Lao, Pakistan, Somalia, Sri Lanka

Systems thinking to estimate the health co-benefits of climate action

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Focus

Sustainable development requires a systemic approach that will lead to effective policy making and investment options. This approach must allow researchers to understand social, economic and environmental drivers of change, identify entry points for intervention and identify and quantify systemic outcomes of action. This case study presents four different projects that employ the same underlying methodologies (systems thinking and system dynamics), supported by a multidisciplinary team.

Projects overview

The first project focuses on the health-food-climate nexus in Somalia. It involves the creation of a systemic, qualitative analysis using a participatory and multi-stakeholder approach to identify key drivers of change in the health-food-climate system. Specifically, it uses Causal Loop Diagrams (CLD) to visually represent these drivers and their causal pathways.

The second project, conducted for the World Health Organization (WHO), considers urban tree planting in Islamabad, Pakistan, and the health co-benefits of climate adaptation strategies in relation to extreme events (flooding or heatwaves).

The third focuses on national dynamics. Conducted in collaboration with Aroha (a non-profit organization that supports vulnerable people and regions) and the Government of Sri Lanka, it uses the Green Economy Model (GEM) to analyse the benefits of climate change mitigation and adaptation across a range of sectors and health outcomes.

The fourth project focuses on WASH (water, sanitation and hygiene), which promotes access to safe and reliable water supply and sanitation in Lao. The project uses an integrated cost benefit analysis (CBA) to capture the tangible and intangible benefits of action. It was implemented in collaboration with Save the Children and used in the preparation of a Green Climate Fund (GCF) funding proposal.

Team

The multi-disciplinary team comprises international and local members and covers both scientific knowledge and policy responsibilities. The team at KnowlEdge (an environmental consultancy specializing in customized methodologies) offered expertise in systems thinking and system dynamics as well as thematic knowledge on macroeconomics, urban development and spatial analysis. Project managers at Save the Children and Aroha provided knowledge of the climate and health nexus. Local partners also provided access to decision makers at the national level for the Sri Lanka case study and at the local and regional level for the Somalia case study.

Methods

Three main tools were used to understand the interrelations that exist between climate and human health. These tools were informed by, and customized based on, the use of a multi-stakeholder and co-creation process. The tools were Causal Loop Diagrams (CLD), quantitative simulation methods and models and integrated cost benefit analysis (CBA).

Causal Loop Diagram (CLD)

This is a visual tool, typically co-developed with stakeholders and experts, that represents the links that exist between key indicators within a given sector or system (Probst and Bassi, 2014). For example, a CLD might show the causal links between food prices, household income and food affordability. These links are illustrated using variables and arrows which also highlight the presence of circular relationships or feedback loops. There are two types of feedback loop: reinforcing and balancing. Reinforcing loops amplify change in the system – positive or negative – or arise when an intervention amplifies a desirable dynamic, thus reinforcing it (Forrester, 2002). Balancing loops represent counterbalancing forces that shift behaviour toward a goal or equilibrium (Forrester, 2002).

Quantitative simulation methods and models

System Dynamics (SD) models provide insights on the relative strength of various drivers of change (scenario analysis), and support policy makers to identify and prioritize policy interventions (policy analysis). Spatial models are a perfect complement to SD models, since they offer detail on location-specific impacts of action. This study used an open-source model, InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs), that maps and 'values' ecosystems and resources. For example, InVEST was used to estimate the impact of land cover change (e.g. tree planting) on water retention (reducing flood risk) and temperature (reducing the impact of extreme heat).

Cost benefit analysis (CBA)

Integrated CBA allows the results from the biophysical models (SD and InVEST) to be integrated into a financial assessment (GCF, 2022; IFAD, 2015). CBA can determine the economic viability of specific climate interventions, both from the perspective of an investor (financial CBA) and from a societal perspective (economic CBA). In this case, the CBA allowed researchers to fully capture the health co-benefits of climate action.

These three methods, harmonized using a systemic approach, supported decision making for the climate and health nexus from conceptualization (using CLDs) to the assessment of intervention options (with the quantitative models), and ending with the creation of an investment and financing plan (using an integrated CBA).

Results

Project one: Exploring the health-food-climate nexus with Causal Loop Diagrams in Somalia

This project focused on food systems, specifically in relation to climate-related displacement, access to food and health services. The key goal was to create a shared understanding of the complexity underpinning the health-food-climate nexus in Somalia, and to stimulate coordinated action.

An integrated CLD depicting the relationships in this nexus was developed with Save the Children Somalia and local stakeholders. A simplified version of the diagram is presented in Figure 1. The core of the exercise was to identify links between climate impacts and health. For instance, flood damage leads to the closure of healthcare facilities, while damage to roads reduces access both to healthcare services and affected areas, which increases the prevalence of disease. These dynamics tend to grow stronger over time and are represented by two reinforcing feedback loops (R3 and R4 in Figure 1). Heatwaves reduce the availability and productivity of health workers and constrain access to healthcare, since the distance that can be travelled during high temperatures is limited. An additional pressure is caused by the displacement of people as a result of floods and droughts, which trigger migration to urban areas and may give rise to violent clan conflicts.

The full version of the Figure 1 diagram includes greater detail on food production and illustrates how cultural aspects, such as clan traditions and nomadic livestock herding, lead to adverse health outcomes that disproportionately affect women.

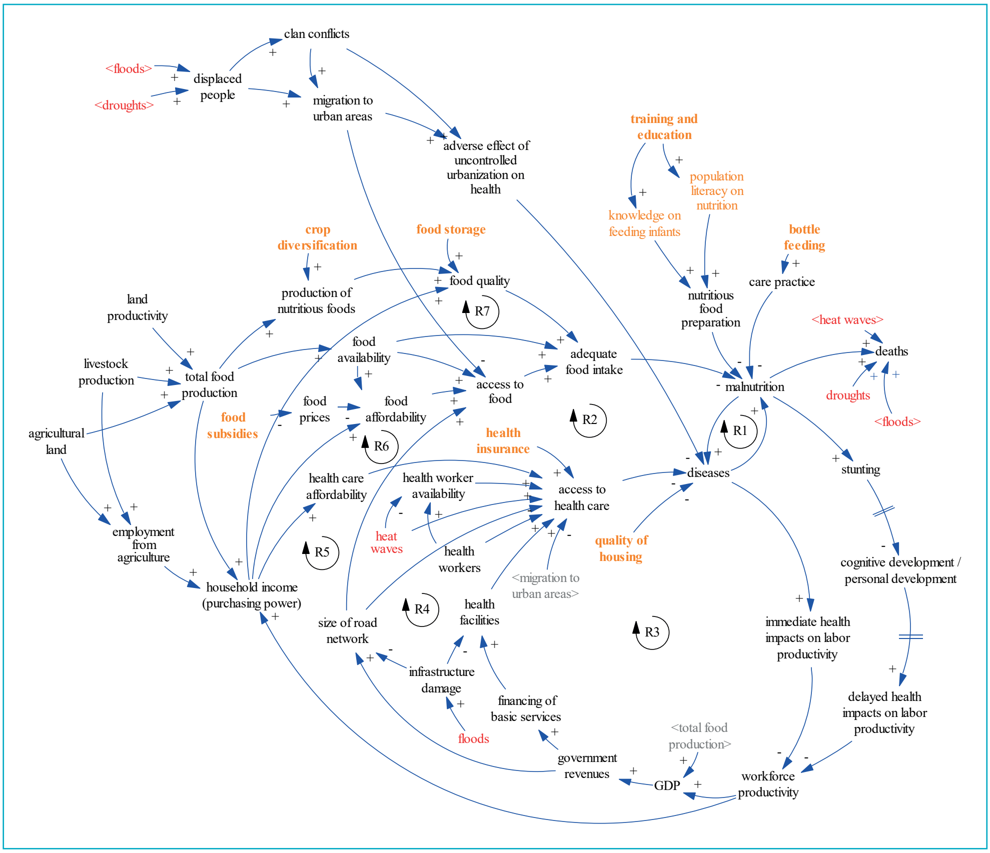

Figure 1: Causal Loop Diagram (CLD) depicting the relationships between health, food and climate in Somalia (simplified)

Project two: Assessing the impact of Nature Based Infrastructure (NBI) on flood risk and extreme heat in Islamabad, Pakistan

This project focused on urban issues, specifically flooding and extreme heat. The key goal was to highlight the importance of health co-benefits when analysing investments that primarily aim to reduce emissions (e.g. tree planting) as part of a climate mitigation strategy.

The InVEST model was used to estimate the extent to which tree planting could reduce heat via changes in land use, shade, evapotranspiration, albedo and proximity to cooling islands such as parks (WHO, 2023). Results showed that tree planting could result in a 0.7-degree Celsius reduction in temperature in Islamabad (Figure 2).

As well as reducing heat, another intangible benefit of urban tree planting is that it reduces cases of diarrhoea. In this analysis, the study projected a 3.22% reduction in cases in Islamabad as a result of tree planting, resulting in a 10% saving of the initial capital outlay. This is especially significant when considering the additional benefits of tree planting in densely populated areas such as air pollution reduction, water filtration and improvements in mental health and labour productivity. A similar analysis was carried out to estimate the impact of tree planting on water retention (and thus mitigate against damage through floods). Net savings in that analysis reached USD 51 million over 30 years.

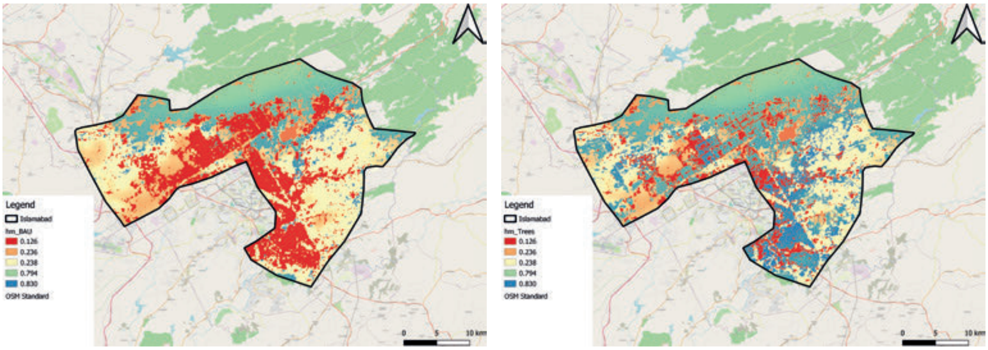

Figure 2: Heat mitigation index across Islamabad under two land use scenarios: the current situation (left) and with the addition of trees along major roads (right). Red zones indicate lower heat mitigation, while blue zones highlight the highest impact on heat mitigation (WHO, 2023)

Project three: Quantifying the health co-benefits of national climate adaptation strategies in Sri Lanka

This project focused on all food systems, urban issues and health system strengthening. The key goal was to estimate the many and varied outcomes of climate action.

KnowlEdge supported Aroha to create Climate Prosperity Plans (CPP) for countries most vulnerable to climate change, one of them being Sri Lanka. The Green Economy Model (GEM), an integrated systems model, was customized to include various health related indicators such as the impact of diets on non-communicable diseases, the impacts of heat on labour productivity, and the impacts of infectious disease on total factor productivity.

Results showed that investments in climate adaptation and mitigation would result in higher gross domestic product (GDP) and employment, improvements in labour productivity via better human health and savings in public finances via lower health and energy costs. The CPP for Sri Lanka was launched at COP27 (Climate Vulnerable Forum & V20, 2022).

Project four: Creating an integrated CBA for WASH investments in Lao

This project focused on health system strengthening. They key goal was the creation of an economic and financial analysis to support investment decisions in WASH for Lao. Save the Children and KnowlEdge partnered with Globalfields (a green finance consultancy) to develop a project that would improve health system climate resilience at a local level.

The proposal focused on 100 health facilities in 25 climate-vulnerable rural districts in Lao to address and manage dengue and diarrhoeal diseases. KnowlEdge assessed

ITEM	NPV	S-NPV	BCR	S-BCR	IRR	S-IRR	PP (years)	PP (years)
1: General health centre strengthening	USD 5,863	USD 104,032	1.07	2.20	12%	47%	8.00	3.00
2: Screened building to reduce vector-borne diseases	USD (1,279)	USD 3,875	0.07	3.83	-49%	98%	NEGATIVE	1.00
3: Climate proofing -passive and active design for building resilience	USD 12,982	USD 13,279	4.44	4.52	69%	71%	2.00	2.00
4: Climate proofing -undergrounding transmission lines	USD 5,463,972	USD 5,591,062	12.99	13.27	176%	180%	1.00	1.00
5: Photovoltaic system	USD 2,387	USD 66,383	1.11	3.99	13%	77%	8.00	2.00
6: Water wells	USD 3,013	USD 4,860	1.69	2.12	32%	44%	3.00	3.00
7: Water catchment	USD 4,018	USD 5,071	5.48	6.66	134%	165%	1.00	1.00
8: Latrines	USD (444)	USD 1,170	0.00	3.64	NEGATIVE	85%	NEGATIVE	2.00
9: Rainwater harvesting	USD 5,330	USD 6,126	1.60	1.69	26%	28%	4.00	4.00

Table 1: Cost Benefit Analysis (CBA) of nine investments in Lao. NPV (net present value), BCR (benefit cost ratio), IRR (internal rate of return) and PP (payback period) reflect a financial analysis; S-NPV, S-IRR, S-BCR and S-Payback Period (where S = social) reflect an economic analysis that considers the economic valuation of social and environmental impacts.

the health co-benefits of a proposed investment and summarized the analysis in an integrated CBA.

Outcomes indicated that an investment of USD 10.3 million would generate USD 47.2 million in tangible revenues. Furthermore, the results highlighted the beneficial nature of investments in the health sector with significant benefit to cost ratios (BCR). Specifically, the study considered investments in the adoption of interventions/products for one health facility, with a fixed lifetime of the investment (e.g. 20 years). The avoided costs of mortality included associated health care costs, avoided lost productivity costs and income from a healthy working person. These avoided costs represented what might be called societal benefits, among the multiple benefits that the project could generate.

Finally, nine investments were analysed for their likely impacts. In green are the investments found to be especially viable (Table1).

For several investments, including latrines, general health system strengthening and photovoltaic installation, the value of the societal benefits was significantly greater than the original investment or revenues created by them. These analyses reflect the importance of considering the societal impacts of investments in addition to the direct economic benefits they generate.

Lessons learned

This case study highlights the clear yet multi-faceted link between climate and health. It also shows that a multi-stakeholder approach is needed to make this link explicit and meaningfully aid developmental goals.

CLDs illustrate how reinforcing loops are strengthened over time, and how they may trigger vicious cycles when action is not taken. They also illustrate the many co-benefits of action and show, with coordinated resolve, that vicious cycles can be turned into virtuous cycles.

Integrated CBAs reflect the importance of considering the societal impacts of investments in addition to the direct economic benefits they generate.

A systemic co-creation and ownership approach encourages more active involvement from local actors.

Positive outcomes have already come out of this research:

- The Somalia, CLD is being used by Save the Children to coordinate action with local stakeholders and generate funding opportunities for future projects;

- The assessment carried out with Aroha has informed national policy on climate adaptation in Sri Lanka;
- The CBA for Lao has informed the preparation of a project proposal submitted to the Green Climate Fund, the world's largest fund mandated to support developing countries realize climate-resilient ambitions, resulting in an investment decision for projects that create societal benefits.

In summary, systemic assessments in the health-climate realm generate useful information for a range of audiences. It is important to include a variety of experts in the process, which puts them in contact with decision makers and gives them access to relevant policy domains. Additionally, decision makers – including government officials, private sector stakeholders and representatives of civil society – can learn about the impact of their actions on the performance system. This supports the co-creation of strategies and policies and underpins mutual development and synergy.

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