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The City of San Diego Adaptation Economic Analysis
Krout & Associates
May 13, 2012

The Cost Come Before the Benefit

How much to adapt is an economic problem—how to allocate limited resources for climate adaptation strategies while also providing other necessary services. Decision-makers ask: What is the potential loss to local economies and communities from climate change? What is the cost to implement adaptation strategies? Will the benefits outweigh the costs?

For many areas at risk, the potential loss from climate change can be reduced or eliminated by adaptation strategies. However, without adequate data, perceived threats from climate change may lead to implementation of strategies without understanding of the short- and long-term impacts to the local economy. Reactive adaptation strategies implemented by the public agencies, private businesses, and residents may protect individual assets (i.e. homes and businesses), but may not address the local economy's cumulative needs. Reactive adaptation measures will in many cases be more costly than proactive, planned strategies. A homeowner or business may take their own actions to adapt, without public interventions, but under the guidance existing public policy. These spontaneous and autonomous actions are vital to the overall effort to adapt to a changing climate; however, the private sector is primarily market driven, and as a result, will act in there own best interest. A disjointed approach to adaptation can lead to economic inefficiencies, or worse, limited or no protection for public resources such as water and open space.

As a result, it is necessary for the public decision-makers to consider the possible risks and implementation costs from a holistic perspective. Consideration should be given not only to the economic implications of adaptation strategies, but also the environmental and the social impacts. Ecosystems already suffer environmental degradation and climate change will pose an additional stresses. Climate adaptation strategies should consider the value (benefit) of amenities and resources from an economic and social-value perspective. Additionally, exposure to climate change poses different risks to different groups of people. In general, temperature increases have a larger detrimental effect on older individual and the physically ill as compared to the general population. Low-income households are more likely to live in floodplains and susceptible to flood. While an adaptation strategy may provide beneficial economic impacts to a subset of the community, the costs may be unequally distributed leading to hardship for economically disadvantaged populations.

There are numerous methods and models available to perform an economic analysis of climate adaptation strategies. The intent is not to define a detailed model, nor to evaluate a specific adaptation strategy, but rather to illustrate the general framework of analysis. The framework describes the general steps to perform the analysis. The general framework should provide a roadmap to assess the local risk from climate change and help identify a cost-effective set of adaptation strategies.

Economic Framework for Assessment

The economic framework illustrates a multi-step process for quantitatively evaluating a set of climate adaptation strategies. The first step is to estimate the potential loss from climate change to vulnerable

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sectors. The second step is to determine the cost to protect and preserve those vulnerable sectors. The final step is to develop detailed cost-benefit assessments of climate adaptation strategies.

1. Estimate potential losses
2. Calculate implementation cost of adaptation strategies
3. Perform cost-benefit analyses for proposed adaptation strategies

With limited resources, it is not always feasible to implement every climate adaptation strategy. A quantitative evaluation of the strategies should be considered the baseline for discussion. The section concludes with a discussion of the economic implications that should be considered when evaluating adaptation strategies. In combination, the understanding of quantitative and qualitative data can provide clarity for decision-makers considering climate adaptation strategies.

Step 1. Estimate potential loss from a climate change event

What is the value of what may be lost to vulnerable sectors by a climate change event? Put another way, what is the benefit of the vulnerable sector to the economy? The evaluation of the potential loss depends upon calculations of climate change risk and the asset value within the market sectors vulnerable to climate change. This risk is defined as the likelihood of an event occurring and the magnitude of consequences should that event occur (NPCC). Forecasts of the frequency, magnitude, and sector vulnerability are traditionally forecast with the use of specialized climate change probability models. The potential loss is calculated as a function of the severity and frequency of the climate hazard, the value of assets exposed to the hazard, and the vulnerability of those assets to the hazard.

The role of the economic analysis is to assess the economic impacts to assets. Local businesses; cultural and recreational centers; and the underlying physical infrastructure (including water and transportation networks) provide tangible and intangible value or benefits (economically, environmentally, and socially) to a community. By first understanding the value, the potential losses from a climate-change related event (by not implementing adaptation strategies), can be calculated. Assessment of vulnerable sectors should incorporate forecasted changes in the economy and regional demographics to account for the risk of climate change on a evolving economic and population base.

An estimation of infrastructure and other tangible resource values can be calculated using the replacement cost and adjusting for inflation (all else held equal). The cost of replacing intangible resources is more difficult. Environmental quality and social cohesion are complex resources to apply a monetary value, yet methods do exist to provide estimation[1]. By measuring the overall value or benefit, decision-makers can understand the total economic, environmental and/or social loss to the local community if a significant climatic event occurred.

Step 2. Calculate implementation costs of adaptation strategies

Cost for adaptation strategies include the labor and resource costs necessary to implement a proposed strategy. From an economic perspective, the strategies can be divided into three general categories for cost assessment: Maintenance and operations, capital investment including redevelopment, and regulatory and climate change policy. Timing for implementation of specific adaptation strategies within

[1] A series of methods exist for benefit estimation including the travel-cost method, hedonic pricing, and contingent valuation.

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these categories is an important cost consideration as well. Maintenance and operations costs will occur in the short and long-term; however, capital improvements may decrease maintenance costs over the long-term if implemented in the short-term.

The asset valuation is highly dependent on the associated risk in terms of understanding the possible level of frequency and magnitude. When estimating the economic value of an asset, we assume the entire benefit may be lost from a climate change event. The probability is low that an entire sector would be eliminated. It is more likely that only a proportion of the value will affected and over a limited period of time. Therefore, when estimating costs, loss of the entire sector is a baseline, with the understanding that the actual costs will depend on the frequency, magnitude, and overall vulnerability of the sector.

Step 3. Perform cost-benefit analyses for proposed adaptation strategies

The costs of adaptation and potential losses from future climate change are used in cost-benefit analyses to examine the impact of climate change. Through cost-benefit analysis, where the cost-benefit ratio is a measurement of the capital and operating expenditures against total economic benefit, decision-makers can compare, quantitatively, the financial impact of climate adaptation measures. A simple terms, the most cost-effective adaptation strategy is one where:

Adaptation Costs < Potential Losses from Climate Change (without Adaptation)

Take for example a local park that would be hypothetically inundated by water from increased rainfall and flooding. Assume in this example that the cost to replace the park facilities is $200, the monetary value, of the park[2]. Assume that decision-makers can select from one of two strategies: Upgrade of existing storm drains or development of new bio-swales to divert water. Assume implementation of the first adaptation strategy costs $150 (up-front) to prevent or reduce damages from climate change events by $200. Now assume the second adaptation strategy, bio-swales, costs $100 (up-front) to prevent or reduce damages by $200. In this simplified example, the second scenario has a greater benefit-to-cost ratio, and therefore could be the recommended strategy.

Cost-benefit approaches are typically more complex than the example above. The models traditionally attempt to normalize costs and benefits over time. Future expected costs and benefits are converted into a “net present value” amount using a selected discount rate. The discount rate used for climate change adaptation strategies is highly subjective. Risk associated with possible losses from climate change events can be calculated via probability models and incorporated into the discount rate.

Economic Assessment Considerations

Adaptation is not free. On the other end, the investment potential is unlimited to hedge against all possible losses. To be cost-effective, adaptation strategies should:

Identify cost savings through planned projects

[2] This analysis ignores the underlying opportunity cost of the land. The assumption is the land use would remain constant.

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"Planning for climate change today is less expensive than rebuilding an entire network after a catastrophe." – Plan NYC

Proactive planning for climate adaptation is less expensive the reactive, emergency measures after a severe climate action event. Through planning, decision-makers can determine the overall feasibility and applicability of the most cost-effective adaptation strategies.

Prioritize hard and soft adaptation strategies

Adaption strategies can be categorized in to "hard" and "soft". Hard adaptation strategies usually imply the use of specific technologies and actions involving capital goods, such as dikes, seawalls and reinforced buildings, whereas "soft" adaptation strategies focus on information, capacity building, policy and strategy development, and institutional arrangements (World Bank).

Hard adaptation strategies (e.g., capital improvement) is often more expensive than soft adaptation strategies. At the same time, they may also be less flexible in the long term if forecasting of future climate impacts is over- or under-estimated. Soft adaptation strategies (e.g., policy reform) are often less costly in monetary terms, more flexible and tend to focus on the affected people rather than the affected land, should be considered and combined with hard options.

III. Reduce risk exposure and mitigate residual losses with insurance

The total cost of climate change is the sum of the cost of adaptation, mitigation, and any residual potential losses not averted by the mitigation or adaptation strategies. It is not normally cost-effective to implement adaptation or mitigation strategies that completely reduce the potential losses from a climate change event. Insurance reduces the exposure to climate change risk, by covering the residual losses, and should be incorporated into the cost-benefit analyses of climate adaptation strategies.