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# Reconciling Local Sustainable Development Benefits and Global Greenhouse Gas Mitigation in Asia: Research Trends and Needs

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## Abstract

In recent years, researchers have exhibited a growing interest in co-benefits – defined as the local developmental benefits of climate actions. Some of this interest stems from the emerging awareness that policies with co-benefits may become eligible for future inflows of carbon finance. Much of this attention relates to studies that estimate that the co-benefits of climate actions could significantly offset the costs of mitigating greenhouse gas emissions. Yet, whereas many studies have pointed to this potential cost-savings, fewer indications have appeared that this line of research has resonated with policymakers in Asia. The policy impacts of co-benefit studies have thus far been modest in the region. To understand why this is the case, we examine the institutional and methodological barriers that have made it difficult to integrate co-benefit estimates into policies. We then identify areas that researchers could pursue to make their studies more policy relevant.

Key words: Co-benefits; ancillary benefits; cost-benefit analysis

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# I Introduction

In recent years, researchers have become increasingly interested in co-benefits – defined as the developmental benefits of climate actions. Some of this attention reflects the growing realization that policies with co-benefits may become eligible for financial support from the successor agreement to the Kyoto Protocol (Winkler, et al. 2002). Much of the attention stems from an emerging consensus that co-benefits could offset the costs of mitigating greenhouse gas (GHG) emissions in developing countries (Chen, et al. 2001; Joh, et al. 2001; Kan, 2004; National Renewable Energy Laboratory, 2005; EPTRI, 2005; Manila Observatory, 2005; Aunan, et al. 2004; Wang and Mauzerall, 2006; Aunan, et al. 2006).

This emerging consensus could become particularly important to Asia (Castillo, 2007; Koehn, 2008). While Asia contributes a growing proportion of the world's GHGs, the region's developing countries have expressed concerns that investing in climate actions will divert resources from poverty alleviation, pollution reduction, and other development priorities. Policies that simultaneously address global climate goals and local development needs could allay these cost concerns. Yet, whereas most studies have demonstrated this potential by quantifying the value of co-benefits, less attention has been paid to the conditions under which co-benefits are likely to factor into policy decisions (IGES, 2007).

This is an important oversight. Though the influence of research on co-benefits seems likely to expand, thus far several institutional and methodological barriers have limited its impacts in Asia. The purpose of this paper is therefore to analyze these barriers. Our analysis suggests that, since Asia's local governments are becoming more responsible for implementing measures with co-benefits, alternative quantification methods may be needed to complement the data and time-intensive estimation techniques employed in much of the co-benefits literature. Compiling these methods in the form of policy guidelines would enhance their usability for local level policymakers.

The remainder of the paper is organized as follows. The following section reviews trends in research on co-benefits. Section III discusses institutional and methodological barriers to realizing co-benefits in Asia. Section IV describes rapid assessment and alternative quantification methods that will be needed to facilitate the entry of co-benefit estimates into policy decisions in Asia. Section V concludes the paper.

## II Trends in research on co-benefits

While the term "co-benefits" originated approximately a decade ago, estimating the impacts of public policies has a longer history. During the mid-nineteenth century, the French engineer-economist Jules Dupuit developed the earliest forms of cost-benefit analysis (CBA) to assess the impacts of local infrastructure projects. Less than a century later, CBA spread yet further when the American Corps of Engineers employed the technique to evaluate federal water projects in the post-depression United States. By the 1980s, CBA was being used to measure the cost-effectiveness of a wide range of national and subnational regulatory programs (Pearce, et al. 2006).

The application of CBA to climate policies has a shorter history. This recent interest began when scholars recognized there were local benefits associated with climate policies that had been overlooked in earlier studies on "slowing" climate change (Nordhaus, 1991). Morgenstern, for instance, noted that "these [additional benefits and costs] include health and/or welfare benefits due to reduction in criteria air pollutants;... benefits of energy savings measures; and, conversely, potentially low agricultural yields as a result of reduced CO2 fertiliz[ation]" (Morgenstern, 1991). The recognition of these benefits was significant because their inclusion in cost calculations could alter wait-and-see recommendations counselled in climate-only work.

Their recognition was further significant because scholars, realizing that policymakers would be reluctant to invest in long-term climate policies, could use CBA to estimate the short-term, local impacts of measures with co-benefits (Markyanda and Rubbelke, 2003). This realization helped generate a growing body of empirically-driven co-benefit literature. Table 1 contains results from many of these studies, organizing them in terms of their location, year of publication, type of co-benefits, and estimated value of benefits normalized per ton of carbon mitigated. The table demonstrates that this research has yielded more than 35 estimates from 14 countries.

**Table 1: Studies on co-benefits**

| Location | Year | Air Pollutants | Endpoint | Average Estimated Value of Co-benefits/ Ton of $CO_2$ |
|---|---|---|---|---|
| United States | 1991 | -- | Health | $165.00 |
| United States | 1993 | VOCs | Health | $251.00 |
| United States | 1993 | TSP, PM, $SO_x$, $NO_x$, CO, VOC, $CO_2$, Pb | Health | $41.00 |
| United States | 1993 | $SO_2$, $NO_x$, PM | Health | $3.00 |
| United States | 1993 | $SO_2$, $NO_x$, PM, Pb, CO, VOC | Health | $33.00 |

| | | | | |
|---|---|---|---|---|
| United States | 1995 | $SO_2$, $NO_x$, PM | Health | $24.00 |
| United States | 1994 | Criteria Pollutants | Health | $88.00 |
| United States | 1995 | Pb, PM, $SO_x$, $SO_4$, $O_3$ | Health | $40.00 |
| United States | 1998 | -- | Health | $10.00 |
| United States | 1999 | $SO_2$, $NO_x$ | Health | $2.00-$3.00 |
| United States | 1999 | Criteria Pollutants | Health | $8.00-$68.00 |
| United States | 1999 | -- | Health | $300.00 |
| Norway | 1992 | -- | Health | $102.00-$146.00 |
| Norway | 1994 | $SO_2$, $NO_x$, CO, VOC, $CO_2$, $CH_4$, $N_2O$, Particulates | Health, Recreation, Corrosion, Traffic Noise, Road Maintenance, and Accidents | $246.00 |
| United Kingdom | 1992 | $SO_2$, $NO_x$, PM | Health | $195.00 |
| United Kingdom | 1993 | -- | Health | $44.00-$201.00 |
| Germany | -- | -- | Health | $312.00 |
| Western Europe | 2000 | $SO_2$, $NO_x$, PM | Human and Animal Health, Materials, Buildings and Other Infrastructure, Vegetation | $153.00 |
| European Union | 2000 | -- | Health | $53.00-$79.00 |
| Seoul/Inchon, Korea | 2001 | PM | Health | $10-42.00 |
| Hungary | 1998, 2000 | TSP, $SO_2$, $NO_x$, CO, VOC, $CO_2$,$CH_4$,$N_2O$, Particulates | Health, Material and Vegetation Damage | $508.00 |
| Buenos Aires, Argentina | 2002 | PM | Health | $56.00-$138.00 |
| Mexico City, Mexico | 2003 | PM, $O_3$ | Health | $149.00 |
| Mexico City (BRT), Mexico | 2007 | TSP, $NO_x$ | Health, Time Savings | $107.00 |
| Santiago, Chile | 1999 | Seven Air Pollutants | Health, IQ (from Pb) | $251.00-$267.00 |
| Santiago, Chile | 2000 | $SO_2$, $NO_x$, CO, NMHC, PM, and Resuspended Dust | Health | $62.00 |
| Santiago, Chile | 2006 | PM, $O_3$ | Health, Agriculture | $6.00-$103.00 |
| China | 2008 | PM | Health | $28.00-$274.00 |
| Beijing, China | 2005 | $SO_2$, $NO_x$, PM | Health | $759.05 |
| Zaozhuang, China | 2006 | -- | Health | ---[1] |
| Shanxi, China | 2003 | -- | Health | $120.40 |
| China | 2000 | $SO_2$, PM | Health | $52.00 |
| Shanghai, China | 1999 | $SO_2$, $NO_x$, PM | Health | $43.65 |
| China | 1999 | $SO_2$, PM | Health | -- |
| Manila, Philippines | 2005 | PM | Health | $285.44 |
| Hyderabad, India | 2005 | PM | Health | $873.50 |
| India | 2001 | PM | Health | $58.00 |

Source: IPCC, 2001; Pearce, 2000; Chen et al. 2001; Gaoli, 2002; Joh et al. 2001; Kan 2004; McKinley, 2003; National Renewable Energy Laboratory 2005; EPTRI 2005; Manila Observatory 2005, Aunan et al. 2004.

Beyond demonstrating the growing number of co-benefit studies, table 1 underlines two features of this research that merit attention. The first is that the majority of co-benefits come from improvements in local air quality and related impacts on public health. There are several types of co-benefits, ranging from shorter commuting times to advances in energy efficient technologies. Yet most of the literature traces the linkages between hypothetical GHG mitigation scenarios to the abatement of criteria pollutants to reduced rates of morbidity and premature mortality.[2] Cleaner air and better health are the co-benefits that have thus far drawn the most attention from researchers (Jochem and Madlener, 2003).

The second notable feature of this research is the growing interest in estimating co-benefits from developing countries. Prior to 2000, only three out of 19 studies quantified the value of co-benefits from non-Annex I countries (developing countries that do not have binding reduction commitments in the Kyoto protocol). Since 2000, 14 out of 17 studies have focused on non-Annex I countries. This trend arguably reflects the recognition that developing countries would prefer to invest in integrated as opposed to climate-only policies. It is also arguably attributable to the finding that, though cross-study co-benefit estimates vary significantly, their values tend to be greater in developing than developed countries (IPCC, 2001; IPCC, 2007).

Both the underlying causes and possible consequences of these trends relate to Asia. In terms of causes, the comparatively greater values were likely the product of higher population densities in developing countries. Higher population densities would increase exposure rates to urban air pollutants and, therefore, raise the number of beneficiaries from policies with co-benefits. The greater values were also likely the product of initially poorer urban air quality in developing countries. Initially poorer air quality would increase a measure's marginal impact on pollution and, therefore, boost the benefits from policies with co-benefits (O'Connor, 2001). Since Asia is home to many of the world's most densely populated cities and China is home to 20 of 30 of the world's most polluted cities (World Bank, 2007a), it is clear why these studies would have implications in the region.

What is less apparent is that these implications could extend from inside to outside Asia. Inside Asia, many countries have experimented with policies to reduce the social and environmental costs of rapid industrialization, including air pollution, energy efficiency, and sustainable transportation measures. These are precisely the kinds of measures that, if designed and implemented effectively, could deliver co-benefits. Outside Asia, many of these same policies could qualify for financial support from a post-2012 climate change regime that recognizes non-Annex I parties for pledging policies that reduce GHG emissions while delivering other development benefits (Winkler, et al. 2002). These are also precisely the kind of institutional reforms that could encourage Asia's developing countries to incorporate an analysis of co-benefits into policy decisions.

But while some studies have implied the future climate regime may lead to greater consideration of co-benefits, few studies have addressed a more immediate question: where and when would Asia's policymakers use these estimates to strengthen policies? Most of the empirical results in table 1 demonstrate the cost-savings from hypothetical mitigation scenarios. But by looking toward the hypothetical future, these studies look past Asia's recent experience with air pollution, energy efficiency, and sustainable transportation measures. This recent history can shed light on the difficulties of designing and implementing measures with co-benefits and, more importantly, where it would be advantageous to integrate an analysis of co-benefits in Asia's future policy decisions.

## III Institutional and methodological barriers

### (1) Institutional barriers

In both developed and developing countries, policymaking frequently involves bargaining between agencies with competing administrative portfolios and programmatic objectives. Policy outputs therefore reflect the results of interagency negotiations. But while bureaucratic bargaining occurs in many countries, its influence tends to be more pronounced when key agencies lack leverage or have recently begun to challenge the established bureaucratic order. Both descriptions are consistent with what is happening to climate and environmental agencies in many countries in Asia. Correspondingly, bureaucratic bargaining has tended to result in policies that fall into one of two categories.

The first category includes measures that suffer from obvious design flaws. To illustrate, when Thailand's Ministry of Science, Technology, and the Environment (MOSTE) was reforming the country's air pollution regulations, it granted the Thailand Electricity Generating Authority (TEGA) the responsibility for regulating its own plants (Rock, 2002). The decision diminished the likelihood that the measure would deliver significant health benefits. It also suggested that it would be difficult to overcome opposition from TEGA, even if MOSTE could demonstrate the cost-savings of more stringent regulations.

The second category includes measures that contain ambitious but still somewhat ambiguous goals. To illustrate, when China's National Development Reform Commission (NDRC) and the recently promoted State Environmental Protection Agency (SEPA) (now the Ministry of Environmental Protection) successfully inserted a 20% energy efficiency improvement target into China's 11th Five-Year Plan (2006-2010), local governments were delegated the responsibility for devising concrete actions to achieve the national goal (Teng and Gu, 2007). The target has thus far proved difficult to reach, demonstrating again the difficulties of maximizing an integrated measure's health benefits.

The first and second scenarios are in some ways similar; in both cases policies fell short of reaching their potential. Yet the reasons for these shortfalls differ. In the case of China's energy efficiency targets, the difficulties had more to do with the limitations of local governments than the limitations on national climate and environmental agencies. This is an important distinction. It suggests as Asia's national level climate and environmental agencies become more successful challenging rival agencies, the next step will be taking concrete actions needed to realize co-benefits. It further implies that local governments will become increasing responsible for taking these next steps. In fact, in countries from India to Indonesia climate issues have moved up the national policy agenda as implementation responsibilities have been delegated to local governments.

At least in theory, the devolution of authority is promising. It can serve to strengthen institutional linkages between local development needs and GHG mitigation targets. But while it has these putative advantages, it also presents other practical challenges. One is that local governments might oppose measures in which benefits are spread nationally but costs are concentrated locally. Closing a coal-fired power plant, for instance, could save lives across a region but also impose job losses in a community. Cases with unevenly distributed costs and benefits may require stronger programs to compensate policy losers, an important area of research that lies outside the purview of this article.

Another obstacle that is more closely related to the article's main argument is the capacity of local level agencies to generate and then apply their own co-benefit estimates. These constraints include the technical and managerial skills of existing employees as well as the attraction, recruitment and retainment of skilled staff. To highlight a concrete example, a recent World Bank report recently observed that India's State Pollution Control Boards "are ... characterized by a dominant presence of non-technical staff, differential availability of staff for monitoring polluting industrial units, and large staff vacancy positions" (World Bank 2007b). A similar description could apply to China's local environmental protection personnel; there is an average of 21 to 14 personnel focusing on environmental issues at the city and county levels in China respectively (see table 2).

**Table 2: Environmental personnel in China**

| Level | Number of Organizations | Overall Number of Employees | Environmental Protection Bureaus | Monitoring Stations | Inspection Personnel | Average Number of Personnel |
|---|---|---|---|---|---|---|
| National | 41 | 2065 | 215 | 108 | 45 | 50 |
| Provincial | 352 | 10911 | 1946 | 2825 | 772 | 31 |
| City | 2005 | 43084 | 9081 | 16143 | 9169 | 21 |
| County | 7680 | 109839 | 32899 | 28613 | 42859 | 14 |

Source: 2006 Huanjing Tongji Nianbao (2006 Environmental Statistics Yearbook)

### (2) Methodological barriers

The above review of institutional barriers implies that it is not easy to integrate quantification into the design and implementation of actual policies. To demonstrate why it is challenging, it is useful to review the major steps needed to complete a CBA, the quantification method used in most of the previous co-benefits studies. These steps include: listing potential impacts of a policy or project; predicting the quantitative impacts of that policy or project; attaching monetary values to those impacts; discounting for time to find present values; and then adding up and comparing the benefits and costs (See Table 3) (Boardman, et al. 2005).

**Table 3: Major steps needed to conduct a CBA**

1. Create a list of potential impacts of a policy/project
2. Predict quantitative impacts
3. Attach monetary values to all impacts
4. Discount for time to find present values if the policy/project extends over years
5. Add up the benefits and costs

To illustrate some of the difficulty in applying CBA, take the case of a fuel tax (implemented in China, Philippines, Hong Kong, and Taiwan; and considered in Indonesia). A fuel tax may cause changes in driving behaviour, a shift in purchasing behaviour as well as a shift in production behaviour toward more fuel-efficient models, all of which can potentially produce health-related co-benefits. However, there are many health effects whose cause-and-effect relationships are not obvious (such as the effects of emission changes on cardiac arrest), and determining what diseases are impacted by emissions can be complicated for non-specialists (Boardman, et al. 2005). In addition, the primary changes in driving behaviours and automobile production may have downstream effects on the production of automobile parts, the medical industry, the insurance market, among others. Deciding boundaries for analysis (deciding which impacts should be included for subsequent analysis) presents another challenge for non-specialists, particularly when the primary behavioural changes have further effects on other actors and cause repercussions in other markets.

Further complicating quantification is the need for dependable data and technical knowledge. In steps 2 and 3, CBA involves predicting quantitative impacts and attaching monetary values to identified impacts. These two steps require extensive data sets if costs and benefits are to be estimated accurately. In the case of analyzing environmental policies and projects, predicting quantitative impacts necessitates an understanding of how proposed actions (e.g., tightening emissions standards, introducing cleaner public transportation, or imposing environmental taxes) will change ambient environmental quality as well as the behaviour of consumers, firms, and other relevant agents. This may involve the development and use of environmental simulation models, which, in turn, requires technical knowledge as well as extensive inputs from environmental monitoring data.[3] For example, the Integrated Environmental Strategies (IES) program of the United States Environmental Protection Agency (US EPA), which applied the standard CBA to estimate co-benefits in several cities in Asia, proceeded with the steps in table 4 to obtain co-benefit estimates (US EPA, 2005). As is evident from these steps, the IES employs a combination of several technical models, making the procedure fairly complicated and data intensive.

**Table 4: Key steps in applying the IES model**

| |
|---|
| 1. Projection of energy use by the LEAP model |
| 2. Estimation of emission factors by fuel types |
| 3. Projection of stationary, mobile and fugitive emissions from each grid (1km x 1km) |
| 4. Projection of ambient concentrations of major pollutants using Industrial Sources Complex (ISC) |
| 5. Estimation of human health effects |
| 6. Attaching monetary values on the health effects |

A related issue is the need to acquire market prices and economic data to establish monetary values on predicted impacts. The data required for these purposes are typically less dependable in developing countries in Asia "since even rudimentary environmental databases are lacking throughout the region and systems of national accounts and other standard measures of economic performance and social well-being exclude the costs and benefits associated with the use of environmental services" (ADB, 2001).

In sum, the troubles associated with defining the impacts of policies, securing reliable data, using technical models, and related technical difficulties make applying the standard CBA problematic in developing countries. The next section discusses attempts to resolve these methodological difficulties.

## IV Rapid assessment methods

### (1) Simplifying CBA

The previous sections point to an important tension. On one hand, there is reason to believe that co-benefits might be greater in developing Asia than other regions, and policies with these benefits might be attractive to regional policymakers. On the other, there are significant institutional and methodological barriers to designing, implementing, and estimating the effects of these policies. Initial attempts have been made to reconcile this tension by introducing alternatives to the standard CBA. In this section, we discuss rapid assessment methods, a simplified version of the standard CBA, that may be more amenable to policymakers in developing countries in Asia.

Rapid assessment methods refer to a collection of methods that reduces data, budget, and time requirements. Rapid assessment methods are based on CBA, but modify part of the quantification procedures used in the standard CBA. One of the rapid assessment methods that can simplify the standard CBA is the emissions-based unit value approach. The emissions-based unit value approach derives how a unit reduction of emissions of a certain pollutant translates into benefits measured in monetary terms. A table summarizing the relationship between changes in emissions and estimated benefits is constructed first by making appropriate adjustments to the estimates in previous CBA studies. Table 5 is an example of such a table for the case of health benefits of reduced emissions from coal-fired power plants in New York (Rowe et al., 1994; ADB, 1996). For example, previous studies suggest that a ton of emission reductions of $PM_{10}$ would bring a total of US$3,000-$5,000 of health benefits, of which 60% ($1,800-$3,000) accrued in the form of a reduction in premature mortality, 20% in the form of a reduction in adult chronic morbidity, and so on. Similarly, a ton of emission reductions of $SO_2$ would bring a total of US$750-$1,300 of health benefits, of which $375-$650 was attributed to a reduction in premature mortality. Once such a table is constructed, it can be applied to estimate health co-benefits of other similar studies by further adjusting to population density, level of income, and other relevant location-specific factors.

**Table 5: Estimated health benefits for coal-fired power plants (US$/ton)**

| Pollutant | Premature mortality | Adult chronic morbidity | Acute morbidity | Material damages | Reduced visibility | Total value (US dollars) |
|---|---|---|---|---|---|---|
| $PM_{10}$ | 60% | 20% | 10% | 5% | 5% | $3,000-$5,000 |
| $SO_2$ | 50% | 15% | 10% | 20% | 5% | $750-$1,300 |

Source: Rowe, et al. 1994; ADB, 1996.

If co-benefits of a fuel tax are to be estimated, it may not be appropriate to directly apply table 5 since it was constructed for emissions reductions from coal-fired power plants. This actually illustrates the need to construct a table for each of the major policies with potential co-benefits, including fuel efficiency standards, renewable energy targets, clean technology development initiatives, among others. Constructing such tables would greatly enhance the usability of rapid assessment methods to policymakers.

Other types of co-benefits can also be estimated using rapid assessment methods. Consider estimating the benefits of reduced number of deaths in traffic accidents (people may drive less or shift to public transportation due to higher fuel prices, which may reduce traffic accidents). To estimate the value of lives saved, the standard CBA may employ contingent valuation method and use local people's willingness to pay (WTP) values. Rapid assessment methods can alternatively rely on benefit transfer: benefit transfer literally transfers estimates of previous studies to the current study with appropriate adjustments, thereby reducing time, budget, and the technical burden of conducting on-the-ground estimations. Past studies that estimated the value of lives saved under similar conditions can be found through online databases.[4] Since WTP values vary according to factors such as income, total number of people affected, areas affected, average exposure time to the air, and weather conditions, the values can be adjusted according to these attributes in order to transfer the estimates to the current study.

To offer another example, consider estimating the benefits of time saved due to reduced congestion. Another rapid assessment method, a cost-based approach, can be employed. Since CBA evaluates policies from social perspectives, social costs and benefits, rather than market costs and benefits, should be used in principle. In practice, however, market costs and benefits are much easier to calculate, and the differences between the social and market values can be reasonably small under appropriate conditions. By applying a cost-based approach, the benefit of time saved can be estimated based on hourly salary and changes in commuting time rather than willingness to pay estimates, which necessitates conducting surveys that are time consuming, costly and technically more complicated.

As shown above, there are several rapid assessment methods that can replace part of the standard CBA, but they are not prepared in the form that non-specialists can apply without difficulty. For example, applying the emissions-based unit value approach to estimate health co-benefits of a fuel tax would be difficult unless a table is prepared that describes the relationship between emissions and final estimates (a table like Table 5). Similarly, to estimate other co-benefits of a fuel tax, rapid assessment methods need to be developed and presented in sufficiently simple formats. In sum, there is a need for developing and compiling simpler estimation methods for each of the major policies with significant co-benefits.

Rapid assessment methods are not without weaknesses. In principle, there is a trade-off between their usability and objectivity; the ease of use tends to be improved only at the expense of objectivity. We believe, however, that improving the usability of the standard CBA with rapid assessment methods will be beneficial to practitioners. In the next sections, we briefly discuss two alternative methods that are potentially more user friendly, a checklist approach and multi-criteria analysis (MCA).

### (2) A checklist approach

In table 3, we presented the major steps needed to carry out CBA. A checklist approach simplifies step 1 by preparing a checklist consisting of major co-benefits, thereby overcoming the difficulties associated with defining the impacts of policies. In addition, step 2, predicting quantitative impacts, is usually much simpler than the standard CBA. Furthermore, a checklist approach vastly simplifies steps 3 and 4. That is, it does not explicitly monetize impacts and it typically excludes time dimensions from analyses.[5]

A representative example in the field of co-benefits is the CDM Gold Standard. The Gold Standard employs a checklist approach as a basis for quantifying developmental co-benefits of GHG mitigation projects. A set of developmental co-benefit indicators (checklist) is used to determine if a project satisfies sustainability requirements for Gold Standard certification.

**Table 6: A checklist used in the CDM Gold Standard**

| |
|---|
| 1. Local/regional/global environment<br>– Water quality and quantity<br>– Air quality (emissions other than GHGs)<br>– Other pollutants (e.g. toxic chemicals, ozone, etc.)<br>– Soil quality and quantity<br>– Biodiversity |
| 2. Social sustainability and development<br>– Employment quality<br>– Livelihood of the poor – poverty alleviation, distributional equity, access to essential services<br>– Access to energy services<br>– Human and institutional capacity |
| 3. Economic and technological development<br>– Employment (number)<br>– Balance of payments<br>– Technological self reliance |

Sources: Gold Standard, 2006

Table 6 is a checklist used by the CDM Gold Standard. The Gold Standard checklist has three major components: environment, social development, and economic development. Under each component, there are several indicators such as water quality and quantity, access to energy services, and technological self-reliance. A project is assessed against each indicator, which corresponds to step 2 (predicting quantitative impacts) of the standard CBA. A project receives scores ranging from -2 (major negative impact) to +2 (major positive impact) under each indicator. Sophisticated models can be used to assess scores, but simplified procedures are more typical. After step 2, a total score is calculated without monetizing each impact. A project fails to satisfy the sustainability requirements if a project has scores of -2, a non-positive total score, or a negative subtotal score for any of the three components (Gold Standard, 2006).

As this example illustrates, a checklist approach is simpler than the standard CBA, and can reduce the difficulties associated with defining the impacts of policies, securing reliable data, and using technical models. However, it tends to be less objective since quantitative impacts are assessed using simplified procedures, where simplification is achieved typically by subjective assumptions, human judgment, and approximation.

**(3) Multi-criteria analysis (MCA)**

Multi-criteria analysis (MCA) is a tool that applies a transparent and scientific method to decision-making problems in the face of complex, and often conflicting, multiple criteria. Simply stated, MCA is a more rigorous version of a checklist approach in that it uses statistical procedures. Like a checklist approach, MCA does not monetize impacts. However, a major difference is MCA attaches a weight to each indicator through expert or stakeholder consultations and statistical applications. Instead of a simple summation, a weighted summation is used to calculate the total score of a project, and a decision is made according to the ranks of total scores of projects. The values of weights can be interpreted as reflecting social values associated with each factor. Therefore, depending on the social and developmental needs, different countries or communities can have different values for weights.

MCA has several strengths. For instance, decision-making may involve multiple criteria for social, economic, environmental factors. Some of these criteria cannot be easily condensed into a monetary value, particularly when ethical and moral principles are involved.[6] MCA supports decision-making without translating every feasible variable into a single (monetary) measure. An additional strength is that MCA can reasonably incorporate both quantitative and qualitative data, because scores can be given to even qualitative data through, for example, expert judgments (a checklist approach can also handle both quantitative and qualitative data).

Yet, MCA is not without weaknesses. For instance, absolute values of total scores may be difficult to interpret. In a CBA, a net benefit indicates a social value of a policy as measured by a monetary unit, but only relative scores have meaning in the case of MCA. An additional weakness is that MCA is comparatively more sophisticated and requires expert or stakeholder consultations and statistical applications. Finally, as with many of the techniques discussed in this section, although MCA applies statistical procedures, the subjectivity of experts may be an unavoidable drawback.

**(4) Comparisons of CBA, MCA, and a checklist approach**

As discussed above, there is typically a trade-off between objectivity and usability in these approaches. CBA attempts to monetize all impacts and thus facilitates comparisons in a relatively objective manner. MCA applies statistical methods to support decision making without translating every impact into a single monetary value, albeit with a degree of subjectivity. A checklist is simple to conduct, but can be subjective.

The strengths and weaknesses of these methods are summarized in table 7. A greater number of plus signs indicate the method has desirable properties in terms of each criterion. In general, CBA is objective, but requires technical expertise, data, and time. A checklist approach, on the other hand, requires less data, time and technical expertise, but is less objective and could present difficulties when it comes to comparisons of policies. MCA tends to fall between CBA and a checklist approach.

**Table 7: Comparisons of CBA, MCA, and a checklist approach**

| Criteria | CBA | MCA | Checklist approach |
|---|---|---|---|
| Data requirement | +<br>Data intensive | ++<br>Relatively less data intensive, qualitative data can be incorporated | +++<br>Less data intensive, qualitative data can be incorporated |
| Time requirement | +<br>Time consuming, but there are rapid assessment methods | ++<br>Relatively time consuming | +++<br>Less time consuming |
| Needs of technical expertise | +<br>Technically demanding, but there are rapid assessment methods | ++<br>Relatively technically demanding | +++<br>Less technically demanding |
| Objectivity of estimates | +++<br>Objective,<br>Estimates are measured in monetary values | ++<br>Relatively subjective,<br>Absolute values of total scores carry no meaning by themselves | +<br>Subjective |
| Ease of comparisons across policies | +++<br>Easy | ++<br>Relatively easy,<br>Total scores can be used to rank policies | +<br>Difficult,<br>Total scores cannot be directly compared across policies |

Note: A greater number of plus signs indicates the method has desirable properties in terms of the criterion

The table presents only general picture. For example, rapid assessment methods can be employed to improve the usability of the standard CBA at the expense of objectivity. There is clearly no method that is desirable along all criteria. While the appropriate method will depend on the objective of a study, for many of the reasons raised in this paper it might make more sense to err on the side of usability in developing countries in Asia.

## V Conclusion

In this paper, we have demonstrated that, despite a growing literature on co-benefits, there exist significant institutional and methodological hurdles to realizing the local impacts of climate policies. We have further argued that, at least in the near term, simpler estimation techniques may be needed to complement the standard CBA. CBA has a long history, but its recent application has tended to be in places where there is a full understanding of the scope of policy impacts, adequate data, and sufficient human and material resources to integrate estimates into policies. Many of these conditions are absent in Asia.

In view of their absence, we believe that future research needs to look more closely at the types of policies to which the standard CBA or rapid assessment methods can be applied in estimating co-benefits. It would also be useful to investigate the trade-offs of quantifying co-benefits without monetization, and the types of policies to which a checklist approach and MCA could be effectively applied. But most importantly, it is necessary to develop and compile simpler methods for major policies with significant co-benefits, perhaps in the form of policy guidelines. We believe this would greatly enhance usability for policymakers by reducing time, technical difficulty, data requirements, and dependence on technical models.

In moving in this direction, we further believe that it is important that co-benefit researchers focus their efforts in locations where there are insufficient resources but significant co-benefits. If one of the primary objectives of these studies is to strengthen the linkages between local developmental and international climate objectives, then it makes sense to work with local policymakers to find out what techniques works for local policymakers (Morgenstern, 2002).[7] In a similar vein, it may be advisable to focus on non-health impacts of integrated policies (such as reduced traffic congestion) that may be more tangible and politically attractive than the health impacts estimated in most studies (IGES, 2007; See Aunan et al., 2000 for impacts on crop yields for instance).

We recognize that our argument runs counter to the wisdom that simplifying techniques and adapting them to local circumstances could create confusion. Indeed, writing at a time when initial wave of co-benefit studies were published, Krupnick et al. (2000) warned that the "methods should be consistent and estimates should not." We accept this wisdom but worry about its policy implications. For in the same piece, Krupnick et al. also warned about the applications of co-benefit approaches in developing countries.  Now that we have had some time to examine those prospects, we conclude that it might be worthwhile to weigh the trade-offs between methodological rigor and policy relevance, especially in places where co-benefits might be sizable but the capacity to estimate them is not.

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*Notes*

1 The Zaozhuang study does not look specifically at $CO_2$.

2 There are a wide variety of co-benefits, though most studies focus on improvements in local air quality (reduced $PM_{10}$, $PM_{2.5}$, ground level ozone leading to reduced morbidity and mortality rates) and related improvements in local public health. Other co-benefits include reduced harm from transregional air pollutants (acid rain and sand storms); reduced congestion; reduced industrial sprawl; reduced traffic accidents; increased employment opportunities in potential growth industries; reduced oil dependence; increased foreign exchange credits; increased foreign investment; greater technology transfer; and improved efficiencies in industrial processes.

3 For instance, in Jakarta equipment for monitoring ambient air quality was recently shut down, raising concerns about the accuracy of the data reported for the city.

4 See, for example, the United States Environmental Protection Agency's (EPA) Envalue at http://www.epa.nsw.gov.au/envalue/Default.asp?ordertype=MEDIUM and Canada's EVRI at http://www.environment.nsw.gov.au/education/evri.htm.

5 Co-benefits could be realized in the near term, minimizing problems with discount rates and intergenerational equity that otherwise prove difficult in estimating climate costs and benefits.

6 For example, Hammitt and Zhou (2006) applied contingent valuation to China to estimate willingness to pay (WTP) to reduce risks of mortality. The value of statistical life (a reference value of a human life saved) in China derived from the study was in the range of US$4,000 - US$17,000, substantially less than the United States Environmental Protection Agency's (EPA) recommended value of US$6.1 million in 1999 dollars (US EPA, 2000). The fact that the value of statistical life estimate in China is far less than that in the United States does not mean life saved in two countries can be treated differently. A direct application of these results may raise tough moral questions.

7 Morgenstern et al, 2002, for instance, make the case for working from the bottom up, noting that in the case of Taiyuan, China "incremental changes to ongoing policies with demonstrated local benefits may be an extremely effective way of starting down the long road of carbon mitigation, especially in developing countries."

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