org/governance/wgi/.

beyond local levels and harnessing sufficient availability of resources may be more challenging when governance is less effective.

The best methods for scaling out agricultural interventions will vary based on local contexts. Behavioral interventions, such as peer learning, expert consultations, or radio broadcasts, are unlikely to have uniform effects across locations. Piloting of ideas that are new to an area should be used before a full rollout, and analysis should be done to understand both direct impacts (e.g., crop yields) and indirect impacts (e.g., migration intentions). Successful programming will also need to account for location-specific structural barriers, such as lack of official land titles for property, insufficient access to capital for desired improvements, or lack of access to markets that could allow farmers to achieve higher incomes.[86]

Key Findings and Actions to Consider

Prioritization: Lack of prioritization in the realm of climate-related adaptation hampers the creation of an effective development response. Experts from academia, think tanks, government, and international agencies point to insufficient information to efficiently prioritize actions. Studies often examine immediate and local outputs but fail to measure cascading, society-wide impacts associated with risk reduction. Sufficient analysis is unlikely to arise organically from the development community or academia, both of which currently focus on more narrowly defined impact evaluations. Investment in understanding society-wide impacts associated with risk reduction due to climate adaptation programs will be essential for realizing systems change. USAID can play a global leadership role in developing metrics, methods, and/or models for quantifying adaptation impact.

Actions to consider:

- Invest in data collection and modeling to capture both direct impacts and broad measures of risk reduction that would place USAID at the forefront of global efforts to develop metrics and methods to identify the full impacts of adaptation programs. Useful modeling will account for baseline climate risks, their effects on social, economic, and political outcomes, and the difference between those values at a society-wide/macro level under "business and usual" and "adaptation" scenarios. Effective research teams would include natural and social scientists with macro-level modeling skills, working in tandem with stakeholders/community leaders with strong local knowledge.
- Invest in local, regional, and national data collection on outcomes to improve modeling. In some areas (particularly in Africa), investment in improved technology for data collection on climate impacts is also desirable. Piloting data collection and transdisciplinary modeling could occur in target countries. Data collection can include demographic information to identify poor and marginalized people, and their needs can be weighted heavily in modeling; this will help fill key gaps in understanding the impact of climate programming on members of different communities.
- Incentivize development of international agreement on adaptation metrics or methods for quantifying adaptation impact that would facilitate comparisons.

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[86] International Fund for Agricultural Development, "Access to markets: Making value chains work for poor rural people," (2012) https://www.ifad.org/documents/38714170/39886304/Access+to+markets.pdf/d843d356-7349-4db3-a3c1-23d5c884d3ad?t=1521823973000.

Implementation: Innovation in scaling out effective adaptation techniques is needed. To operate at the scale needed for meaningful adaptation across multiple geographic areas and sectors experiencing game changing situations, stakeholders at the individual or household level will need to function as direct implementers of change. Scientists and development experts with knowledge of promising adaptation techniques need to reach communities, learn from local knowledge, provide information to stakeholders, and support end-users/implementers at scale. This requires innovation in scaling out adaptation strategies to reach stakeholders at the community and household level with more speed and less cost per unit impact.

Actions to consider:

- Incorporate insights from behavioral science to inform strategy for scaling out climate interventions through knowledge diffusion to increase impact for a given level of investment.
- Work with local communities to pilot and test behavioral interventions that incorporate local insights, recognizing that appropriate behavioral interventions are context specific but also that learning can take place across locations.
- Specifically test the viability, reach, and impact of information dissemination. Ascertain whether impact varies based on direct versus indirect learning from training programs. Examine ways to harness knowledge cascades. Test the effectiveness of technology and social media to scale out impact.

Internal migration: Human migration will grow as an adaptive response, and insufficient data and modeling exist to incorporate migration into planning. Each of the six climate impacts studied, as well as others, on their own and in combination are leading to increases in internal (and sometimes external) migration. Migration is often to cities already struggling to provide necessary levels of infrastructure and services, leading to precarious living conditions for migrants. Increased stress on urban systems can lead to further migration, growing economic inequality, and/or political unrest or conflict. Data gathering on population movement within developing countries is of insufficient quality and frequency for planning. Enhanced data collection and modeling on internal migration would help mayors and national governments work together to plan for expected migration and would enhance resilience programming in potential origin and destination areas.

Actions to consider:

- Partner with private companies and external researchers to develop (near) real-time estimates of internal population movements and models of likely future migration patterns. Data from cell phone and social media companies, as well as remote-sensing and earth-observation data, open new possibilities for understanding human mobility. Specialists in analysis of big data and machine learning, along with social scientists, can develop techniques for estimating migration and its impacts on sending and receiving locations. This can inform development programming for adaptation in place and/or building resilience in migration destinations.
- Draw on the knowledge of local leaders, including lessons from the multiple programs connecting mayors worldwide, to enhance the ability of mayors and national governments to increase urban preparedness and resilience for population growth.
- Consider the feasibility and desirability of programs that encourage movement to secondary cities or towns better able to absorb and benefit from population increases. This would avoid increased overcrowding in megacities with large populations already living in informal settlements.

Smallholder farmers: Many smallholder farming communities are at or near tipping points, with lives and livelihoods already threatened by climate change. Significant increases in funding and innovation in program delivery will be necessary to meet the needs of people in these communities. Programming in this sector will benefit from improved data collection and modeling, a better understanding of migration dynamics, and techniques for scaling out knowledge to the household level, as adapted from the broad lessons in this report.

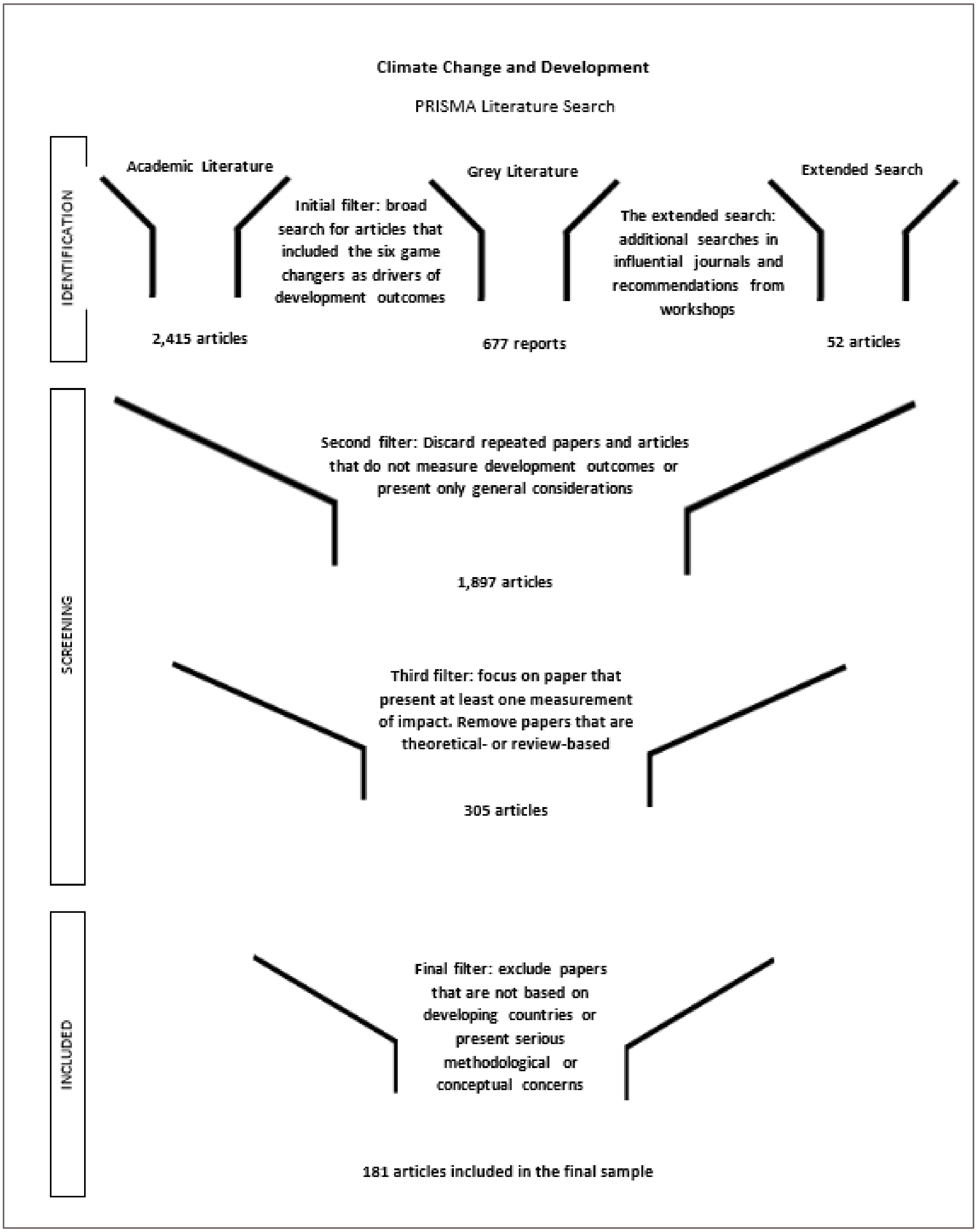
Actions to consider:

- Scale up aid to smallholder farmers where livelihoods are imminently threatened but long-term prospects for productivity with adaptation are positive.
- Invest in research to measure society-wide impacts of agricultural climate-adaptation programs based on changes in risk. This includes conducting surveys and collecting data before, during, and after the program period from the local area and other areas likely to be affected. Researchers should gather data to inform modeling of the "business as usual" outcomes in the absence of adaptation as well as the adaptation scenario. This should be done for direct impacts and cascading effects.
- Increase understanding of likely rural-to-urban migration pathways within countries, through surveys or modeling, particularly where agricultural adaptation is infeasible or not productive given climate forecasts. Invest in building resilience in systems to accommodate increased in-migration.
- Increase and assess the use of scaling out approaches to substantially increase the number of smallholder farmers receiving information on climate-smart agriculture techniques. Pilot new techniques and incorporate local insights regarding information sharing and knowledge diffusion to increase effectiveness. Encourage location-specific innovations in implementation and knowledge diffusion.
- Work directly with smallholder farmers to become agents of change in their communities and to increase impact in situations where government actors are less prepared to assist with implementation and scaling.
- Work with governments where possible to assist with scaling up and scaling out agricultural adaptations.
- Address structural barriers, such as lack of land rights or insufficient access to markets.

Conclusion

Climate-related development assistance is at an inflection point. More financing is needed to meet unprecedented challenges to lives and livelihoods presented by the rapidly growing impacts of climate change, particularly in developing countries and for poor and marginalized communities. Even with additional funding, the scale of the challenge requires innovation to increase the impact of each dollar spent. Climate-related "game changing" scenarios are not a problem of the future but a current lived experience for hundreds of millions of people. Innovations in modeling societal impacts based on an understanding of baseline risk and estimated risk reduction, deployment of new implementation techniques to scale out programs, and investments in data and modeling regarding human mobility can position aid agencies to increase impact per dollar spent and provide strong results to confront current and future climate challenges.

Appendix A: PRISMA Chart



Appendix B: Workshop Participants

Name	Title	Institution	Link to Bio	Country
Farzana Afridi	Professor	Indian Statistical Institute	https://www.isid.ac.in/~fafridi/	India
Jennifer Burney	Professor, Marshall Saunders Chancellor's Endowed Chair in Global Climate Policy and Research	University of California San Diego	https://gps.ucsd.edu/faculty-directory/jennifer-burney.html	United States
German Caruso	Economist	World Bank	http://www.germancaruso.com	United States
Sosten Chiotha	Professor, Regional Director of the Leadership for Environment and Development (LEAD) Southern and Eastern Africa	LEAD	https://www.afidep.org/staff/sosten-chiotha-ph-d/	Malawi
Todd Eisenstadt	Professor, Research Director, Center for Environmental Policy	American University	https://www.american.edu/spa/faculty/eisensta.cfm	United States
Walter Leal	Professor	Hamburg University of Applied Sciences	https://walterleal.info	Germany
Ross Mittiga	Assistant Professor	Catholic University of Chile	https://www.rossmittiga.com	Chile
Nick Obradovich	Senior Research Scientist and Principal Investigator	Max Planck Institute for Human Development	https://nickobradovich.com	Germany
Felicia Peck	Lecturer	University of California Santa Cruz	https://politics.ucsc.edu/about/staff.php?uid=fpeck	United States
James Rising	Assistant Professor	University of Delaware	https://www.udel.edu/academics/colleges/ceoe/departments/smsp/faculty/james-rising/	United States

Appendix C: USAID Experts Consulted

Daniel Abrahams, AAAS Fellow, Center for Conflict Violence and Prevention, Bureau for Conflict, Prevention, and Stabilization, USAID

Alex Apotsos, Technical Advisor, Office of Sustainable Development, Africa Bureau, USAID

Geoffrey Blate, Environment Officer, Office of Environment, Energy, and Infrastructure, Bureau for Development, Democracy, and Innovation, USAID

Allison Brown, Deputy Environmental Officer, Program Office, Prevention, Bureau for Conflict, Prevention, and Stabilization, USAID

Mary Carenbauer, Analyst, Office of Policy, Bureau for Policy, Planning, and Learning, USAID

Steven Gale, Sr. Foresight Advisor, Office of Policy, Bureau for Policy, Planning, and Learning, USAID

Donald McCubbin, Environment Officer, Office of Environment, Energy, and Infrastructure, Bureau for Development, Democracy, and Innovation, USAID

Mark Skeith, Senior Policy Analyst, Office of Policy, Bureau for Policy, Planning, and Learning, USAID

Fernanda Zermoglio, Senior Resilience and Climate Adaptation Advisor, Bureau for Resilience and Food Security