Cost of climate change adaptation in semi-arid regions – estimates from Maharashtra, India

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Abstract

While estimates do exist for the costs of adaptation at a global level ($200 billion to $500 billion per year), there are few studies that provide bottom-up costs of adaptation (Gray & Srinidhi, 2013). The data presented here is from Watershed Organisation Trust (WOTR)'s climate change adaptation (CCA) project in the Ahmednagar district of Maharashtra, India. The costs cover over two decades of both adaptation and development activities and attempts to differentiate between them to find a climate change relevance to the investments.

Keywords: *Development, Climate finance, Costs of adaptation, Semi-arid, India*

Introduction

This study seeks to establish a range of bottom-up adaptation costs in semi-arid regions of India (The World Bank Group, 2010). These regions cover 69.6% of the total land in the country (Ministry of Environment and Forests, 2010). The focus area of analysis is in Ahmednagar district of Maharashtra in central India. Known to be a drought prone area with about 400-450 mm of rainfall, the primary concern in the region was securing water resources (Central Groundwater Board (CGWB), 2014). Thus, the first step to building resilience began with the watershed development project under the Indo-German Watershed Development Programme (IGWDP) in 1992 (1992-2005).

A climate change adaptation project was implemented between 2009 and 2014. The list of activities include 14 broad categories of interventions including activities under Biodiversity, Livestock, Disaster Risk Reduction, Water Budgeting, Agriculture, Agro-advisories etc. (Watershed Organisation Trust, 2014) (Bhushan, Srinidhi, Kumar, & Singh, 2014).

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Methodology

The CCA project by WOTR has been carried out in 25 villages in the Ahmednagar district of Maharashtra and the monetary data around it pertains to the investments made towards these activities. We have used two ways of differentiating costs that address development or adaptation deficits.

i) **Objective-based method:** involves classifying an activity as development or adaptation based on stated objective (explicit / implicit) of the activity. It also takes into consideration whether the activity was historically being carried out in development projects or if it is a new and 'additional' activity (Resch, Allan, Alvarez, & Bisht, 2017). The key variable being estimated is the sum of the costs which are meant for activities that have "adaptation" as the goal.

ii) **Benefits-based method:** an assessment of the total benefits generated from that particular activity and the proportion of which is associated with adaptation or mitigation. This assessment is based on a number of Cost Benefit Analyses (CBA) under 'business-as-usual' and 'climate-change' scenarios (Resch, Allan, Alvarez, & Bisht, 2017). The key variable being estimated is the sum of the investments that have clear climate change adaptation benefits.

These costs are then compared with the area of the land under treatment and the ratio of cost per unit area is derived. These figures can be used to estimate costs of Adaptation over the wider semi-arid areas of the region.

Findings

Objective-Based Approach

Under the objective-based methodology, activities and their sub-activities were classified into the following categories based on the primary vision behind the activity:

i) Purely Adaptation (A)
ii) Purely Development (D)
iii) Purely Mitigation (M)
iv) A mix of the three (AD/AM/DM/ADM)

Summing-up the costs for each category and then calculating their ratios led to the following split between the three objectives:

Table 1. Split between Adaptation, Development and Mitigation under the Objective-Based Approach (Source: WOTR's CCA financial records, 2014)

Category	Project level
Adaptation	25%
Development	46%
Mitigation	30%

Another important feature of the costs was that they were very sensitive to changes in the ecosystem and terrain. The comparatively hilly areas required much higher costs as compared to plateau areas for development as well as adaptation activities. The resulting split between the adaptation, development and mitigation costs are as follows:

Table 2. Adaptation, Development and Mitigation costs for plateau and hilly regions (Source: WOTR's CCA financial records, 2014)

Objective based Division	Ratio	Project Level (INR)	Plateau Region (INR)	Hilly Region (INR)
Adaptation	25%	3587.15	2729.66	6674.59
Development	46%	6641.34	5053.77	12357.51
Mitigation	30%	4334.23	3298.16	8064.68
Total (INR)	100%	14562.73	11081.59	27096.77

Note: 1 USD = 66.19 INR (3-year average exchange rate)

Thus the costs of an integrated development-adaptation project in semi-arid parts of South Asia (Objective-based method) range from about 11,080 rupees (US$168) to about 27,100 rupees (US$410) per hectare, and adaptation costs amounting to about 25% of the total.

Benefits-based Approach

The benefits-based approach recognises that each type of activity contributes a certain proportion of benefits towards development, adaptation, and mitigation. Based on several cost-benefit analyses (CBAs), proportions for standard activities (development, adaptation and mitigation) have been calculated by Resch et al. (2017). These analyses ae based on various projects in the Indian sub-continent and so would be applicable to WOTR's CCA project in Maharashtra too.

Table 3. Range of benefit-based contribution towards Adaptation, Development and Mitigation (Source: WOTR's CCA financial records, 2014)

Overall	**Lower Bound (LB)**	**Upper Bound (UB)**
Adaptation Ratio	5%	26%
Mitigation Ratio	1%	6%
Development Ratio	68%	93%

Note: Sum of all LBs or UBs will not add-up to 100. LB case for Adaptation and Mitigation + UB case for Development will be equal to 100.

The earlier differentiation in costs between the hilly regions and the plateau region applies – leading to a broad range from the lower bound-Plateau region regions costs to upper bound-hilly regions.

Table 4. Split between Adaptation, Development and Mitigation costs based on ratios mentioned in 'Table 3' (Source: WOTR's CCA financial records, 2014)

Division based on Benefits	**Plateau (INR)**		**Hilly (INR)**	
	Lower Bound	***Upper Bound***	***Lower Bound***	***Upper Bound***
Adaptation	647	3051	1507	7114
Mitigation	176	698	411	1627
Development	8075	11001	18826	25648
Total	11824		27566	

Note: 1 USD = 66.19 INR (3-year average exchange rate)

Thus the costs of an integrated development-adaptation project in semi-arid parts of South Asia (Benefits-based approach) range from about 11,820 rupees (US$179) to about 27,570 rupees (US$417) per hectare, with adaptation costs amounting to about 7,110 rupees (US$108) or 26% of the total at the higher end.

Discussion

The delineation of adaptation, development and mitigation costs is a cause for concern and active debate in the climate finance sphere where the determination of how adaptation finance can be calculated has been a much deliberated topic.

Although this paper points to quite a detailed segregation of the costs, based on objectives and benefits, we should not lose sight of the broader fact that these distinctions (in most cases) are purely academic and often, in reality, adaptation and development will go hand-in-hand. The distinction between the two is less of a 'definitional question' and more of an 'operational process' that establishes the 'adaptation function' of any action based on locale-specific climate information (Hammill & McGray, 2018).

Conclusion

- The adaptation and development splits from both the methods (objective- and benefits-based) are not too divergent and have a very similar upper bound and average value.
- The integrated project costs (adaptation + development) compares well with the budget for national watershed development activities - INR 12,000 and 15,000 per ha respectively (Government of India, 2011) - and is expectedly higher than those.
- A large part of Maharashtra, and the rest of India (69.6%), fall into the category of semi-arid, sub-humid regions. Such per hectare cost estimates will be very useful for climate proofing of agriculture (Ministry of Environment and Forests, 2010).
- UNEP Adaptation Gap report assesses that adaptation costs in developing countries between $140 billion to $300 billion (UNEP, 2017), and such bottom-up analyses could be an excellent basis for validating top-down Climate finance estimates.

Conflicts of Interest (Declaration)

The data pertains to WOTR's CCA project, supported by NABARD and SDC. The use of the data for this study has been sanctioned by the concerned organisations.

Acknowledgements

The study would not have been possible without the support of the various knowledge partners and donors of the CCA project, including the Swiss Agency for Development Cooperation (SDC) and National bank for Agriculture and Rural Development (NABARD).

Notes

This study is based on data from one project and can only be roughly extrapolated to similar contexts.

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