

Ex-post Impact Assessment of the Study: 'Impact of Climate Change on Water Resources and Agriculture in Sri Lanka'

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Abstract: *The ex-post impact assessment (epIA) of the research report titled 'Impact of Climate Change on Water Resources and Agriculture in Sri Lanka: A Review and Preliminary Vulnerability Mapping' is carried out using the approach and criteria developed by the Standing Panel on Impact Assessment (SPIA) of the Consultative Group on International Agriculture Research (CGIAR) and other international agencies. The research was supported by the Climate Change, Agriculture and Food Security (CCAFS) program of the CGIAR and falls in the policy oriented research (POR) category of the CGIAR. The assessment is based on bibliometric analysis, key informant interviews and quantitative data from a structured questionnaire survey.*

The assessment revealed that the findings of the study mentioned has significantly influenced Sri Lanka's climate change strategies and policies. The methodology developed by the study has been adopted in the preparation of sector vulnerability profiles that form the basis for the National Climate Change Adaptation Strategy for Sri Lanka:2011 to 2016 and has been referred to in Sri Lanka's Second National Communication to the United Nations Framework Convention on Climate Change (UNFCCC).

The study has generated a demand for capacity building for climate change and vulnerability analysis in government departments where IWMI's input was solicited. The lead author was invited to be a member of expert committees and advisory bodies on climate change set-up by government. Besides, the recommendations from the study have led to an initiative to establish climate stations across Sri Lanka. The main reasons for the broader appeal of the study is the timeliness of the topic and concerted efforts made to engage key stakeholders.

Key Words: *Policy research, ex-post Impact, Evaluation, Climate Change, Vulnerability, adaptation, strategies, Sri Lanka*

I Objective and Scope

This paper reports the results of an ex-post impact assessment (epIA) of the study titled "Impact of Climate Change on Water Resources and Agriculture in Sri Lanka: A Review and Preliminary Vulnerability Mapping"(Eriyagama, et. al., 2010)¹, which was carried out under the auspices of the flagship programme ' Climate Change, Agriculture and Food Security' (CCAFS) of the International Water Management Institute (IWMI).The focus of the epIA is to assess the nature, relevance, effectiveness, sustainability, scale (geographical breadth) and methodological advances of the research impacts. Nature of the impacts include effective policy changes, induced public investments and capacity building. Relevance of the research pertains to how the research fits into the current policies and priorities at the global, regional and country levels; national and international research and in the over arching theme i.e., CCAFS in the present case. Effectiveness is in terms of achieving or expected to achieve the outputs and outcomes. Sustainability refers to long term and continued impacts, which could be political, financial, economic, social, institutional and environmental. Scale impacts could be sub-regional, regional, country and multiple countries. Methodological impacts are in terms of adoption of innovative methods and tools used in the research. Assessing the impacts is complex due to problems associated with attribution, circularity and valuation of the impacts (Ryan and Garrett, 2003). It is difficult to pin point the impact of a specific research output, as multiple policies and development initiatives happen in tandem. This is more so in the context of policy oriented research because of the methodological problems associated with tracing impact pathways and attributing the impacts.²

This paper does not attempt to evaluate the research output per se. The research study was peer reviewed and is available in the public domain. The primary focus of epIA reported in this paper is confined to the impacts the research has generated after the report was published in 2010.

II The Methodology

The research report under review was not a planned policy oriented research. The study reviews science based investigations on climate change and constructs a vulnerability index using different technical and socioeconomic indicators.

Six indicators were used to assess impacts viz., nature, relevance, effectiveness, sustainability, scale and methodological advances. Efforts were made to identify and assess tangible and intangible impacts and spill over effects. The time lag between the completion of the research study and the epIA was adequate to capture the impacts and their sustainability. Though the research was published in 2010 its dissemination in draft form was started in 2009 itself, providing a five year time lag for epIA, i.e., 2009 to 2014. To capture the follow

¹Along with number of other reports and outputs related to / associated with this report.

²In order to address the methodological issues the Science Council's Standing Panel on Impact Assessment (SPIA) initiated an exploratory study of POR impacts at the request of donors, to evaluate the existing evidence of both direct and indirect POR outcomes and impacts from different types of CGIAR research (CGIAR, 2006).

up policy initiatives in Sri Lanka and spill over impacts (research methods and tools) in other places like Nepal within IWMI.

A three stage approach is adopted for the impact assessment. As a first step an exhaustive review of the research report and related research documents and publications was carried out. The related material include research publications, reports and policy documents. Policy documents prior to and after the publication of the study in 2010 were reviewed in order to assess the policy changes after the publication and dissemination of the results of the study. Old and new policy documents were critically reviewed to identify the inputs (terminology, methods, tools and recommendations) adopted from the research study. At the second stage face-to-face discussions and interviews with the authors of the report were held. This was followed by interviews and discussions with relevant stakeholders including key government agencies dealing with or connected to climate change issues directly or indirectly³.

Discussions with the authors were focused on identifying the process of the impact pathway in the theory of change. Semi-structured interviews with the relevant stakeholders were conducted with a focus on assessing the policy impacts of the research at various levels. In total 16 people were interviewed or discussed (see Appendix Table A1). Of them three are directly associated with the report as authors, though one of them is also a stakeholder at the policy level. At the third level a structured format was canvassed to the stakeholders to elicit their perceptions on the research output in terms of its relevance and usefulness. They were asked to provide scores on 1-10 scale for four important indicators viz., relevance, timeliness, usefulness and influence (see Appendix Table A2). In the end seven stakeholders have responded with filled in forms.

III Ex-Post Impact Assessment of the Research Output

This section presents impact assessment of the research study in terms of achievements and limitations using the criteria and indicators stated earlier. The analysis is based on the evidence from the published policy documents, related research reports, discussions with the authors, other stakeholders - policy makers and academics - and the information elicited from the questionnaire canvassed (see Appendix Table A2). We have used the input, output, uptake, influence and impact criteria along with the indicators of impact viz., nature, relevance, effectiveness, sustainability, etc., to present the assessment.

Inputs

Here inputs refer to and include the report in terms of its quality and the costs (efforts) involved. The quality of the report would determine the uptake and influence of the research. Besides, the costs incurred help in assessing the returns to research (benefit-cost ratio). In what follows we provide a brief account of the study.

³These were: Department of Agriculture; Ministry of Environment and Natural Resources; Department of Meteorology; Water Resources Board; Coast Conservation Department (CCD); Irrigation Department; National Water Supply and Drainage Board; Ministry of Irrigation; Irrigation Department; University of Colombo; Rice Research and Development Institute (RRDI) and Sri Lanka Association for the Advancement of Science (SLAAS).

The research was initiated under CCAFS⁴ in order to provide background information and identify research gaps on climate change impacts on water resources and agriculture in Sri Lanka. Secondary information was collected from various departments and this process was translated into stakeholder engagement at the policy level.

This report was a collaborative effort between IWMI, Centre for Poverty Analysis (CEPA) and National council for Disaster Management, Ministry of Disaster Management and Human Rights, Sri Lanka. It is the first detailed report on impacts of climate change on water resources and agriculture and first to attempt the vulnerability mapping covering the entire country, excluding the areas disturbed by the civil war (due to lack of data).⁵ Climate change was not a priority till 2008 as it was neither reflected nor integrated in to the sectoral policies like agriculture (GoSL, 2007); energy (GoSL, 2008) and forestry (GoSL, 1995). The size of the project is small both in terms of time frame and budget. The project took less than a year to complete at a modest budget of US\$ 50,000.

The report addresses the second objective of the CCAFS theme i.e., diagnosis and analysis. It provides an exhaustive review of literature on climate change pertaining to Sri Lanka and its impacts on water resources and agriculture. The impacts are presented under different future climate scenarios. It presents various cropping strategies recommended by different studies and departments (see p. 16). Following the IPCC's definition of vulnerability as a function of exposure, sensitivity and adaptive capacity) the study constructed an index of climate change vulnerability at the district level. The research provides a combination of process, method and policy oriented research output. It adopts a capacity based approach (methods and decision support tools) rather than an impact based approach (developmental interventions). Important observations of the study include:

- Clear indication of increase in temperature and a decline in rainfall during recent decades, though the future scenarios of rainfall are not very clear.
- Increase in number of consecutive dry days and decline in consecutive wet days.
- Changes in precipitation may have more impact than changes in temperature.
- Increased stress on water resources with an expected increase in demand for irrigation for paddy (13-23 percent). However, in southern region irrigation requirement may decline (2-4 percent).
- Dry regions are the worst affected in the context of climate change.
- Paddy yields might increase (24-39 percent) due to increased CO₂ emissions.
- Reduction in precipitation may adversely affect tea and coconut production.
- Fisheries appear to be less vulnerable.

⁴The main objectives of the CCAFS include: i) to develop and test pro-poor adaptation and mitigation technologies, practices and systems; and ii) to provide diagnosis and analysis that will ensure cost effective investments, the inclusion of agriculture in climate change policies and the inclusion of climate policies into agricultural policies from sub-national to global level in a way that brings benefits.

⁵Though there were some earlier studies reviewing the climate scenarios of Sri Lanka (Droogers, 2003), they were not comprehensive enough to provide a national scenario and identify the impacts on agriculture and water resources.

- Increasing competition for water resources between irrigation and hydro power could result in food insecurity.
- In terms of vulnerability, regions that are characterised as dry, agriculture dependent, high population density and low education levels are observed to be more vulnerable.

Outputs from the study

The research has generated number of outputs between 2009 and 2013, given its short time span and size. There are five papers published at different levels (Appendix A3). Apart from the main report- published as IWMI research report (no. 135) that was internally peer reviewed, the project outputs include publications in a peer reviewed edited book, a case study by an international agency and in the conference proceedings. It is yet to be published in a peer reviewed journal. Three conference papers / presentations were made and five articles were published as part of a series of newspaper articles on climate change in Sri Lanka initiated by the news paper. Two of them are by the authors and the rest by other IWMI staff. The publication of a series on climate change, reflected the interest it generated. There are also capacity building and training activities taken up by the team (more details on this later).

Dissemination

As far as dissemination is concerned this report has paved the way for partnership between IWMI and the Sri Lankan government on climate change policies. The dissemination process began with the stakeholder engagement from the beginning of the research. Number of departments were involved in the research by providing data and other inputs. As a result the awareness is high at above 80 percent, though the awareness is more at the top level⁶. More than 70 percent of the people interviewed have reported high or moderate level of interaction or engagement with the lead authors and as much percentage of respondents have high or moderate awareness about the report (Table 1). Of the respondents 80 percent reported that the report has been useful in understanding climate change aspects better and all of them agreed that the report has provided new insights into climate change and vulnerability. More importantly, 80 percent of the respondents either used the results in their work or planning to use them in future (Table 1). The research has created effective awareness on climate change and vulnerability issues. Policy makers not only are aware of the research but also are using it in their work. According to them the most important contribution of the report is in terms of methodologies (techniques) / adaptation strategies /. The research thus has made a significant contribution to the development of Sri Lanka's climate change adaptation policies. This is very much evident during our discussions with the stakeholders, especially from the Climate Change Secretariat (CCS) that was responsible for drafting the national strategy. They clearly indicated how the report was useful in preparing the strategy. Similarly, officials from water board and the coordinating secretariat for science, technology and innovation (COSTI) have clearly indicated that they are planning to implement some of the recommendations made in the report.

⁶Our discussions with lower level staff in the departments revealed that they are not aware of the research.

Table 1: Perception of the Stakeholders Regarding the Awareness and Uptake of the Report

Indicator	Response indicator	% of Responses (n=7)
Nature of engagement process (Interactions with the lead authors)	High	28
	Moderate	44
	Low	28
Awareness about the report in the respective (respondents) Department	High	43
	Moderate	29
	Low	28
Usefulness of the report in understanding CC better	Yes	80
Used the results or methods in work	Yes	80
Planning to make use of the report in the future	Yes	80
Research provided new insights in to CC and Vulnerability	Yes	100
Most important contribution of the report	Application of the methodology applied during the National Climate Change Adaptation Strategy	43
	Adaptation Strategies	29
	A well-researched publication on CC related studies performed in Sri Lanka	29
Applicability of the results across Sri Lanka	Yes	71
	Needs refinement	29

Influence

Though the study was not demand driven per se, demand for the study has been quite conspicuous among the policy circles since its first presentation in 2009. In June 2009 the initial findings were presented at the 'Water for Food Conference' in Colombo, which was attended by the representatives from government agencies, international organisations and NGOs. This generated a demand for research and analysis on climate change.

The research report is one of the most influential documents in the context of climate change policies and strategies in Sri Lanka and is referred to in a number of policy documents on climate change. The findings have been incorporated in the Sri Lanka's National Climate Change Adaptation Strategy 2011-2016 (NCCAS), which was finalised in 2011 and Sri Lanka's Second National Communication on Climate Change that was submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in November 2010. In fact, the lead author was involved in the preparation of the second national communication to the UNFCCC, which is mainly due to the research output. The team, responsible for

preparing both these documents, from the climate change secretariat under the ministry of environment and renewable energy, Sri Lanka, has clearly endorsed the influence of the research output in preparing these documents. The research findings are being used in a number of new projects, including a 2012 UNDP initiative aimed at building climate resilient activities into national household food security improvement and rural infrastructure programmes.

The study methodology and strategies proposed for assessments on climate change impacts have been adopted in other studies. The methodology to prepare district-level vulnerability index has been used to delineate sector vulnerability profiles (SVPs) for the entire Sri Lanka. The SVPs form the basis for the main document NCCAS 2011-16. The SVPs were prepared for the five important sectors viz., i) agriculture & fisheries; ii) water; iii) health; iv) urban development, human settlement and economic infrastructure, and v) biodiversity and ecosystem services. The vulnerability methodology (used in the research study) was refined and adopted to sector specific regions. Two partners expressed interest in joining IWMI to conduct a wider study on vulnerability mapping (WRENmedia, 2013).

Besides, the NCCAS 2011-16 addresses most of the issues raised in the research report. The lead authors were also involved in a number of committees and advisory groups (WRENmedia, 2013) while preparing these strategy documents. They were also invited as resource persons to the workshops on climate change organised by various departments. It is reflected in the large number of departments (71 percent) that invited the team to participate in the meetings and workshops (Table 2). But, the reverse is not true, as less than a third of the stakeholders have attended the programmes organised by the team or IWMI. This could be due to the differences in the current priorities between policy and research. Majority of the stakeholders (57 percent) have indicated that they have contributed to the research report in terms of providing data or participated in the discussions. This explains the influence of the research and hence its impact.

Table 2: Stakeholders Involvement and Interaction with the Researchers

Perception of Stakeholders	% Reporting
Attendance of the stakeholders or their colleagues in any of IWMI programmes related to this report	29
Authors Attendance/participation in programmes on climate change? organised by the department or ministry	71
Contribution to the research by the stakeholders or their colleagues	57

The influence of the output is also observed in research and academic aspects. For instance, the research division of the Department of Meteorology uses the research report as a hand book in their regular work. University of Peradeniya, department of agriculture, uses it as a

reference material⁷. The Water Resources Board is proposing a collaborative study with IWMI on the "Possible Direct and Indirect Impacts of Climate Change on Coastal Aquifer Systems of Sri Lanka"⁸.

Outcomes and Impacts

The most important outcome of the research study is its contribution to main-streaming the climate change policies in Sri Lanka. Its contribution and role in shaping the climate policies in Sri Lanka is quite substantial and unprecedented⁹. Apart from providing clear synthesis of climate change impacts on water resources and agriculture, it provides a policy decision support tool in the form of vulnerability index. The index is considered as highly relevant and useful in the Sri Lankan context. One reason could be the timeliness of the research, which is emphasised even by the lead authors. Timeliness has scored 7.7 on a 10 point scale¹⁰ and all the respondents gave more than 6 rating (Table 3). Its influence on the national climate change adaptation strategy has received highest rating i.e., 7.9. The usefulness was also rated high at 7.3. The relatively low rating in terms of policy relevance is due to the reason that the study could not cover some of the important sub-sectors like groundwater, coastal zones, fisheries, etc. While these ratings in general are quite high as those interviewed were senior government officials. The ratings are likely to come down if the sample expands to lower level officials. That is percolation of the awareness and impacts of the research output are not deep at present.

Table 3: Perception of the Stakeholders on the Research Study

Stakeholder Perceptions	Average rating on 0-10 scale (N= 7)	% of stakeholders give a rating of ≥ 6
Policy relevance to the concerned department (i.e., respondents)	6.3	80
Timeliness	7.7	100
Usefulness	7.3	80
Influencing the National Climate Change Adaptation Strategy	7.9	100

The outcomes and impacts can be grouped as tangible and intangible. Given the nature and coverage of the research the expected tangible outcomes and impacts include policy changes, implementation of these changes and ultimately the benefit flows to the target groups. The intangible outcomes and impacts include knowledge and learning, awareness and capacity

⁷ Based on personnel communication with Prof. Budhi Marambe, Department of Agriculture, University of Peradeniya.

⁸ Based on our discussions with Mr. Karuna Ratna, DGM, Water Resources Board, Sri Lanka.

⁹ As reflected in its extensive referencing in strategy documents on climate change and also based on the personal interview with staff in the Climate Change Secretariat.

¹⁰ This is based on the data generated from the questionnaire canvassed among various stakeholders (see Appendix Table A1). Respondents were requested to provide a score on 1-10 scale on four indicators viz., policy relevance; timeliness, usefulness of the report and also its role in influencing the National Climate Change Adaptation Strategy. The scores provided by the stakeholders on each indicator are averaged to get the overall score. A score close to 'Ten' indicates high impact and close to 'Zero' indicates low impact.

building (Table 4). As seen from table 3, policy relevance of the research is quite high in generic terms though the impact is limited to specific departments. Effectiveness of these policy changes or initiatives is not yet clear and may depend on number of socioeconomic and political factors and hence the impact may be moderate. In the case of intangible impacts, the requirement for capacity building is high but may take some time to take shape in a systematic manner. Since mainstreaming of climate change has taken place at various levels of policy process the impacts are likely to be sustainable, i.e., climate change continues to be part of policies at least in the medium term. The intangible impacts of knowledge, awareness and capacity building are low due to the absence of capacities at present. In terms of geographical breadth the impacts are country wide, while the intangible impacts may be more centralised. The outcomes and impacts are quite high regarding the advancement of methods and tools as far as Sri Lanka is concerned.

Table 4: Tangible and Intangible Outcomes and Impacts and their features

Outcome / Impact	Tangible	Intangible
Nature of Impact	Policy, Implementation, Benefit flows.	Knowledge and learning; Awareness; Capacity building
Relevance	High	High
Effectiveness	Medium	Low
Sustainability	High	Low
Scale (geographical breadth)	Country wide	Limited
Methods and Tools	High	Medium

Among the numerous outcomes in terms of policy pronouncements and initiatives during the last five years on climate change, some of them may be considered as having greater impact. The NCCAS 2011-16, which reflects the research output to a large extent in water and agriculture sectors appears to be moving forward in a systematic manner with an integrated framework and structured five strategic thrust areas i.e., the SVPs. An estimated 47.7 billion rupees (\$ 364 million) incremental additional financing, beyond current and ongoing expenditure, will be required to implement the NCCAS over its 6 year duration (GoSL, 2010a). The vast majority of these financial resources are expected to be channelled directly to the broad base of agencies and stakeholders (both within Government and beyond), to finance and implement climate change adaptation interventions on varied scales. The Ministry of Environment will play a facilitation and coordination role in the process. A pipeline of projects related to each strategic thrust area has also been developed as an integral part of the NCCAS development process to expedite investment. Once materialised, this would have a substantial impact on enhancing the resilience and adaptive capacity of Sri Lankan people.

Another impact of the research outputs is regarding the suggestion about improving the quality of climate data. Initiatives are already underway in this regard to establish climate stations across Sri Lanka. The two important data requirements are high quality data on climate variables, especially rainfall and groundwater monitoring, quality as well as quantity.

In the case of climate data Sri Lanka relies on a network of rainfall stations using manual measurement and communicating through telephone. The study suggested generation of digitised climate data. As a resource person on providing input into formulation of Next Generation projects on climate change, under the coordinating secretariat for science, technology and innovation (COSTI)¹¹ the lead author suggested the establishment of low cost automatic rain gauge stations across the country. COSTI has taken up this suggestion to develop a public-private partnership (PPP) model involving government (department of Meteorology), industry and insurance companies to establish the stations. Manufacturing industry is roped in to supply the rain gauge instruments within the country and insurance companies will support the initiative for getting more accurate weather information at a much smaller scale (village) than it is available presently. COSTI is planning to establish the stations in all the 10000 schools across the country. These stations will be connected to a central server. Dissemination of data would be through mobile applications- farmers receive weather information through their mobiles. Ministry of education is supporting this initiative and confident that their network of parent associations (linked through mobiles) is the fastest way to communicate. According to Prof. Alwis, Director, COSTI: "This is one of the first initiatives from COSTI. Since the idea is from IWMI, it will have a major say in this initiative in terms of quality and type of the instruments and the scale." He is confident that the initiative will roll out very soon. This is a great opportunity for IWMI to have a multiplier effect of the impacts- economic as well as social.

Besides, proposals for renovating traditional tank systems, establishing rainwater harvesting systems and promoting water saving technologies (micro irrigation) to reduce water stress in dry regions are at an advanced stage of implementation (Vermeulena, et. al., 2013). In the case of groundwater monitoring water resource board is planning to establish 1000 monitoring wells across the country to monitor quantity and quality of groundwater. Another big initiative pertaining to data management at the national level is the establishment of a national data base on water named as water information system for Sri Lanka. IWMI is the nodal agency for providing the platform for public domain data management. All the relevant departments are requested to share their data. Software is developed to provide public access to data based on the classification of data. The initiative was flagged off by the Hon. President of Sri Lanka, who visited IWMI head quarters in early 2014. This initiative is progressing well despite the reluctance of some departments to share the data¹². In a recent development, the national planning department has requested the lead author to provide the vulnerability mapping data presented in the research report to make investments in one of the most vulnerable and poorest districts. All though these initiatives can't be considered as direct impacts they are triggered by the research. These initiatives could be translated into measurable impacts in the near future.

¹¹COSTI brings together more than 25 ministries and more than 70 institutions together to support the coordination and monitoring activities related to science, technology and innovation.

¹² Based on the personal interview with Dr. Herath Manthrithilake, Head Sri Lanka Development Initiative, IWMI.

Intangible or Capacity Impacts

Capacity building is a necessary component of any process as it enhances the ability of people and organizations to understand the methodologies and tools that are required to formulate policies. This is more so in the context of climate change policy inputs as they are more technical in nature when compared to economic policy research. At the university level the climate change oriented training helps in providing appropriate skills for taking up climate related research. As of now the capacities at the departmental level are limited as far as climate research is concerned. Only the technical people in some departments are capable of understanding and using the research outputs. This is reflected in the high demand for capacity building for their staff, as 86 percent of the respondents expressed their desire.

Need for capacity building (for staff) for better understanding and using / applying the report results	Very much	43
	To some extent	43
	Not necessary	14

The capacity building impacts of the research are already evident. IWMI has signed an agreement with the ministry of environment to conduct capacity building to water sector agencies in Sri Lanka on climate change vulnerability assessments in 2013. The first training workshop was held in December 2013. The Ministry has requested that IWMI should continue to assist them with capacity building requirements. Another training workshop on vulnerability assessments in the water sector is expected to be conducted in 2015. The water resources board has expressed its desire to train their staff on GIS with the help of IWMI.

Costs and benefits

Estimating the benefits from a POR is a difficult proposition given the time lags between policy making, implementation and benefit flows. And the benefit flows could be widely diffused. At the same time the exercise of costs versus benefits provide a decision support tool for the research community as well as policy makers. It certainly helps the funding agencies in selecting right projects and make funding decisions.

In the present case we are in a position to identify the potential benefits that are likely to enhance socioeconomic welfare of the communities in Sri Lanka. But, there is no concrete and quantifiable evidence given that the policy strategies are in the process of getting translated into implementation. At the same time there is ample evidence that the benefits may reasonably be expected in the near future. The main constraints in translating the policies in to programmes include: funding, institutional arrangements and capacities at the policy and implementation level. The expected welfare gains are mainly in the form of reduced water stress, reduced flood related losses, improved crop resilience and improved food security.

IWMI had spent about \$ 50, 000 on this research report towards staff and travel over the period of one year. In addition some time was spent by different departments in Sri Lanka while supporting the research, which may be modest. In comparison to these modest costs the

likely and potential benefits from the policy research outcomes mentioned in the previous section could be enormous. As we are not in a position to determine and quantify the welfare benefits, an alternative approach is used, i.e., induced investments from the government or other donors in climate change initiatives related to water and agriculture. Of the estimated total financial requirements (\$ 364 million) of implementing the NCCAS plan 2011-16 about a quarter i.e., \$ 86 million is required for water and agricultural sector. Besides, another \$ 27 million is estimated for mainstreaming climate change adaptation into national planning and development (GoSL, 2010a). Under the later component, establishment of 10000 weather stations is likely to be implemented very soon. The investments required for establishing the stations are about \$ 1 million assuming that a low cost manually operated rain gauge station would be established in 10000 schools, costing about \$100 per instrument and establishing it¹³. Added to this are the investments being planned for the renovation of traditional tanks. Thus, even a very conservative estimate of these investments indicate a many fold benefit flows when compared to the actual costs of the research. Thus the research is likely to generate high returns and benefit-cost ratios. The induced public investment in establishing rain gauge stations itself would be 20 times of the research costs (benefit-cost ratio= 20).

Spin-off or Follow up Impacts

The spin-off or follow up impacts are assessed in terms of initiating new research within or outside the institution using the methods and tools adopted in the research. One such follow up activity can be traced to IWMI work in Nepal, which is on the similar lines of the present study. IWMI, Nepal¹⁴ was contracted by ADB to take up a scoping study for the pilot program for climate resilience (PPCR). The objectives include: i) identify watersheds that are vulnerable to climate change in the mid-hills and mountains of Nepal, and ii) model the impacts of watershed interventions on hydrology and dry season water availability in two vulnerable watersheds (Gurung, et. al., 2013). This study helped convincing the department of soil conservation and watershed management (DSCWM) on investing in water focused watershed management programs. It took a long time for the government to finally approve the PPCR program, resulting in a \$ 30 million investment. The vulnerability maps produced by IWMI and the idea for watershed interventions are now being used by other organizations viz., Helvetas, UNDP, etc. So, the impact has gone beyond the ADB program in Nepal. This study is an off shoot of the Sri Lankan research study, as it dealt with vulnerability mapping using similar methodology, though the earlier study was not referred to in the Nepal studies.

IV Concluding Remarks

¹³The market prices of the instruments range between \$100 and \$ 2000 depending the sophistication of the technology, i.e., manual, semi and fully automatic. As per the specifications of the Sri Lanka Met Dept, each met station costs about \$5000 (based on personnel communication with Dr. Uday Bhaskar Project Lead, CSIRO, Australia (the project is being funded by AUSAID). We have taken the costs of manual rainfall measuring instruments, which were used in some villages of Telangana by the Agro-meteorology department, Agricultural University, Hyderabad. The IWMI monthly update (31st March, 2015) mentions about a cheap rainfall forecasting device at US\$ 250 developed by Sri Lankan Scientists.

¹⁴Dr. Luna Bharati, IWMI, Nepal, has provided the information. Also see Re-thinking investment in sustainable landscapes and livelihoods at the Global Landscape Forum on November 16, 2013. The session is sponsored by the CGIAR Research Program on Water, Land and Ecosystems. (<http://wle.cgiar.org/blog/2013/11/07/wle-at-the-global-landscapesforum/>); Siddique, et. al., (2012).

The research study appears to be the most influential as far as its impact on climate change policies in Sri Lanka are concerned. The main reason is the timing of the research. The research coincided with the Sri Lankan policy initiatives on climate change. Sri Lanka ratified the United Nations Framework Convention for Climate Change (UNFCCC) in November 1993 and is among the first 50 countries to have ratified the convention. Sri Lanka submitted its initial national communication (INC) to UNFCCC in October, 2000. The research study was coincided with Sri Lanka's second communication under UNFCCC, which was submitted in November 2011. The vulnerability mapping developed in the research study was found to be useful for formulating climate change policies at the regional and sectoral level.

But for the stakeholder engagement process adopted by the study, such an influence would not have been possible. Research and policies often go in parallel without knowing what is happening on the other side. The involvement of all the important departments in the preparation of the research study, as collaborators and contributors, has helped in giving a sense of ownership of the research among the policy makers. At the same time the global commitments on climate change has triggered the need for informed policy formulations and the research study provided the scientific basis for this. The involvement of international agencies like ADB, UNDP, etc., has also encouraged the policy makers to look towards IWMI, which has the international standing in quality research. That is IWMI has a wider acceptability among the international agencies.

The scientific and technical nature of the subject could be one of the key factors in making it most influential. Limited capacities to understand and adopt the methodologies has also forced the departments to involve IWMI in the process of preparing the policy documents. Thus climate change research with scientific basis has greater potential in influencing the policy.

In the end, irrespective of the logical links between the research findings and policy initiatives and endorsements of the policy makers the question of attribution remains. The multi level approach of our assessment clearly establishes the linkages between research outputs and consequent policy changes. There are no competing claims from other research studies and hence the causality could be established, though the timing could be a coincidence. But, measuring the contribution of the research in the follow up actions would need some more time.

Nevertheless, the epIA of the modest size research has provided clear and logical evidence on its policy impacts. Majority of stakeholders felt that the research report is very timely in the context of Sri Lanka's climate change policies. The report is considered as the baseline and a reference point for climate change initiatives in Sri Lanka. The influence and impact of the research is beyond policy, as the report is used as reference material at the post graduate level in some universities. It is observed that number of suggestions made in the report are being adopted by the relevant departments and are in progress for implementation. The report has generated demand for capacity building, as there is a felt need for capacity building in

number of departments dealing with climate change. The research has also resulted in spin off impacts beyond Sri Lanka.

While it is too early to quantify the welfare benefits, there are clear indications of potential future benefits. Besides, the research has induced public investment by many folds when compared to its costs. Thus the research can be placed in high pay off category as it reveals potential for favourable returns and high benefit-cost ratios in the near future.

The policy research has fulfilled the important criteria of providing insights into the status of the system (identifying the vulnerability hot spots across Sri Lanka) for arriving at informed policy decisions. At the same time it enhanced the body of knowledge that led to improved understanding of the implications of alternative policies and guided policy decisions. The research also contributed to the overarching theme of CCAFS.

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References

- CGIAR (2006), Impact assessment of policy-oriented research in the CGIAR: a scoping study report, Consultative Group for International Agricultural Research, Science Council Secretariat: Rome, Italy.
- CGIAR (2008), Impact Assessment of Policy-Oriented Research in the CGIAR: Evidence and Insights from Case Studies; Study commissioned by the Science Council Standing Panel on Impact Assessment. CGIAR Science Council Secretariat: Rome, Italy.
- CGIAR Research Program on Aquatic Agricultural Systems. (2013), AAS Practice Brief: Evaluating natural resource management programs. CGIAR Research Program on Aquatic Agricultural Systems. Penang, Malaysia. Practice Brief: AAS-2013-23.
- Eriyagama N. and V. Smakhtin (2010), Observed and Projected Climatic Changes, Their Impacts and Adaptation Options for Sri Lanka: A Review. In: Evans A. and K. Jinapala (eds.) *Proceedings of the National Conference on Water, Food Security and Climate Change in Sri Lanka, Volume 2: Water Quality, Environment and Climate Change*. Colombo, Sri Lanka: International Water Management Institute.
- Eriyagama N., V. Smakhtin, L. Chandrapala and K. Fernando (2010) *Impacts of Climate Change on Water Resources and Agriculture in Sri Lanka: A Review and Preliminary Vulnerability Mapping*, IWMI Research Report 135. Colombo, Sri Lanka: International Water Management Institute.
- Eriyagama N. (2010) Impacts of Climate Change on Water Resources and Agriculture in Sri Lanka: Vulnerability Hotspots and Options for Adaptation. *Water Matters. News of*

- IWMI Research in Sri Lanka*, Issue 5, April 2010. Colombo, Sri Lanka: International Water Management Institute.
- Gardner Bruce(1999), Returns to policy-related social science research in agriculture. IFPRI Impact Assessment Discussion Paper No. 9. International Food Policy Research Institute: Washington, DC.
- Gardner Bruce (2008),. Methods of assessing policy-oriented research: a review. In ‘Impact assessment of policy-oriented research in the CGIAR: evidence and insights from case studies. A study commissioned by the Science Council Standing Panel on Impact Assessment’. CGIAR Science Council Secretariat: Rome, Italy.
- GoSL (1995), National Forest Policy of Sri Lanka -1995, Forest Department, Government of Sri Lanka.
(http://www.forestdept.gov.lk/web/index.php?option=com_content&view=frontpage&Itemid=1&lang=en)
- GoSL (2007), "National Agriculture Policy", Ministry of Agriculture Development and Agrarian Services, Government of Sri Lanka.
(http://ruaf-asia.iwmi.org/Data/Sites/6/PDFs/National_Agril_Policy.pdf)
- GoSL (2008), National Energy Policy & Strategies of Sri Lanka, Ministry of power and energy, Government of Sri Lanka.
(http://www.ceb.lk/download/db/national_energy_policy.pdf)
- GoSL (2010a), National Climate Change Adaptation Strategy for Sri Lanka: 2011 to 2016, Climate Change Secretariat Ministry of Environment, Government of Sri Lanka, Colombo.
- GoSL (2010b), Sector Vulnerability Profile: Water, Climate Change Secretariat Ministry of Environment, Government of Sri Lanka, Colombo.
- GoSL (2010c), Sector Vulnerability Profile: Agriculture and Fisheries, Climate Change Secretariat Ministry of Environment, Government of Sri Lanka, Colombo.
- GoSL (2010d),Sector Vulnerability Profile: Biodiversity and Ecosystem Services, Climate Change Secretariat Ministry of Environment, Government of Sri Lanka, Colombo.
- GoSL (2010e), Sector Vulnerability Profile: Health, Climate Change Secretariat Ministry of Environment, Government of Sri Lanka, Colombo.
- GoSL (2010f), Sector Vulnerability Profile: Urban Development, Human Settlements and Economic Infrastructure, Climate Change Secretariat Ministry of Environment, Government of Sri Lanka, Colombo.
- GoSL (2011), Enabling Activities For The Preparation Of Sri Lanka’s Second National Communication to the United Nations Framework on Climate Change (UNFCCC), Climate Change Secretariat Ministry of Environment, Government of Sri Lanka, Colombo.
- Gurung Pabitra, Luna Bharati and Saroj Karki (2013),The Assessment and Management of Water Resources under Current and Future Climate Conditions in the West Seti Sub-basin, Nepal, Consultancy Report Prepared for the Asian Development Bank (ADB),International Water Management Institute (IWMI), Kathmandu, Nepal.
- Lindner, Bob (2011),*Frameworks for assessing policy research and ACIAR’s investment in policy oriented projects in Indonesia*. ACIAR Impact Assessment Series Report No. 72. Australian Centre for International Agricultural Research: Canberra. 68 pp.
- Mayne J. and Stern E. 2013. Impact evaluation of natural resource management research programs: a broader view. ACIAR Impact Assessment Series Report No. 84. Australian Centre for International Agricultural Research: Canberra. 79 pp.

- Raitzer, D.A. 2008 Assessing the impact of CIFOR’s influence on policy and practice in the Indonesian pulp and paper sector. Impact Assessment Paper. CIFOR, Bogor, Indonesia.
- Renkow Mitch and Roger Slade (2013), An Assessment of IFPRI’S Work in Ethiopia 1995–2010: Ideology, Influence, and Idiosyncrasy; Independent Impact Assessment Report No. 36, International Food Policy Research Institute, Washington, DC, June.
- Ryan, J.G. and Garrett, J.L. 2003. *The Impact of Economic Policy Research: Lessons on Attribution and Evaluation from IFPRI*. Impact Assessment Discussion Paper No. 20. International Food Policy Research Institute (IFPRI): Washington DC, USA.
- Siddiqui Salman, Luna Bharati, Menuka Pant, Pabitra Gurung, Biplov Rakhali, Laxmi D. Maharjan (2012), Nepal: Building Climate Resilience of Watersheds in Mountain Eco-Regions – Climate Change and Vulnerability Mapping in Watersheds in Middle and High Mountains of Nepal, ADB Technical Assistance Consultant’s Report, Project Preparatory Technical Assistance 7883-NEP For Department of Soil Conservation and Watershed Management (DSCWM), Government of Nepal, International Water Management Institute (IWMI) Kathmandu, Nepal, April.
- Stein Danielle and Craig Valters (2012), Understanding Theory Of Change In International Development, JSRP Paper 1, August. (http://www.theoryofchange.org/wp-content/uploads/toco_library/pdf/understandingtheoryofChangeSteinValtersPN.pdf).
- Walker T., Maredia M., Kelley T., La Rovere R., Templeton D., Thiele G., and Douthwaite B. 2008. Strategic Guidance for Ex Post Impact Assessment of Agricultural Research. Report prepared for the Standing Panel on Impact Assessment, CGIAR Science Council. Science Council Secretariat: Rome, Italy.
- WRENmedia (2013) "Influencing climate change policy in Sri Lanka, A case study" , Research Programme on Climate Change, Agriculture and Food Security (CCAFS), Swiss Agency for Development and Cooperation (SDC) and European Initiative on Agriculture Research for Development (EIARD), February.
- Vermeulena, Sonja J., Andrew J. Challinora, Philip K. Thorntona, Bruce M. ampbella, Nishadi Eriyagamaa, Joost M. Vervoorta, James Kinyangia, Andy Jarvisa, Peter Läderach, Julian Ramirez-Villegasa, Kathryn J. Nicklin, Ed Hawkinsh, and Daniel R. Smithc (2013), Addressing uncertainty in adaptation planning for agriculture, In Ed Jeffrey Sayer, James Cook University, Cairns, QLD, Australia, and accepted by the Editorial Board April 2013.

Appendix

A1: List of People Interviewed

Sl. No.	Name	Affiliation
1	Dr. Madar Samad	Theme Leader; IWMI
2.	Dr. Vladimir Smakhtin	Theme Leader, IWMI
3.	Ms. Nishadi Eriyagama	Water Resources Engineer, IWMI
4.	Dr. Herath Manthrithilake	Head Sri Lanka Development Initiative, IWMI
5.	Prof. Ajith P. de Alwis	Project Director, COSTI
6.	Dr. L. Manawadu	Prof.; Department of Geography, Uni. of Colombo
7.	Mr. G. R. R. Karuna Ratna	DGM, Water resources Board
8.	Dr. Budhi Marambe (on	University of Peradeniya, Kandy

	Phone)	
9.	Ms. Anoja Seneviratne	Head, Mitigation, Disaster Management Centre
10.	Ms. T. S. Meagastenna	Director, Irrigation Water management
11.	Dr. D. B. T. Wijesekara	Additional Secretary, Dept. of Agriculture
12.	Mr. Lalith Chandra Pala	Director General, Department of Meteorology
13.	Ms. H. K. T. Dulani	Asst. Director, Climate Change Secretariat (CCS)
14.	Ms. Nirosha Keme	Environmental Management Officer, CCS
15.	Ms. Kema Keasturiarachi	Environmental Management Officer, CCS
16.	Mr. Sudharma Elakanda	Additional Director General, Mahaweli Authority of Sri Lanka

A2: Review Format for Impact Evaluation of the Project "Impact of Climate Change on Water Resources and Agriculture in Srilanka"

Name:

Designation:

Department:

Check List	Response / Remarks
i) Nature of engagement process. Interactions with the lead authors	
ii) Number of people in your Department aware of the report	
iii) In what aspects the report helped you understand CC better. viz., terminology, CC impacts; CC vulnerability across Sri Lanka, adaptation strategies.	
iii) In your view what is the most important contribution of the report	
iv) Have you / your department used the results or methods in your work. And how?	
v) Are you planning to use them in future?	
vi) Has the research provided any new insights in to CC and Vulnerability ?	
vii) Applicability of the results across Sri Lanka	
viii) Have you attended any of IWMI programmes related to this report?	

ix) Has any of the authors attended or participated in programmes organised by your department or ministry?	
x) Nature of your contribution to the research.	
xi) Is there a need for capacity building to your staff for better understanding and using / applying the report results?	
xii) How do you rate (on 1-10 scale) the research in terms of:	
-Policy relevance (for your department)	
-Timeliness	
- Usefulness	
- Influencing the National Climate Change Adaptation Strategy (20011-16) formulation	

A3: Papers and Publications from the Research Project

1	Eriyagama N. (2010) Impacts of Climate Change on Water Resources and Agriculture in Sri Lanka: Vulnerability Hotspots and Options for Adaptation. <i>Water Matters. News of IWMIResearch in Sri Lanka</i> , Issue 5, April 2010. Colombo, Sri Lanka: International Water Management Institute.
2	Eriyagama N. and V. Smakhtin (2010) Observed and Projected Climatic Changes, Their Impacts and Adaptation Options for Sri Lanka: A Review. In: Evans A. and K. Jinapala (eds.) <i>Proceedings of the National Conference on Water, Food Security and Climate Change in Sri Lanka, Volume 2: Water Quality, Environment and Climate Change</i> . Colombo, Sri Lanka: International Water Management Institute.
3	Eriyagama N. (2013) "Influencing climate change policy in Sri Lanka, A case study" WRENmedia, Swiss Agency for Development and Cooperation (SDC) and European Initiative on Agriculture Research for Development (EIARD).
4	Vermeulena, Sonja J., Andrew J. Challinora, Philip K. Thorntona, Bruce M. ampbella, Nishadi Eriyagamaa, Joost M. Vervoorta, James Kinyangia, Andy Jarvisa, Peter Läderacha, Julian Ramirez-Villegasa, Kathryn J. Nicklinc, Ed Hawkinsh, and Daniel R. Smithc (2013), Addressing uncertainty in adaptation planning for agriculture, In Ed Jeffrey Sayer, James Cook University, Cairns, QLD, Australia, and accepted by the Editorial Board April 2013.
Conference Presentations and Papers	
1	Eriyagama Nishadi (2009), Climate Change And Sri Lanka's Water Future Workshop on Vulnerability and Adaptation to Climate Change in the Water Resources Sector, Colombo, Sri Lanka, September.
2	Eriyagama Nishadi (2010), Responding To Climate Change Signals And Impacts: Case of Sri Lanka Regional Workshop on Strategic Assessment for Climate Change Adaptation in Natural Resource Management, Colombo, Sri Lanka, June 201

3	Eriyagama Nishadi & Vladimir Smakhtin (2011), Future Of Water And Agriculture In Sri Lanka In The Face of Climate Change GWP Workshop on Climate Change Food and Water Security Colombo, Sri Lanka, February.
News Paper Articles	
1	Major food crisis looming: Experts by Indika Sakalasooriya, Business Editor, Daily Mirror – January 18, 2011 (This is the first article which featured IWMI research). (http://www.dailymirror.lk/business/economy/9122-major-food-crisis-looming-experts-.html)
2	Lankan economy to be marred by floods and droughts in future by Nishadi Eriyagama, IWMI – February 03, 2011 (http://print2.dailymirror.lk/business/127-local/34700.html)
3	Floods are only part of the story by Nishadi Eriyagama, IWMI – February 16, 2011. (http://www.iwmi.cgiar.org/news_room/pdf/Floods_are_only_part_of_the_story_Local.pdf)
4	Groundwater holds future for local water management by Aditya Sood, IWMI – February 22, 2011 (http://print2.dailymirror.lk/business/127-local/36324.html)
5	Climate change will drive food prices by Terry Clayton, IWMI – March 23, 2011 (http://print2.dailymirror.lk/business/127-local/38984.html)
6	Climate change – Adapting to the future by HerathManthrithilake, IWMI – March 14, 2011 (http://print2.dailymirror.lk/business/127-local/38064.html)