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UNU-IAS Policy Report

Urban Development with Climate Co-Benefits: Aligning Climate, Environmental and Other Development Goals in Cities

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Urban Development with Climate Co-Benefits:
Aligning Climate, Environmental and Other Development Goals in Cities

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Foreword

There is a growing realization that in order to reduce greenhouse gases (GHG), climate policies need to be aligned with development objectives, particularly in developing countries, which face a range of development pressures. Consequently when climate policy is focused solely on GHG emissions reduction it runs the risk of weak political will and policy effectiveness. Factors such as economic development, health and safety, energy security, air and water pollution, and social justice, for example, are central to public concern, and finding ways to align them with climate policy has a higher chance of getting political support.

There are already some discussions on how to address development issues in line with climate change mitigation. The realization that the development agenda is becoming an increasingly important component of GHG mitigation is recognized by the Intergovernmental Panel on Climate Change, under the term "co-benefits approach". The co-benefits approach aims to produce several different benefits from one particular policy, and has the potential to become a significant part of future climate policy for developing countries.

Given the variable nature of co-benefits, it can be argued that the co-benefits approach would be more effective at the local scale. It is generally easier to plan, implement and measure co-benefits at the local level rather than national level, as municipalities can link their local climate policy to their own local content, making local climate policy more visible, specific and recognizable.

The current impasse with international level climate negotiations makes actions taken at the urban scale all the more relevant especially as more than half the world's population now lives in cities. In this context, I am pleased that the United Nations University Institute of Advanced Studies (UNU-IAS) has been actively carrying out research not only on understanding the drivers and obstacles to achieving co-benefits but also to develop practical tools that help mainstream co-benefits at the local level. UNU-IAS also stands ready to work further with its existing and future collaborators to address how the important concept of co-benefits approach can be expanded and embedded into the international and domestic policy decision-making frameworks.

Govindan Parayil
Director, UNU-IAS and Vice-Rector, UNU
November 2013

Executive Summary

The achievement of any meaningful development goals needs to change how we develop and manage our cities. Rapid urbanization in developing countries demands a massive provision of infrastructure, public transportation, housing and jobs for their population, as well as a healthy environment. Consequently, urban areas in those countries contribute increasingly to climate change, and suffers its impacts. The climate co-benefits approach in this report refers to the development and implementation of policies and strategies that simultaneously contribute to addressing climate change and solving local environmental problems, which also have other development impacts. The co-benefits approach is especially important for developing countries, which have to overcome many challenges simultaneously with limited capacities and resources. Thus, the objective of this report is to examine the main obstacles, opportunities and challenges to implementation of climate co-benefit related policies in urban areas. The report focuses primarily upon sub-national processes, particularly in cities in developing countries, but the research also looked into the links of sub-national processes to national and international processes. The report relies on the results of research done in Brazil, China, India, Indonesia and Japan. It offers a series of lessons for understanding projects and policies that generate co-benefits and the factors that influence them. This report provides insight on successful ways to promote, design and implement the urban co-benefits approach in urban areas.

Keywords: urbanization; pollution in cities; urban transitions; co-benefits; climate change; development; pollution prevention; governmental policies

1. Introduction

Half of the world's population lives in urban areas now. In recent decades, rapid urbanization has transformed not only land use but people's values and lifestyles. For example, between 1990 and 2010, Asia alone added 754 million urban inhabitants, more than the total population of the United States and Western Europe combined (UN-HABITAT, 2011). It is expected that urban residents in Asia will continue to increase at the rate of 44 million people/year (ADB, 2008), one billion more people will become urban residents in the next 25 years. Currently about 60 per cent of the urban residents live in small and medium sized cities rather than in megacities; however their densities are in the range of 10,000–20,000 people/km^2, which is far higher than the rest of the world (Dahiya, 2012). African cities are also growing rapidly and the continent will likely present the next urbanization boom.

The global economy has been growing at a fast pace in the last two decades, not only giving many of its inhabitants more income to improve their livelihoods, but also increasing their consumption patterns and generating many negative impacts on the environment and upon human health. Taken together, these features make urbanization and its impact to the environment unique in scale and the potential problems pose huge challenges both locally as well as globally.

This situation has brought tremendous technical and institutional challenges at local, regional and global levels. Although urbanization has, to a certain extent, brought social changes and improved the economic development, there are a number of drawbacks that have emerged arising from this trend in urban development in recent years. City managers have been struggling to keep pace with the growth of their cities both in size and population, with regard to infrastructure facilities and their development. Apart from traditional local environmental problems such as air and water pollution, and solid waste, managers of developing cities must address global environmental problems such as climate change, while simultaneously addressing a growing demand for jobs, housing, education, health care and transportation (McCormick et al., 2013).

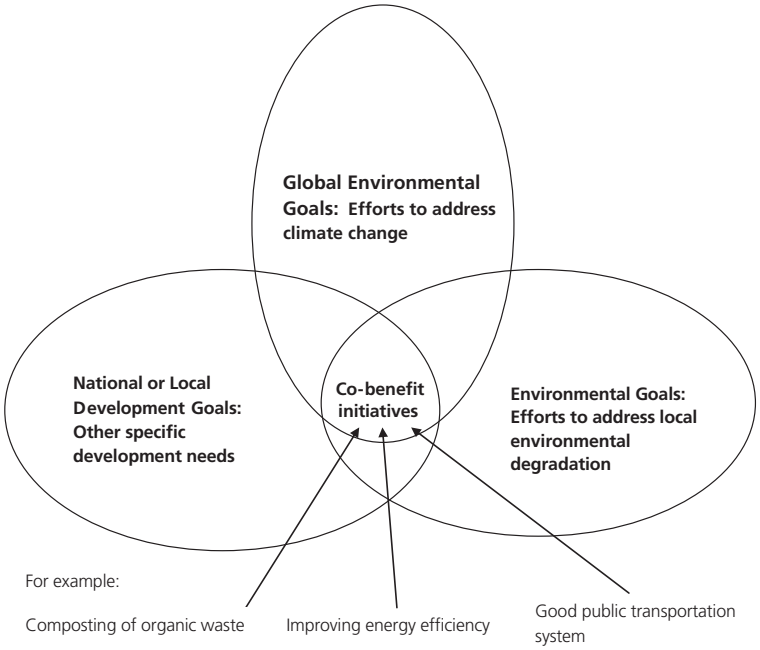
The increase of greenhouse gas (GHG) emissions originating from activities in cities such as construction and use of buildings, manufacturing, transport, energy consumption and waste treatment poses a major problem, as the emissions from urban areas account for 67 per cent of the total GHG emissions (ADB, 2008). Despite the magnitude of the transformation, urbanization in many developing countries, particularly in Asia and Africa, is still in a relatively early phase and that presents a massive opportunity to anticipate, prepare and mitigate the negative environmental impacts associated with badly-planned or un-planned, large scale urbanization.

The cumulative effects of individual projects have not been effective enough to mitigate environmental degradation in those cities (Shatkin, 2007). Despite recent extensive efforts to improve urban management policies and practices, the environmental quality of urban areas in many developing countries continues to become more and more unsatisfactory with respect to local and global environmental impacts. This might be due to the fact that the designated policies have not specifically addressed particular environmental problems, which are perceived as being separate from others. Urban environmental

management, in specific sectors, has not yet considered mutual impacts and synergistic interactions from other policies and/or practices in different sectors, nor has it adequately addressed issues of scaling innovative changes at a citywide or regional basis. Conversely, other sectors have not embedded the idea that tackling local and global environmental issues can help to achieve their goals (e.g., in health).

In order to address the existing gaps in the existing urban development processes, the co-benefits approach has emerged as a means to achieve more than one outcome with a single policy. This approach can facilitate developing countries to implement climate friendly policies by tackling both global and local environmental problems together, while simultaneously contributing to solutions for local development needs (Figure 1). Often, GHG emissions are not taken into account during the development process, as the other needs for local development outweigh global concerns on tackling climate change problems. Additionally, local environmental impacts also tend to be neglected. For this reason, the co-benefits approach can develop policies that simultaneously incorporate both global climate (such as GHG emission) and local environmental concerns (such as air pollution) into other development processes.

Figure 1 - Framework of Co-benefits Approach for Cities



Because actions at the local level are critical to attain sustainable development objectives, co-benefits policies must be developed to respond to a series of drivers at local, national and international levels. By linking policies in climate change mitigation within sectors of waste, transportation, housing and energy, coherent actions at the local level can be coordinated to attain an effective intervention for pursuing co-benefits. This report discusses how co-benefits has been found to be feasible for some cities in the developing world, as they have been able to tackle various environmental and development challenges with limited organizational capacity and financial resources.

Planning for building upon such co-benefits not only strengthens the society and the government's policy-making processes at the local level but also enables each measure to contribute to mitigating climate change impacts at the global scale. By addressing global and local issues in concert, coherent actions of policy-making can be mutually beneficial for local and global communities in the long-term. In addition, there is a need for multi-faceted policies, which avoid the usual competition between conventional development and environmental goals but integrate them to ensure that co-benefits are sought and built upon during the planning phase rather than as an *ex-post* process with the development of tools for planning for urban development with co-benefits approach.

This report highlights a number of successful initiatives that improved regional urban sustainability while also addressing other local problems, thus achieving co-benefits. The report and cases presented here not only detail the magnitude of the co-benefits that certain sectors achieved, but also provide insights into the conditions, which enabled local co-benefits to continue to evolve. They provide ideas on how positive changes can be attained as well as an understanding on how cities can generate solutions that have large, short and long-term positive benefits in terms of climate change mitigation and how this approach can be effectively embedded into local policy settings to contribute to cities' ability to generate co-benefits at local level. Consequently, valuable lessons can be learned on how to promote win-win situations in climate change mitigation, environmental quality and local development across cities.

2. Climate co-benefits in cities

Climate co-benefits have been identified by various organizations as win-win opportunities to tackle climate change with other positive outcomes (OECD, 2003; MOEJ, 2008; Netherlands Environmental Assessment Agency, 2009). The urban climate co-benefits approach in this report refers to the implementation of initiatives (policies, projects, etc.) that simultaneously contribute to reducing the contribution to man-made global climate change while solving local environmental problems in cities, and in turn potentially having other positive developmental impacts, such as improvements in citizen health, energy security and income generation. Indeed, many actions that combat climate change and its causes and consequences have trickle-down effects on other local benefits, many times unintentionally. However, we need to understand how to plan, generate and amplify climate co-benefits intentionally in order to mainstream climate-friendly actions more effectively into the development process. This report analyses the climate co-benefits concept empirically in cities in Brazil, China, India, Indonesia and Japan, and identifies points that can strengthen the planning process so that development processes can more intentionally realize multiple impacts on both the local and the global scale. The co-benefits approach is especially important for developing countries, which have to overcome many challenges simultaneously with limited human capacities and economic resources.

Moreover, it is essential to encourage the implementation of climate-friendly measures in developing countries, which do not yet have international obligations to reduce their total carbon emissions. That is where much progress can be made as these countries are still in the early process of development and can avoid many unsustainable outcomes along the pathway of development. There have been several studies documenting urban transformation strategies that address climate change in different parts of the world, particularly in more developed countries (McCormick et al., 2013). However, given that most of those practices require large initial investments, adoption of new technologies, and widespread changes in individual behaviour, it is difficult to see how they can be scaled up sufficiently to stimulate systemic change in developing countries without an explicit effort to make decision-makers aware of the total beneficial impact of these co-benefits.

The case studies offer a series of lessons for understanding how co-benefit initiatives have been implemented and how policymakers can design, promote and implement urban co-benefits approaches in their cities. Many of the case studies showed the importance of initiatives in spurring larger effects in the same or other cities. The studies also examined the conditions under which co-benefits policies can be effective in achieving significant results, how the public sector works, and what the main drivers pushing for co-benefits are. If co-benefits are to become an objective of public interventions, governments and other stakeholders need to learn how to promote the co-benefits approach, engage and empower other actors, and spur innovative processes in society. The objective of this report is to examine the main obstacles, opportunities and challenges to implementation of environmental co-benefits related initiatives in urban areas, particularly in developing countries.

3. Why are co-benefits in cities important for emerging economies?

Discussions in the literature on climate change and cities have dealt mostly with the physical and meteorological issues and less on the economic, social and policy aspects (Hallegatte and Corfee-Morlot, 2011). City governments in many countries are responsible for or have significant influence over areas and activities that produce GHG emissions, and consequently the municipal governments have the potential to bring about co-benefits, particularly in the areas of transportation, waste management, and buildings and construction (Collier and Lofstedt, 1997; Monni and Raes, 2008; Brown and Southworth, 2008; Zusman et al., 2012). Indeed, cities have often led the way in addressing climate change by innovating, starting new policies, and actively participating in international discussions to share their experiences. Toronto, Canada was the first government to establish targets to address GHG emissions before any national government or international agreements were developed (Kousky and Schneider, 2003). Tokyo Metropolitan Government was the first government in the world to seek to cap emissions from buildings. Most of the discussion in the relevant literature has been about mitigation in cities in more developed countries like Europe, the US or Japan (Monni and Raes, 2008; Bulkeley and Betsill, 2003; Betsill and Bulkeley, 2007; Collier and Löfstedt, 1997; Peterson and Rose, 2006). Discussion about developing countries has been predominantly related to adaptation rather than to prevention or mitigation (Adger et al., 2003; McGranahan et al., 2007; Revi, 2008), because those cities were polluting less and had less capacity to adapt to climatic change. However, cities in developing countries have increased their emissions enormously, through increases in both urbanization and income. In China, for example, the largest 35 cities contribute 40 per cent of the country's CO_2 emissions, though they have only 18 per cent of the population (Dhakal, 2009). At the same time, Chinese cities are among the most polluted in the world. Effective action dealing with these polluting urban sectors could be key to reducing both local and global air pollutants, and to improving the quality of life for Chinese and neighbouring countries' citizens.

Today's developed countries faced tremendous environmental problems as they grew economically and in extent of urbanization. Even though some urban environmental problems were effectively addressed (e.g., local sanitation) during industrialization, the environment was severely degraded, sometimes with significant negative consequences for the local population and for the ecosystem, more broadly. For example, in Japan, mercury pollution in Minamata and sulfur oxide smog in Yokkaichi severely affected local development in the 1960s when whole communities were poisoned (Tsuru, 1999). The costs of solving those problems were huge. However, as citizens became more conscious and localities became wealthier, they started to invest in cleaner technologies and changed the trajectory of the pollution curve, the so-called environmental Kuznets curve (see Figure 2a). Nevertheless, the contribution to global environmental problems, such as climate change, kept increasing in most cases. Presently, many of these countries face the challenge of reducing GHG emissions, and governments that previously, successfully addressed local air pollution now face new obstacles in implementing policies to address climate change (Puppim de Oliveira, 2011; see also Box 1).

On the one hand, sustainability challenges of cities in the developed world are more often related to "over-development" caused by over-consumption of energy and natural resources, urban sprawl and emission of GHGs (McGranahan et al., 2001). Many of these urban areas have a stable population and have solved past local environmental problems, such as local air and water pollution (or the brown agenda). Moreover, these cities are more prepared financially, technologically and administratively to adapt to the impacts of global climate change.

However, many developing countries have rapidly urbanized and industrialized in the last few decades and are now following similar paths of environmental degradation. Thus, cities in the developing world face a triple challenge to sustainability. Firstly, those cities are growing rapidly and need to provide the urban infrastructure for the booming urban population. Secondly, there is a growing degradation of the local environmental quality because of the lack of environmental safeguards. Thirdly, cities need to address both mitigation and adaptation to the increasingly damaging effects of climate changes. Successful mitigation in these rapidly developing cities is key to achieving worldwide stabilization in the emissions of GHGs. These areas are also home to large populations of poor people who are most vulnerable to the effects of global change. By addressing local environmental problems and global environmental problems at the same time, cities in developing countries can "tunnel through" the curves that determined the relation between wealth and environmental quality in the settlements of developed countries (Figure 2b), and more effectively confront the triple challenge of rapid growth, emissions mitigation and adaptation to changing climate conditions.

Figure 2a – Graphic Representation of a Typical Wealth Versus Environmental Burdens (no scale, based on McGranahan et al., 2001)

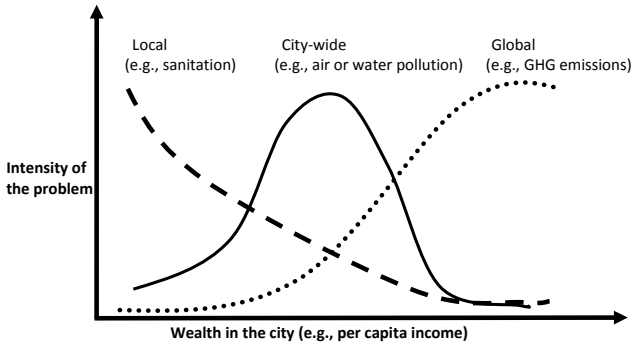
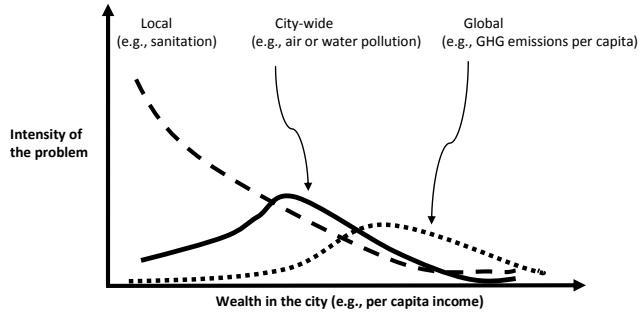


Figure 2b – Required Changes in the Curves

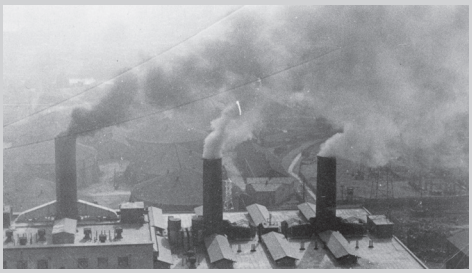


Box 1: A Quantitative Analysis of Kawasaki Air Pollution History and Local Government Policy

Kawasaki is located in the Tokyo Metropolitan Region and is a major industrial district in Japan with a total area of about 140 km^2.

The Location of Kawasaki City
Source: Kawasaki City Bureau

After World War II, rapid industrialization brought about drastic change to the area. National economic policies declared the income-doubling plan, which encouraged local development and industrial production. As a result, energy consumption and pollutant emission rapidly increased resulting in high concentrations of sulfur oxides (SOx) and mono-nitrogen oxides (NOx). These pollutants, generated mainly from thermal plants and petrochemical facilities, had an enormous health impact, and many residents suffered from respiratory problems known as "Kawasaki Asthma".

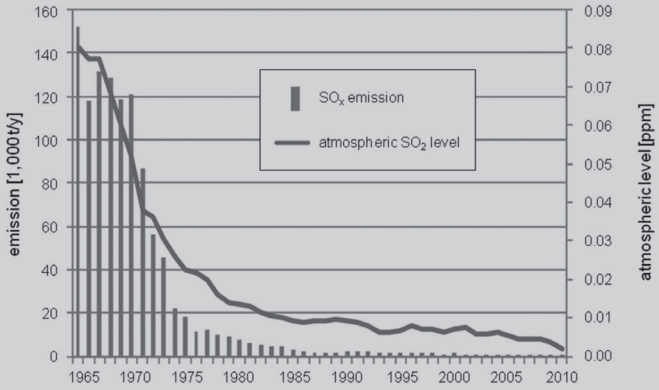


Smog from the Facilities (Source: Kanagawa Environmental Research Center)

The Kawasaki Asthma (Source: Asahi Shimbun, December 1970)

In response to local pleas and accusations, the Kawasaki government took the initiative to establish a regulation framework for pollution control prior to the National Law. In 1959, the city established a monetary support programme for pollution control facilities. In 1960, the "Pollution Control Ordinance" was enacted, which was comprehensively revised in 1972. By 1970, the severity of industrial pollution was recognized nationwide, and priorities finally shifted from industrial progress to health and safety. During this time, the city government actively promoted pollution control

measures and a compensation programme for its residents. By 1975, the city had significantly mitigated the SOx concentration. Thus, the active government involvement generated various programmes to initiate companies for effective emission control and to support residents, resulting in improvement of the regional air quality.



SOx Emissions from Industrial Facilities and Atmospheric SO_2 Levels

Data originally from:
Kawasaki City Pollution Monitoring Centre. Data for the years 1965-1972 represent major facilities only.

After the 1980s, strong competition with foreign manufacturing brought structural changes to the area, eroding the dominance of the heavy industries. The city became interested in revitalizing the area by modernizing the existing industrial network by including environmental components as a new overriding structure. As a result, Kawasaki shifted its industrial development policy and registered with the Eco Town programme, rearranging its industrial network with particular emphasis on domestic waste recycling capacity. Basically, Kawasaki used the abundant land left by heavy industries to establish and strengthen material and energy cascading webs, enabled mostly by massive central and local government funds. Yet, for the most part, it is acknowledged that the economic and environmental benefits exceed the cost of the investments (e.g. increase in local tax revenue and job creation).

Many Asian countries today are now going through the same situation Japan has experienced, along with rapid economic growth and increase of energy consumption. Japan's experience can contribute to our understanding on how we can reduce both CO_2 and air pollutants in an effective way.

References:
Kanada et al., 2012; Kanada et al., 2013.

Box written by Aki Suwa and Csaba Pusztai based on work by Momoe Kanada and Tsuyoshi Fujita.

The policy environment differs from country to country. Most developed countries have binding international commitments and established targets to reduce GHG emissions. Some have enforceable national targets and regulations. Air and water quality standards are strictly enforced. On the other hand, developing countries have neither binding international commitments nor national targets for total GHG emissions. Environmental regulation exists, but they are weakly enforced in many countries. Cities in more developed countries have greater institutional capacity and must answer to political demands for better environmental quality and GHG control from politicians and civil society. Environmental issues are seldom priorities of cities in developing countries, where issues of providing infrastructure, public transportation, housing and jobs for the urban population top the policy and political agenda. Climate change policies, if they are to be implemented, must match the local priorities of countries and cities (Puppim de Oliveira, 2009). Successful implementation of climate change is even more important for developing countries, as their cities are in earlier stages of development and can avoid many of the problems faced in the past in developed countries.

Thus, co-benefits can be appealing to developing countries. Firstly, many co-benefits projects have important local socio-economic gains. Addressing environmental problems, at the local and global levels, can help cities to save resources in the short and long term, as well as improve the quality of life of the local population through the generation of jobs and health benefits. Secondly, it has political appeal. Many developing countries blame developed countries for causing climate change and feel that the richer countries must bear the full responsibility and should pay to solve the problem. Implementing co-benefits has more popular appeal as they have a strong local benefit component in terms of improvements in local environment and the social, economic and political consequences that come with this improvement.

4. Research methodology and overview of case studies

This research used the case study method (Ragin, 1992). The objective of the research was to understand how urban co-benefits have been generated by studying cases where climate co-benefits were actually implemented in cities in Brazil, China, India, Indonesia and Japan in order to identify opportunities to generate urban co-benefits intentionally in many other contexts. Through its focus on opportunities for co-benefits, the research was designed to develop a more comprehensive approach in examining the multiple, often competing, policy environments in which urban management was implemented in specific sectors.

This report examines the research that involved the collection of quantitative and qualitative information in the countries in which the case studies were done. The field research was done between April 2011 and March 2013 through a series of in-depth research in the countries and cities involved.

The cases were carried out where co-benefits already happened looking at the policy drivers and implementation processes of one intervention (e.g., project, programme, policy) that led to co-benefits in one case in one specific city. In order to do that, we need to understand how the intervention was able to move the environmental situation from A to B (Figure 3 below).

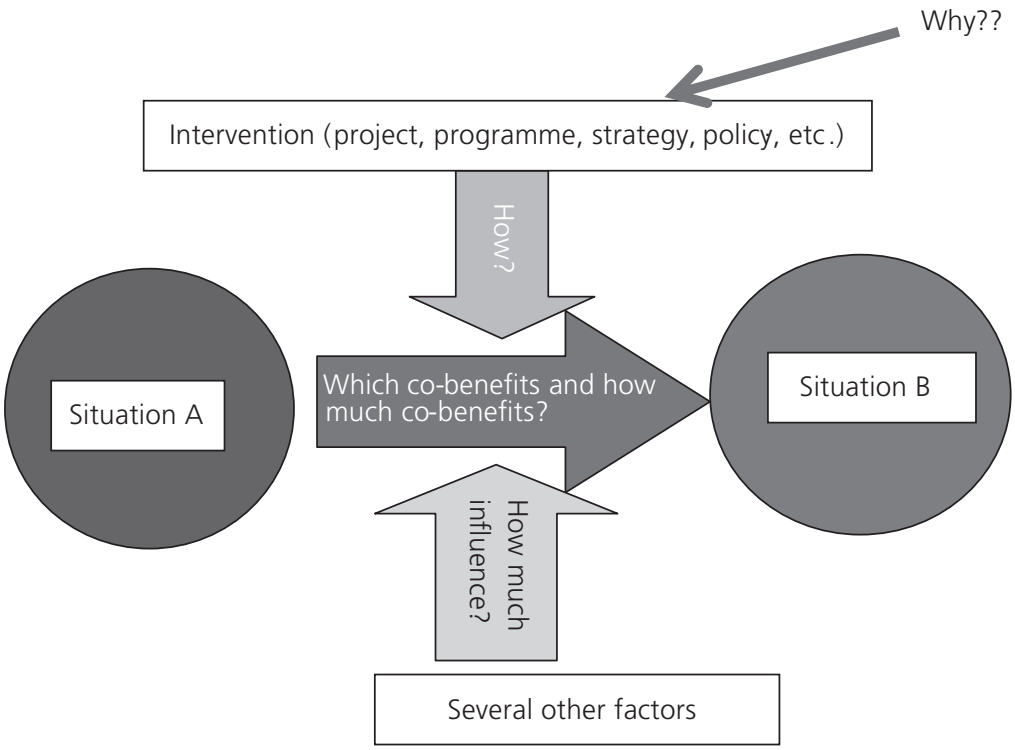
- Which possible environmental co-benefits have already happened? (qualitative information describing the links between the project and co-benefits)

- What was the magnitude and range of co-benefits? (quantification of as many co-benefits as possible, through secondary data, estimates)

- How the particular intervention was implemented? (different actors and actions, challenges and obstacles, and how the action was able to overcome those)

- Why was it implemented? (political, economic, social reasons it was implemented)

Figure 3 - Approach to the Cases of Co-benefits



Summary of the case studies

In this section, we provide a summary of the situation and case studies in each country with some key information on the urbanization process and the institutional framework which affects the implementation of co-benefits in each country along with examples of the types of projects that have been undertaken there. More details of the cases are provided along the report in boxes.

Brazil has experienced one of the world's most drastic processes of socio-economic and territorial reorganization as a result of rapid urbanization since the 1930s, to become one of the most urbanized countries in the world (with more than 80 per cent of the population living in urban areas). There is huge potential for co-benefits as lack of good public transportation and waste management and disposal are a growing concern among policymakers, and there is increasing pressure from organized civil society groups and the population in general. The City of São Paulo started with a series of actions to address climate change in the energy sector, as well as waste management (Puppim de Oliveira, 2009). The city had ambitious plans to reduce 30 per cent of its GHG emissions by 2012 as compared to 2005. Many of the actions imply co-benefits. In Rio de Janeiro, there is also a set of initiatives to reduce urban pollution and tackle climate change at the same time, through a series of transport initiatives such as expansion of the metro lines and Bus Rapid Transit (BRT) lines.

China has begun several initiatives to address both local environmental pollution, and more recently, GHG emissions, including international voluntary commitments to improve fossil carbon use efficiency. Shenyang is one of the biggest industrial cities in China; its leadership has plans to lower its carbon emissions and pollution. Besides the transportation sector (Geng et al., 2013), the city's urban plan singled out pollution in the industrial district of Tiexi by moving some of its industries to a different location. Improvements in energy efficiency in the building sector in Shanghai were another aspect addressed in the research (Jiang et al., 2013a). The research also looked at the Baoshan industrial district in Shanghai, as it is also going through a series of initiatives that can lead to co-benefits.

In India, there are great opportunities to explore co-benefits in urban development as the urbanization level is still low (around 30 per cent) and per capita emissions are well below those in most developed countries. The country is still timid with international voluntary commitments to reduce GHG emissions, but political pressures are increasing to reduce local environmental pollution and there are interesting initiatives that generated urban co-benefits. The clean-up process in New Delhi is a good case in point. It started with a court decision that mandated a reduction in the severe air pollution, which resulted in many projects with large co-benefits in the transport and industrial sectors. The Delhi Metro was one of the initiatives in the transportation sector that helped to alleviate congestion and pollution, even though it was planned well before the court decision (Doll and Balaban, 2013). The clean-up process in the city of Surat was also the result of a crisis caused by the lack of proper waste collection that led to a local epidemic of the plague in the 1990s (Kapshe et al., 2013).

Indonesia has also experienced rapid economic growth recently and an increasing urbanization, particularly in the island of Java. The lack of infrastructure and urban services has aggravated environmental problems in several cities. The national government has shown some interest in reducing GHG emissions by reducing deforestation and taking initiatives in the urban area. A few waste composting schemes in the city of Surabaya had a large impact by reducing organic waste by around 30 per cent, which reduced both the quantity of organic wastes transferred to the disposal site and the GHG emissions (Kurniawan et al., 2013). Yogyakarta also had positive results based on interesting initiatives in Community-based Solid Waste Management (CBSWM). The number of CBSWM groups in the city increased from 27 to 93 between 2008 and 2010 and the volume of solid waste taken to the landfill was reduced from 91 thousand to 65 thousand ton per year. The city also started a Bus Rapid Transit (BRT) initiative that led to many other initiatives in the transportation sector (Dirgahayani, 2013).

5. Lessons from the cases

The research provided several initial lessons for understanding co-benefits and how to design, promote, and implement the urban co-benefits approach in developing countries. Even though co-benefits were not considered ex-ante in the interventions studied, the cases showed the important roles some initiatives played in bringing about larger co-benefits. The studies also served as an opportunity to examine the conditions under which co-benefits policies can be effective in achieving significant results. They provided a window to see how the public sector and other actors can work together and they shed light on the main drivers pushing for co-benefits. In order to make co-benefits the goal, we need to develop institutions, organizational capacity and tools to promote co-benefits, engage non-governmental actors, and spur the innovative processes in society.

Behind co-benefits: still limited understanding and discussion of co-benefits

Even though the idea of climate co-benefits has been evolving for almost a decade (OECD, 2003), there are no coherent, co-benefits initiatives as such being implemented in any of the countries analysed nor are they present in the general policy discussions. None of the interviewed people involved in the cases were familiar with the concept of climate co-benefits, with a few exceptions such as some people of the Delhi Metropolitan Rail Corporation, which was involved in a Clean Development Mechanism project (CDM).

Box 2: Environmental Co-benefits of Trans-Jogja Bus System, Yogyakarta, Indonesia

On 18 February 2008, Greater Yogyakarta established its new bus system, the Trans-Jogja, which aimed not only to replace old buses but also to reform the whole public transportation system by introducing a "buy-the-service" scheme. The scheme was an attempt to abolish the sublet revenue sharing system between bus owners and bus crews, which heavily depended on patronage levels commonly applied in Indonesian cities. By applying the new scheme, the provincial government became the regulator and gained control over bus service delivery establishing standards of service to be fulfilled by private operators, while the private sector reduced its risks in delivering the service as the operator. The operators providing the services were compensated by kilometre-travelled payments as agreed in a seven-year contract. There are at least two sources of environmental co-benefits that resulted from the operations of Trans-Jogja bus service. They are the emissions reduction from the vehicle quality improvement (the replacement of conventional buses with Trans-Jogja buses) and the avoided emissions that would have been emitted by Trans-Jogja passengers if they were using their motorized modes.

Elements of the Trans-Jogja Bus System

In terms of vehicle quality improvement, an emissions reduction estimate has been made based on the scrapping of 108 old buses and their replacement with 54 units of Trans-Jogja buses with the remaining 310 conventional buses still in operation. The results show that compared to the baseline situation, the PM, NOx and CO_2 emissions reduction to be achieved within the period between 2010 and 2014 range from 11.43 to 41.15 tons, from 475.53 to 546.40 tons, and 65,538 to 77,769 tons, respectively. Larger reductions of PM and CO_2 could be achieved by employing compressed natural gas (CNG) buses, while reductions in NOx levels could be achieved by employing Euro-IV diesel buses.

The second source of emissions reduction calculated in the study is the motorized trips avoided when travellers took the Trans-Jogja instead of taking other motorized modes, particularly cars, motorcycles and conventional buses. A bus passenger survey carried out in December 2011 with 1,005 respondents found that 34.7 per cent of the respondents shifted from motorcycles, 33.6 per cent from conventional buses, 10.3 per cent from being picked-up/dropped-off by cars, and 5.4 per cent from actually driving cars. The result shows that the operation of an improved Trans-Jogja system within the period of 2010–2024 has the potential to reduce 1,313,016 tons of CO_2 emissions, 3,362.65 tons of PM10, 61,288.72 tons of CO, 19,645.79 tons of NOx and 1,423.75 tons of SO_2. The result confirms that the initiative benefits CO_2 emissions reduction more than local air pollutant reduction. The largest potential of avoided emissions comes from CO_2 and CO reductions.

Reference:

Dirgahayani, 2013.

Box written by Puspita Dirgahayani.

There is also no coherent definition of co-benefits, which can further limit the diffusion of the concept. Different organizations use different definitions, meaning for example, climate change and economy (Indonesia's climate co-benefit definition meaning pro-poor, pro-job, and pro-growth), climate change and health (World Health Organization, 2011), or even approaches having air pollution reduction as the main goal (ICF, 2012). The lack of a well-established definition causes confusion among those who have heard about co-benefits. During the research, some officials at the city level had different perceptions when we mentioned co-benefits. For example people interviewed in Yogyakarta, thought co-benefits were pollution-economy related. Nevertheless, there was great interest in the topic when it was discussed among academics and policymakers. This interest opened opportunities for expanding co-benefits use, and for disseminating tools and methodologies for promoting the co-benefits approach.

The main drivers are rarely in the environmental arena

The initiatives analysed were those where co-benefits were identified, but they were not the main purpose or even mentioned or known by the main stakeholders involved. The initiatives generally had a driver outside the environmental arena and were connected to development needs, such as improving public transportation in Yogyakarta (Box 3) or tapping business opportunities for waste management in Surabaya.

Box 3: Analysing the Co-benefits: Case of Municipal Sewage Management in Surat, India

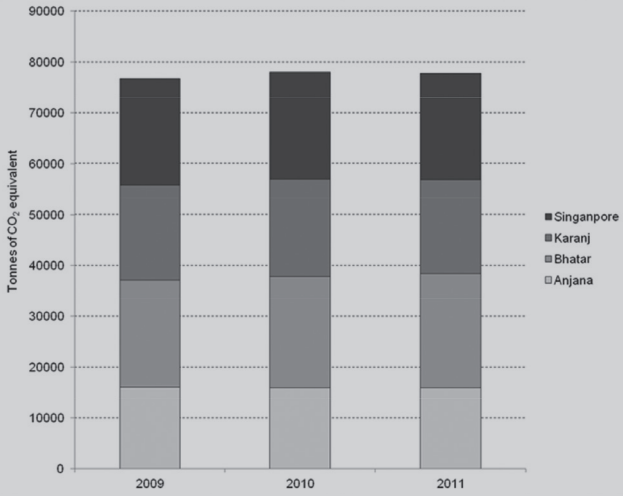
Urban Local Bodies in India are initiating action on pollution and climate change. Among the various initiatives taken in India, the case selected for documentation and analysis is 'Methane recovery and power generation from sewage treatment plant at Surat'.

Surat city is located on the west coast of India, in the southern part of Gujarat state. Surat Municipal Corporation (SMC) is a pioneer in establishing the sewage sludge based power plant in India. SMC has installed one megawatt (MW) captive power plant each at Bhatar, Karanj and Singanpore Sewage Treatment Plants (STPs). In addition, a fourth plant at Anjana has an installed capacity of 0.5 MW.

On average 1.5 to 2.5 million kWh electricity has been generated in these four STPs every year. Correspondingly the biogas generation ranges between 1.6 million and 2.5 million m^3 from each of these STPs.

Before establishment of the project total baseline CO_2e emissions from the STPs were between 19,000 and 27,000 tons per annum. CO_2e emissions from methane range between 15,000 and 25,000 tons per year, whereas, CO_2 emissions due to the use of electricity from the grid were between 2,000 and 4,000 tons per year for different plants.

It is seen that with project intervention there is large reduction in emissions. CO_2e emissions from methane flaring for different plants now range between 2,000 and 3,000 tons. The methane is being used for power generation thus the CO_2 emissions due to the use of electricity from the grid have reduced by about 50 per cent. Each plant is able to save between 15,000 and 22,000 tons of CO_2e amounting to a total of 80,000 tons of emissions saved in Surat every year. The emissions saved in moving from the initial situation (without project intervention) to the situation with project intervention are shown in the below figure.



Total CO_2e Emission Savings from the Four STPs

Reference:
Kapshe et al., 2013.

Box written by Manmohan Kapshe, Paulose Kuriakose, Garima Srivastava and Akhilesh Surjan.

However, environment-related concerns had a strong direct and indirect influence on the motivation for some of the initiatives analysed. For example, the reason for the relocation of the industrial district of Tiexi in Shenyang (China) was the environmental pollution caused by the industries near the urban centre when the central urban areas expanded towards an original industrial district. In India, the environmental health issues in Surat in the 1990s, including cases of the plague, led to a strong push to clean up the city and to introduce an effective waste management system in the region (Kapshe et al., 2013).

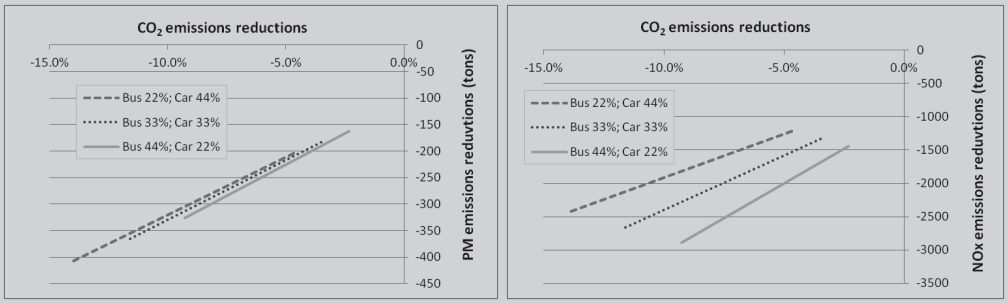
Whilst climate related challenges were not the driving priorities in the cities studied, even for those initiatives that had strong mitigating impacts on climate change, progress was made when identified stakeholders were able to integrate them with their other objectives. In some initiatives, the stakeholders were not even aware of the potential impacts on climate change mitigation or even of the potential for tapping into the financial resources, both domestic and international, available for climate change projects. However, when the potential opportunities were identified, climate change actions were incorporated into the initiative. For example, the Delhi Metro's main objective was to reduce congestion on the roads. The idea of having a CDM project was introduced later and was aligned with the main objectives of the project. This resulted in the first rail-based CDM project in the transport sector (Box 4).

Box 4: Mind the Gap: Realizing the Potential of the Delhi Metro

Although a metro had been planned in the city for many decades, the project had always stalled due to a variety of political and institutional issues. The combination of a series of factors such as the serious increase in congestion in the city, the impending Commonwealth Games in 2010, access to funding from the Japan International Cooperation Agency (JICA) and the establishment of the Delhi Metro Rail Corporation (DMRC), helped the project to be finally realized. Each of these factors played a role in helping overcome barriers to planning, financing and implementing the project. In particular the 60 per cent financing from JICA and the transfer of principally Japanese and Korean technology were instrumental in developing an efficient, high quality rail network. The use of a regenerative braking system in the rolling stock can save up to 35 per cent of the energy needed to run the trains. This feature allowed the DMRC to successfully apply for carbon credits under the Clean Development Mechanism (CDM) of the United Nations Framework Convention on Climate Change (UNFCCC). In doing so, it became the first railway project in the world to be registered under the CDM. The system is calculated to save 411,600 tons of CO_2 in the 10 years of operation 2007–2017 (UNFCCC, 2007). Metros are nonetheless controversial because of their high cost when it can be argued that existing road space should be given over to buses.

Congestion from private vehicles still remains a problem in Delhi despite the metro.

Doll and Balaban (2013) subsequently investigated the potential of the metro to generate further emission savings and co-benefits from analysing how the metro affects the users of other traffic modes in the city. By generating scenarios of ridership increase and mode contribution (i.e. whether metro riders were previously car or bus users), their analysis investigated the range of emissions reductions that could be achieved both from global GHG and also local air pollution emissions. They concluded that there is currently around a 2 per cent reduction of GHG emissions but that far greater reductions could be achieved with greater shifts from car use. They also demonstrated how reductions in GHG emissions correspond to changes in different types of air pollution, showing marked differences which could have implications on policy formulation and target setting.



Analysis shows how air pollution (PM – left; NO_x – right) can vary with GHG emissions for different metro use scenarios

However their analysis also points to a range of issues in the wider transport and energy system. Clearly one big source of co-benefits can be found in switching the type of fuel used to generate the electricity for the trains. Within the transport system itself, increasing metro ridership by attracting more car users raises the issue of how to incentivize the shift out of private vehicles and this is a critical area of policy-making, which can often fall through the gaps when embarking on large infrastructure projects (Balaban and Doll, 2012).

In Delhi, entities such as the Delhi Multi-Modal Transit System Ltd. aim to promote the integration of modes which affect the uptake of public transport. The wider point is that construction of a metro is often a necessary, but not sufficient policy if surrounding policies are not put in place that robustly encourages the shift out of private vehicles and into public transport. However, even seemingly public spirited policies can face opposition from previous supporters. It is notable, that while citizen action led to the Supreme Court decision to switch to compressed natural gas (CNG) fuels, it is also lending weight to a lobby that is fighting bus rapid transit (BRT) schemes in the city precisely because they inhibit the mobility of car drivers.

References:
UNFCCC, 2007; Balaban and Doll, 2012; Doll and Balaban, 2013.

Box written by Christopher N.H. Doll based on work done with Osman Balaban.

Similarly, energy security following the oil shocks of the 1970s was clearly the main policy driver of Brazil's of developing bioethanol. Box 5 describes how starting from an energy security policy, successive policies started to align around an environmental agenda once those benefits were realized. The case shows the importance of different policies to enhance co-benefits. Sustainable transport policies can be broadly categorized according the the Avoid, Shift, Improve framework and these two cases cover many of these elements. Improvements from cleaner fuels may not have lower emissions depending on how the biofuels are produced, subsequently their impact in the fleet is determined by the diffusion of technology to run the fuel and the efficiency in getting old cars off the road. Similarly in Delhi, the co-benefits from the introduction of the metro are largely dependent on how to shift would-be motorists out of private vehicles and into public transport. Both cases show (with varying degree of success) the importance of what can be called boundary policymaking around the central policy.

Box 5: Co-Benefits from Different Initiatives in the Transportation Sector in São Paulo, Brazil

As a response to the mounting energy security concerns on the aftermath of the first oil crisis, the Brazilian government promoted policies that aimed to harness local renewable resources (sugarcane) for the production of a fuel type that could substitute conventional transport fuel. Energy security was the intended benefit of this national strategy that was initiated with the 1975 Pro-Álcool programme. Since then the Brazilian government has enacted a string of biofuel policies, including the 20–25 per cent mandatory blending mandate of ethanol into gasoline. Given its location in the heart of the country's sugarcane producing region and its status as the country's largest city and economic powerhouse, São Paulo was the main initial market for bioethanol. Despite the absence of government subsidies for the production, blending or consumption of bioethanol (Gasparatos et al., 2012), bioethanol constituted 20.4 per cent of the total energy consumed for transport in 2009 (MME, 2011). Besides being an economic and energy security success, the Brazilian bioethanol programme seems to have had certain environmental co-benefits in Brazilian cities.

Due to a set of interconnected factors, Brazilian bioethanol offers significant GHG emission savings when compared to conventional transport fuel. Several life cycle assessments (LCAs) have confirmed that Brazilian bioethanol emits significantly less GHGs than conventional fuel. There is a risk that when direct and indirect land use and cover change (LUCC) is factored into the LCAs, Brazilian bioethanol can incur carbon debts. However, the Brazilian ethanol programme has historically relied on sugarcane grown on the agricultural land of São Paulo state and so there are few LUCC effects at present. This means that sugarcane ethanol production results in relatively small carbon debts. For example, Gibbs et al. (2008) calculate a 3 to 10-year payback time for sugarcane bioethanol from agricultural lands in Brazil.

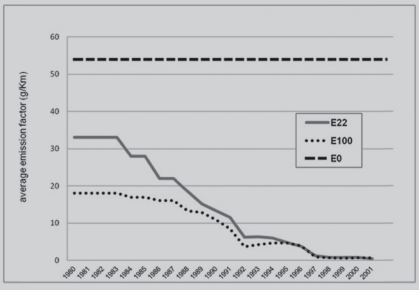
Study	GHG savings (%)	Comment
Luo et al., 2009	81.0	E100 not including LUCC
Walter et al., 2011	78.0	E25, including LUCC
Macedo et al., 2008	81.2	E100 not including LUCC
Macedo et al., 2008	80.9	E25 not including LUCC
ICONE, 2009	60.0–69.0	E100, including LUCC
Zah et al., 2007	85.0	E100, not including LUCC

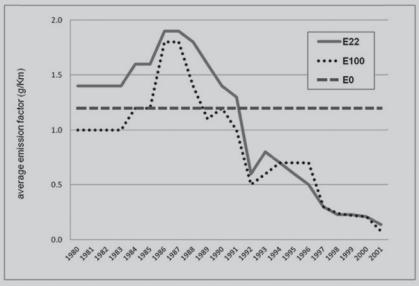
GHG Emission Savings from Different LCAs

Note: E100 denotes pure ethanol, while E25 a blend of 25% ethanol and 75% conventional gasoline.

The high GHG savings reported by LCA studies and low expected carbon debts strongly suggest that bioethanol use in São Paulo's transport system has resulted in lower GHG emissions from the transport sector itself. Although, bioethanol penetration has been partly credited for the improvement of air quality in the city, there is limited empirical evidence regarding the ripple effects of bioethanol use on ambient air quality, particularly in urban settings. However, there are some indications that bioethanol penetration has been a driver of vehicle fleet modernization and might thus have resulted in lower air pollutant emission from the transport sector.

This is due to the fact that vehicles running on ethanol or ethanol/gasoline blends exhibit decreasing emission factors, particularly for CO and NOx, since the early 1980s. More importantly these emission factors are much lower than the emission factors of cars running on pure gasoline in the early 1980s. Additionally ethanol fuel does not contain any sulfur, which suggests that significant SO_2 emissions were avoided from the transport sector due to the adoption of ethanol fuel.





Carbon Monoxide (CO) and Nitrogen Oxides (NOx) Emission Factors for New Brazilian Vehicles (1980-2001). Source (CETESB, 2012).

Note: Horizontal line represents the CO emission factor of vehicles using pure gasoline (54 g/Km in 1980).
Note: Horizontal line represents NOx emission factors for vehicles using pure gasoline (1.2 g/Km in 1980).

Impacts of the Accelerated Vehicle Retirement (AVR) Programme and Vehicle Inspection and Maintenance (I/M) Programme

The Accelerated Vehicle Retirement (AVR) Programme and Vehicle Inspection and Maintenance (I/M) Programme are initiatives under the nationwide Brazilian Motor Vehicle Air Pollution Control Programme (PROCONVE) launched in 1986 to control vehicle emissions. Its main goal was the reduction of atmospheric contamination by setting emission standards, thereby inducing technological improvements of manufacturing processes and verifying that vehicles and engines meet emission limits in standardized tests with a reference fuel.

These policies have also been investigated and show variable results in simulations run for São Paulo. The results of the simultaneous implementation of an AVR Programme and an I/M Programme show reductions in the order of 31 per cent for CO and 32 per cent for HC in the first year, increasing to approximately 40 per cent the following year for both pollutants. In 2010, reductions of up to 66 per cent for CO and 61 per cent for HC could be expected. Considering that in 2008 there would be a replacement of vehicles model year pre-1989 (pre-PROCONVE) and in 2012, of vehicles model year pre-1992 (PROCONVE II), results from Centro Clima (2006) showed a significant decrease in fuel consumption with consequent decrease in CO_2 emissions.

Impacts of the introduction of flex-fuel vehicles

It should be noted that apart from the fuel's qualities itself, environmental co-benefits were catalysed by the rapid introduction of Flex-Fuel-Vehicles (FFV) since 2003 which has led to the gradual phasing-out of older, more polluting and less energy efficient vehicles. FFVs have engines capable of using both hydrous ethanol and gasoline in any proportion entered the market giving the driver the flexibility in the choice of fuel supply. These vehicles receive the generic name of flex-fuel based on the adaptation of existing engines that receive modifications that allow the use of any of the two fuels. Dubeux (2007) simulated the future emissions of CO_2, CO, HC, NOx and R-CHO (aldehydes) due to the introduction of flex-fuel vehicles into the fleet finding significant CO_2 emissions reductions. Even in the case of NOx emissions, which should increase due to the increase in the use of biomass fuels, the emission factor of flex-fuel vehicles when running on gasoline is low enough to offset the increased emissions from vehicles when they are using alcohol, compared to NOx emissions of vehicles only using gasohol. In the case of the other pollutants, emissions would increase. CO and hydrocarbons emissions increase less than 10 per cent, but aldehydes show a significant increase, almost 40 per cent in 2020, even with the adoption of a decay rate constant, which makes this simulation very conservative according to the author.

	2008	2012	2016	2020
CO2 (%)	-16.78	-27.77	-34.85	-38.83
CO (%)	0.44	1.39	2.83	4.30
HC (%)	1.07	3.05	5.67	7.71
NOx (%)	0.35	-0.36	-1.99	-3.06
R-CHO (%)	6.37	14.48	23.72	32.59

Variation of Pollutant Emissions Comparing a Baseline Scenario to a Scenario of Flex-Fuel Vehicles Entrance in the Market

Note: Negative values represent emissions reduction and positive values represent increase in emissions.

References:

MME, 2011; Gasparatos et al., 2012; Gibbs et al., 2008; CETESB, 2012; Luo et al., 2009; Walter et al., 2011; Macedo et al., 2008; ICONE, 2009; Zah et al., 2007; Centro Clima, 2006; Dubeux, 2007; La Rovere and Carloni, 2012.

Box written by Jose A. Puppim de Oliveira and Csaba Pusztai based on work of Alexandros Gasparatos, Emilio La Rovere and Flavia Carloni.

In China, climate change was not a concern when they relocated the industries in the Tiexi District in Shenyang. In a similar and more recent initiative in Baoshan in Shanghai, climate change emerged in the discussions, even though economic benefits and air pollution were still the main concerns driving the project.

The government continues to be the key for large scale/radical changes

When governments were not the main initial drivers, they were important in expanding and replicating the initiative to have a larger impact, as in the case of CBSWM. Communities, NPOs and the private sector may be important in developing the idea and in demonstrating effectiveness on a small scale, but it is government that has the capacity to institutionalize and to increase the scale and push for radical changes at the urban level.

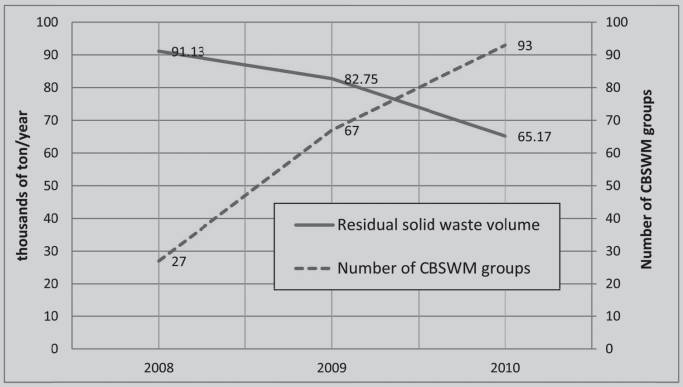
Box 6: Multiple Benefits of Community-Based Solid Waste Management (CBSWM) in Yogyakarta, Indonesia

Communities have always played a significant role in solid waste management in Yogyakarta, Indonesia. However, it was mainly restricted to collection and transportation at the neighbourhood scale. Unorganized sporadic solid waste management had grown through the emergence of formal and informal recycling industries and informal scavengers as well as intermediating recycling agencies.

However, a more organized community-based initiative for waste management has been growing in Yogyakarta since 2003. The first community to initiate this type of environmental management was Sukunan Village, which was recognized at the provincial and subsequently at the national level for best practice in community-based waste management by the Indonesian Ministry of Environment and the Ministry of Public Works in 2006. Since 2005, such practices have been increasingly replicated in other neighbourhoods across the entire region, and even in other parts of the country. The scheme of Municipal Solid Waste Management (MSWM) in Yogyakarta is always a collaboration between community-based and government services. In some parts, the local private sector is also involved in providing MSW transportation.

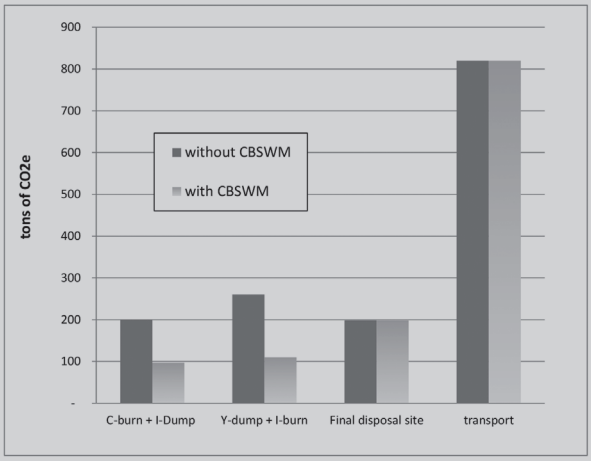
Sukunan's Community-based SWM (CBSWM) system is spreading further as it is disseminated through newspapers and electronic mass media as well as diffused by the government, schools, universities, NGOs, word of mouth, etc. In 2008, the Environment Agency of Yogyakarta Province established an Association of Yogyakarta CBSWM. Currently, the association has a membership of more than 150 communities in Yogyakarta Province.

The growth of CBSWM in the last seven years shows an inverse correlation between waste generation and disposal into landfill with a decrease in solid waste by about 28 per cent from 2008 to 2010 in those areas, showing that CBSWM may have contributed to the drop.



Relationship between Amount of CBSWM Group and Volume of Disposal Solid Waste into the Landfill in Yogyakarta City

Consequently, estimates of reduction in GHG emissions show strong declines with CBSWM techniques versus conventional informal approaches. It should be noted however that the largest contribution to emissions comes from the transport of waste. There is also potential for CBSWM to affect the amount of waste actually going to final disposal.



Estimated Levels of Tons of CO_2 Equivalent with and without CBSWM for Various Stages of the Waste Treatment Process (based on IPCC methodology)

Note: C-burn: collective burning; I-dump: individual dumping; Y-dump: yard dumping; I-burn: individual burning

There are many economic benefits with the establishment of the CBSWM system, such as savings in transportation costs for collection and economic activities generated through recycling. In 2010, for instance, the economic value of reused and recycled products, mostly from handicraft production using plastic solid waste as raw materials, was estimated to be IDR3,143,263,200 (around USD430,000).

The growth of CBSWM also represents an improvement in the cleanness of communities, as the number of open dumps and open burning sites has decreased. Many started to green their environment as well, creating a virtuous cycle. Although there has been no direct scientific evidence yet of the correlation between CBSWM and health, the number of people with dengue fever in the areas analysed decreased from 210 to 178 between 2008 and 2009, while the number of CBSWM schemes grew from 27 to 67.

Reference:
Subanu and Pramono, 2011.

Box written by Jose A. Puppim de Oliveira, Aki Suwa and Christopher N.H. Doll based on the work done by Widodo Pramono.

In the case of solid waste management in Yogyakarta and Surabaya, the community-based schemes started through civil society movements in some localities. However, in Surabaya, the local government was important to expand the initiative to a much larger scale; thereby creating similar initiatives in other areas of the city, as well as introducing new technologies such as the Takakura composting bins (Kurniawan et al., 2013). In Yogyakarta, the number of CBSWM units increased in a few years, with support from the local government. Thus, civil society groups can start innovations and good initiatives, but sooner or later the involvement of governments is essential to scale up the initiatives to have larger impacts (Box 6).

The creation of mechanisms to boost co-benefits requires optimizing public financing at different levels. There are opportunities for reforming the public budget allocation process to give incentives to projects and other initiatives that bring co-benefits. Public funding may be limited, but budgets from different development sectors can be combined to support co-benefits. One role of public organizations is to empower local stakeholders, including the citizens. These organizations should stimulate and accelerate the process of institutional reform towards participatory urban planning and development. Moreover, such reforms can encourage private financing by extending incentives to investors, such as land developers, utility companies and the construction sector.

Coordination between different units of government to implement initiatives with co-benefits

Co-benefits initiatives generally involve various levels and sectors at the same time, for example, land use and transportation modes, or building and energy, national and local governments. The research showed that the cooperation of different governmental units was crucial to implement many of the co-benefit initiatives, particularly those of larger scale that required more radical interventions, such as the Delhi Metro.

The process of coordination among different levels plays out differently in different countries. Some countries, such as China, are very centralized and coordination may not be a problem in the implementation of large scale projects. However, in some countries coordination has to occur at the political level, and politics play important roles to move forward initiatives, particularly, if the mayors, governors and/or presidents are in different political parties, collaboration may be difficult.

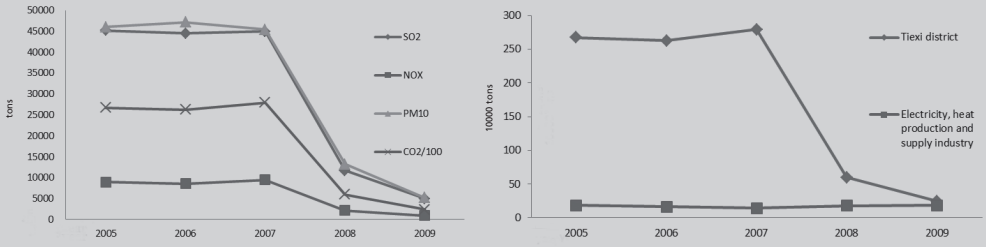
Box 7: Case Study Analysis of Industrial Energy/Material Change in Shenyang, China

The Tiexi District, regarded as a famous industrial base in China, is located in the southwest area of central Shenyang city. Tiexi covers an area of 39.3 km^2, with a population of 850,000 in 2009. On 18 June 2002, the city government integrated the Tiexi District and Shenyang Economic and Technological Development Area into Tiexi New District. Several old industries were relocated from one central area of the district to another area in its periphery. In this process, it was an opportunity to upgrade several plants to make them cleaner and more efficient.

The Shenyang urban region is one of the major drivers of economic development in the country. As an industrial base, the development of the Tiexi District is primarily dependent on the energy consumption of the country's large coal reserves. However, the coal consumed to generate energy causes many environmental challenges, including air pollutant emissions and high GHG emissions. Thus, the local government launched policies and implemented projects to handle these environmental problems.

The Tiexi District's policy measures are mainly categorized as a "relocation of enterprises", "optimization of heating system" and "planting" and have chosen levels of SO_X, NO_X, PM_{10} and CO_2 as the key indicators for measuring the benefits of the target policies. Electricity, heat production and supply industry (EHSI) emissions of CO_2 and air pollutants in the Tiexi District were also calculated.

The research calculated the magnitude of reductions in CO_2 and air pollutant emissions.



CO_2 and Air Pollutant Emissions in the Tiexi District (left) and Comparison between the Tiexi District and EHSI (right–CO_2 only)

From 2005 to 2007, CO_2 emission levels in Tiexi District remained the same. But for years 2008 and 2009, CO_2 emission levels dropped dramatically, as well as air pollutant emission levels, because the Tiexi District government implemented the policy on transforming the old industrial base into a more modern one. The policy had many purposes; one of them was environmental protection. One of the projects in the policy was to remove old enterprises that were primary sources of the GHG and air pollutant emissions.

Reference:
Jiang et al., 2013b.

Box written by Jose A. Puppim de Oliveira based on work of Geng Yong and Bing Xue.

One solution could be to create an organization or a committee to map opportunities for co-benefits in the city government by identifying the need for coordination at the different levels. This could help to facilitate and increase the communication among different governmental bodies and economic sectors. Such an organization or committee could also function as a platform that keeps records, transmits institutional memory and facilitates budget sharing information among local governmental bodies to coordinate initiatives for co-benefits. The cases of the Delhi Metro and Tiexi District industrial relocation are good examples where this coordination occurred. In Delhi, the creation of Delhi Metro Rail Corporation (DMRC) brought together two levels of government (national and local) and was key to moving the project forward as it had the participation of the national government, which controlled land use and had expertise in rail, and the local city government which was responsible for the public transport system in the city (Doll and Balaban, 2013; see also Box 4).

Local autonomy and governance as an underlying factor for effectiveness of co-benefits policies

Local governments, being closest to the citizens, can take leading roles in strengthening networks of citizens and in realizing co-benefits in cities mainly due to their proximity to implementation. They can make significant changes not just by effective implementation of policies but also by strengthening governance by facilitating and encouraging networks of stakeholders at the local and other levels (Khan, 2013). In order to do so, however, they need to develop their capacities in terms of knowledge, information and experience on effective solutions. The development of the cadres by the city of Surabaya to promote environmental awareness was fundamental to boost composting of domestic waste (Kurniawan et al., 2013).

The research indicated that environmental departments in many cities do not have much regulatory power. However, cities have larger roles in public works or municipal transportation regulation. Thus, co-benefits approach should be integrated to a broader spectrum of policy actors beyond environmental officials.

Indeed, local authorities can be more effective in boosting co-benefits in some sectors than others. In some cases, cities may not have the autonomy to make certain decisions or the resources and capacity to implement actions towards co-benefits. Fiscal power still remains in the hands of higher level authorities in many countries, so local authorities may have the responsibilities but they are not able to create financial incentives for co-benefits, such as preferential tax treatments or the development of local programmes. For example, there are many opportunities to advance improved solid waste management (SWM), which could bring enormous co-benefits, in the developing countries studied. In general, SWM responsibility belongs to local authorities but many do not have the resources or technical expertise to establish SWM systems by themselves. In order to push the co-benefits agenda, local governments have to be strengthened through institutional reforms that boost their capacity to move forward different basic public policies. Working with local organizations to promote community-based SWM has shown to be an alternative to consolidating a minimum system of SWM where it does not exist.

The role of legal institutions in enforcement

The existence of legislation does not always equate to enforcement. Even though some countries, in this study, introduced strict environmental laws, enforcement is still a major issue for comprehensive implementation. Moreover, regarding climate change, command-and-control legislation has a limited role, as many actions need changes in larger issues beyond the environmental area, such as provision of good public transportation. In some cases, the enforcement of legislation by public officials or even by the courts can boost environmental improvements in the urban areas and give opportunities for co-benefits. In Delhi (India) for example, a decision from the Supreme Court in 1998 pushing for the enforcement of existing legislation catalysed the process to reduce pollution in industry and to improve public transportation in the city (Dreyfus, 2013).

There is a low level of environmental awareness and limited advocacy for environmental agendas in many developing countries. In many countries there are few local actors who are well aware of environmental issues, professional subject matter experts are scarce, and civil society is not effectively engaged in environmental issues. Thus, the active role of the judiciary system in mandating the enforcement of existing regulation can partially compensate for the gap of a more active civil society.

International cooperation has played an important role in co-benefits

International cooperation was present in diverse forms in some of the cases studied, such as the Delhi Metro and waste management in Indonesia. The cooperation was important to catalyse the process of providing financial support (e.g. loans or grants) or by bringing new, and sometimes simple technologies, such as the case of the Takakura home composters in Surabaya. Nevertheless, international cooperation has been mainly limited to supporting projects, particularly in large countries, where financial requirements for large scale initiatives are huge even though the developing country has the necessary technical expertise.

Box 8: Takakura Home Composting (THC) Method Brings Co-benefits to Surabaya, Indonesia

Surabaya is the capital of the East Java and also serves as a regional economic centre. The city has been confronting the increasing generation of municipal solid waste (MSW). Open dumping is employed for the disposal of MSW in the city. Up to 95 per cent of the total waste collected in the city was disposed in the Benowo open dump. With a 2.1 per cent annual growth of its urban population of more than 3 million in 2012. Surabaya generates over 2.1 thousand tons of MSW daily.

In spite of the city government's campaign to encourage people to recycle and reuse the MSW at source, its generation rate still increases annually by 4 per cent. Unless properly tackled, the city would face serious urban environmental degradation, in which the volume of MSW generated surpasses the city's capacity to handle it. However, the composition of this MSW is between 40 to 60 per cent organic matter and therefore offers the potential for composting.

To address the MSW problem in Surabaya, the city has been cooperating with the Japanese city of Kitakyushu in the area of waste management since 2005. An innovative home composting method using "Takakura bins" (dimensions: 40cmx25cmx70cm) was promoted to reduce organic waste at source. The THC method is ideal for households that usually consist of 5–10 people per family. The THC method may be applied to composting kitchen waste as well as market waste and possesses characteristics such as low energy consumption, indoor use, portability, rapid waste decomposition and no odors at a low cost of production.

While developed in Japan, the device used in the THC method needed to be adapted to accommodate local climate conditions. The annual temperature in Indonesia ranges from 27°C to 35°C. With an annual average temperature of 31°C, the country's climate is ideal for composting activities and the THC method for organic waste reduction was found to match local needs well.

Having used the THC and other composting methods, the city has managed to reduce the volume of organic waste generation at disposal sites by 30 per cent, and consequently GHG emissions were avoided. The compost may be used not only for urban farming, but also for beautifying local environments and gardening. As a result, Surabaya has won the Adipura Award, which is a very prestigious national level prize in Indonesia.

Takakura Bins for Organic Waste Reduction

The city's accomplishment was also internationally recognized. The city won the 2007 Urban Environment Improvement Award from the United Nations Economic and Social Commission for Asia and the Pacific, followed by the 2008 Best Practices Award for Improving the Residential Environment from the United Nations Human Settlements Programme. In 2011, Surabaya was selected by the Association of Southeast Asian Nations as one of the most environmentally sustainable cities in the region.

Reference:

Kurniawan et al., 2013.

Box written by Tonni Kurniawan based on work with Jose A. Puppim de Oliveira, Dickella G.J. Premakumara and Masaya Nagaishi.

Coordination of different forms of international cooperation could bring greater effectiveness to promoting co-benefits. A developed nation through their bilateral cooperation agency could, for example, use the co-benefits approach to streamline sectorial projects to improve the overall effectiveness of its operations. However, as international cooperation comes from many different multilateral and bilateral agencies to the same country or city, local coordination is necessary. Some countries do this at the national level, but rarely at sub-national level. An international mechanism to help in the coordination of the international cooperation may bring benefits. National Appropriate Mitigation Actions (NAMAs) can be such mechanism, but it will have to be adopted at the city level.

Moreover, international networks of cities and local governments could play a crucial role in information sharing and city-to-city cooperation (see Box 8). Through joining such networks, cities and local governments could increase synergies and facilitate knowledge and information exchange among them. Currently there are several networks, such as ICLEI, C40 and CITYNET, which are facilitating interactions among cities and local governments throughout the world. In the case of Shenyang, there has been active cooperation in several areas related to environmental policy and management with Kawasaki in Japan, exchanging experiences and technologies, many of them having resulted in co-benefits. The case of Indonesia documented the co-benefits of cooperation between Kitakyushu and Surabaya in the introduction of composters (see Box 8). There was also the establishment of the Asian Co-benefits Partnership (ACP), which is an opportunity to formalize a partnership with policymakers to promote co-benefits by including local governments in the networking in Asia (IGES, 2013).

The difficulty of assessing co-benefits

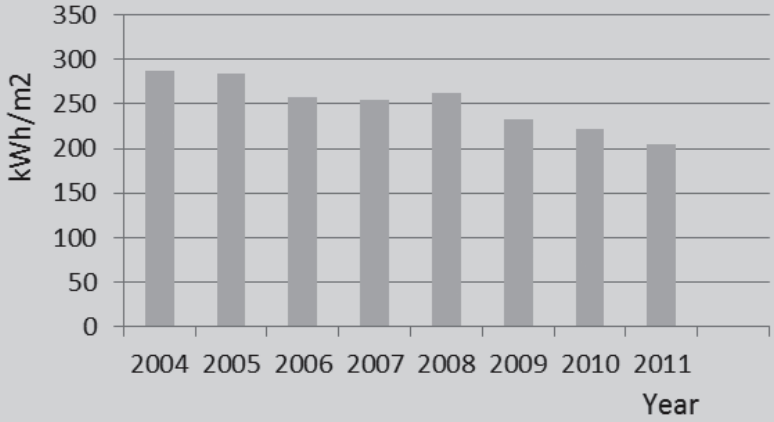
Even though all the initiatives generated clear co-benefits, the quantitative assessment of the co-benefits is not a straightforward task. Many of the benefits were hard to quantify in precise terms, even moreso if a measurable, reportable and verifiable (MRV) reporting method is required. For certain kinds of projects, such as those of the waste sector, that are typical in CDM, such as methane burning in a landfill, the measurements are straightforward. However, as you move to CBSWM, evaluation of the impacts becomes more intricate, as there are no precise data on the baseline and on what would happen with the waste if the initiatives were not present. Depending on where the waste was supposed to be going without the project the impacts were different, both in terms of local environmental impact and climate change so that the composting method could be different. The assessment of more complex projects, such as the relocation of industrial plants in the Tiexi District in Shenyang is even more challenging, as there are many other factors that may have influenced the environmental changes over time, even though the co-benefits are relatively clear. Other sectors, like buildings, which have a huge impact on energy use in cities, can find it difficult to justify the costs of the MRV apporoach for the amount of carbon mitigated by an initiative, even though the aggregate effect may be huge.

Box 9: Energy Saving and Carbon Reduction of Co-benefits Achieved in an IKEA Building in Shanghai, China

The company IKEA is one of the world's largest furniture and home products retailers. One IKEA shopping mall named Xuhui Store is located in Xuhui District of Shanghai. It contains one furniture and home products retail store and one Swedish food restaurant. The total floor area of IKEA Xuhui Store is 35,000 m^2.

Six typical energy efficiency technical measures have been undertaken by the IKEA Xuhui Store since 2008. These measures include energy efficiency improvement in the lighting system, the ventilation system, the escalator system and water heating system.

After adopting these measures, the energy efficiency per unit of floor area (m^2) has been improved by 4.1 per cent per year and thus associated carbon emissions have also been reduced between 2004 and 2011.



Reduction in Energy Consumption per Unit Area at the Xuhui Store

Detailed information of co-benefits of cutting energy use and carbon emissions through technical measures is presented in the table below. The improvement in energy efficiency also led to less local air pollutants as a large part of China's electricity is generated by coal-powered plants.

No.	Item	Energy saving (kWh/year)	Carbon reduction (kg.CO2e/year)
1	Energy efficiency improvement in the lighting system in the retail area		
2	Energy efficiency improvement in the basement lighting system	1,107,500	977,400
3	Energy efficiency improvement in the storage lighting system		
4	Energy efficiency improvement in air-conditioning and ventilation systems	170,000	150,000
5	Energy efficiency improvement in the escalator system	20,000	17,650
6	Central solar water heating system	196,000	173,000
	Total	**1,493,500**	**1,318,050**

Energy Saving and Carbon Reduction Achieved through Technical Measures in IKEA Xuhui Store between 2008 and 2011

Reference:
Jiang et al., 2013a.

Box written by Ping Jiang based on work done with Wenbo Dong, Michelle Kung and Yong Geng.

The complexity of quantifying co-benefits has implications for the development of an assessment tool or methodology for policy-making that could be used broadly. From the cases, there was a trade-off between quantification and generalization of a methodology or tool to assess co-benefits. Precise quantification requires a tool that will be difficult to use for all policymakers from differing levels of technical expertise. This would limit its applicability and consequently its use. More quantification also means more data requirements. This would be costly and time consuming to apply too because large amounts of data have to be collected and input into the system before the quantification tool can be used. Such a tool may not be viable in the context of many developing countries or in the case of small initiatives with limited resources.

However, given the embryonic status of co-benefits in both concept and practice there is space to develop first-order screening tools, which help policymakers understand the magnitude and sources of emissions in a sector and how different interventions produce different co-benefits. The case of the Delhi metro (Box 4) was used to construct a tool for the transport sector and subsequently tools were also developed at UNU-IAS in energy and waste. These tools are described in Box 10 in the next section.

6. Opportunities for introducing co-benefits in the policy agenda

A growing number of organizations are working with climate co-benefits, such as development banks and the World Health Organization (WHO, 2011). There are opportunities for such organizations to coordinate action and research and create momentum to promote the concept of co-benefits. However, there is also a need to standardize the meaning of co-benefits to avoid confusion in the policy arena, as well as develop the concepts and tools that can make understanding and the application in practice more widespread.

A few countries like China have endeavoured to mainstream co-benefits in the policy discourse. The Policy Research Center for Environment and Economy (PRCEE), a centre linked to the Chinese Ministry of the Environment, has developed a project on co-benefits in partnership with Japan. The idea is to introduce the project results into the policy arena to influence China's actions in face of the growing concerns on climate change. In Indonesia, co-benefits are mentioned in legislation and even presidential decrees, showing that there is a discourse at the highest level. In the international area, there is a group that discusses how to improve the CDM, the CDM Policy Dialogue, and one of its recommendations is to strengthen co-benefits (CDM Policy Dialogue, 2012), including the simplification of procedures.

Opportunities for co-benefits in the short-term

In the short-term, the most straightforward initiatives seem to be in waste management, particularly disposal. A more structured approach to the recycling, reduce and re-use (3R) of waste might benefit its adaptation and diffusion, including the work of the informal sector. Urban waste is a major problem in developing countries with significant impacts on health and the environment. Most of the cities in Indonesia, for example, lack waste management services and appropriate disposal are in early stages of development and still very costly. The negative cost impacts could be offset significantly from the huge co-benefits. The city of São Paulo reduced city emissions (in carbon equivalent) by around 10 per cent through use of 2 methane burning landfills (Puppim de Oliveira, 2009).

The institutional part of the implementation is relatively simple as most of the municipalities are responsible for waste management and disposal. The bigger challenge is financing and technical capacity. Proper disposal is still relatively expensive for the budget of most cities in the developing world. On the other hand, this high price for disposal and cheap labour opens opportunities for the 3R at the community level, or even at city level, such as the case of Surabaya, even though investments in landfills are still necessary (Kurniawan et al., 2013). Moreover, most of the countries already have laws determining the proper disposal of waste (which are often not implemented) and there are opportunities for international cooperation and financial support from national and international organizations, as well as the CDM.

Opportunities for co-benefits in the medium-term

Co-benefits can be achieved in the medium-term in certain initiatives, particularly in the transportation, industry and energy sectors. Results of the case studies of this research suggest that many initiatives require large initial investments and have a high level of institutional complexity, which consequently raises risks and transaction costs. For example, improvements in public transportation generally require changes in land use that may generate opposition from different local groups. In many cases, they may require institutional arrangements among different governmental entities to make them happen, such as the case of Delhi Metro. In the energy sector, there are some short-term approaches such as improvement in energy efficiency, but any large scale changes may require huge up-front investments to get co-benefits in the medium to long-term, such as the case of biofuel in Brazil. In a change of fuels, for example, there is a need to create the reliable demand and supply for the different kinds of energy with tremendous financial and economic risks. Moreover, it may require actions in different industry sectors and levels of government.

Opportunities for co-benefits in the long-term

The building and land use sectors are fundamental for generating co-benefits within and beyond the cities in the medium and long-term. One important point of co-benefits in those sectors was that the results from policies were slow to be achieved. Many of the actions were difficult to be implemented both technically and politically, such as retrofitting of inefficient buildings, or required quick action to avoid irreversible losses in opportunities, such as densification in land use or losses in green infrastructure.

A key aspect of building and land use policy is that it sets the city's underlying structural form, and once established, building and land use policies are difficult to change both politically and technically. Moreover, measurement of the co-benefits is complex in several ways. For example, the energy consumed in the building sector, is sometimes transported long distances. An improvement in the energy efficiency in buildings certainly has a positive impact in terms of co-benefits, but it is difficult to determine where this impact will happen. For example, the impact may be many kilometres away where the power plant is located. For land use, changes or better management may lead to opportunities for improvements in other sectors, such as transportation, but the links between the two are not straightforward. Nevertheless, actions in those areas are urgently required to avoid irreversible paths in unsustainable urban development.

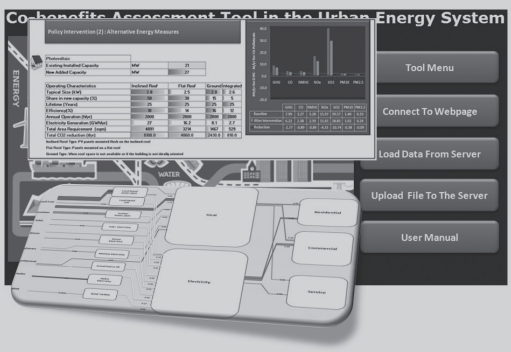
Box 10: Tools for Planning Co-benefits

UNU-IAS has used the insights gained from this extensive research undertaking to develop a series of urban scale tools, which can be used across different urban sectors. The Urban Co-benefits Evaluation Tools are designed to evaluate co-benefits of interventions in different urban sectors. The tools help cities explore and understand

- levels of global climate and local air pollutant emissions in an urban sector and their origins,
- a structured set of interventions based on systemic changes to the sector, and
- potential emissions reductions from implementing different policies to reduce emissions at the city scale.

The approach uses bottom-up data to construct assessments of GHG emissions and air pollution in each sector based on local information. It then applies the Avoid, Shift, Improve (ASI) framework across different sectors. In doing so it aims to help city planners develop an integrated approach to climate and development policy formulation at the city scale. Four tools have currently been developed. Three are in the urban sectors of transport, energy and waste; the fourth tool is a governance tool for the transport sector which prioritizes transport policies based on the relative strength of governance indicators in a city. It may be used to either help cities scope transport policies or identify key areas of governance to focus upon for specific policies. It also provides guidance on how to use the quantitative transport tool.

The Transport Tool is a linear representation of the passenger transport system in a city, from which the impact of the implementation of policies in the following four areas can be evaluated.

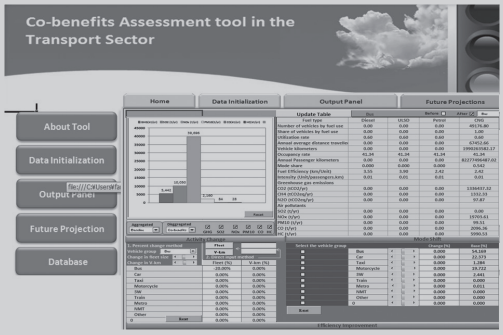


- Activity (fleet size & distance)
- Shift (Mode share)
- Improve (Fuel efficiency)
- Fuel Switch

The tool can be used in a simple intervention mode or with a dynamic baseline. Reported co-benefits are GHG emissions, air pollution and fuel demand.

The Urban Energy System Tool systematically relates GHG emissions based on the specific energy demand in the city to the corresponding social, economic and technological factors that affect this demand. Emissions from the three main "energy consumer" sectors: Residential, Commercial and Service are calculated by considering changes in the following three domains.

- Dwelling sizes
- Building management (end user tech & smart grid)
- Energy sources (local generation)



Cost-Benefit Analysis is considered in the tool as a systematic process for calculating and comparing benefits and costs of different policy interventions.

The Waste Management Tool evaluates the environmental impacts including GHG emissions and air pollutants accompanied by the energy generation potential and cost-benefit analysis of the various waste management strategies by means of a life cycle assessment (LCA). Co-benefits are calculated by making alterations in the following parts of the waste generation and treatment process

- Waste composition by processing method
- Waste transport
- Waste processing technologies

The tools allow for the calculation of environmental co-benefits in different sectors.

Research is ongoing to identify potential synergies in the urban energy system, which allow for the development of an integrated way of planning for co-benefits across sectors.

Access to the UNU-IAS co-benefit tools can found here:

http://www.ias.unu.edu/urban in the Tools section.

Box written by Christopher N.H. Doll and Hooman Farzaneh based on work done in collaboration with Hooman Farzaneh, Mehrnoosh Dashti, Csaba Pusztai and Aki Suwa.

7. Scaling up climate co-benefits

There is a range of opportunities to promote climate co-benefits in cities. Most notably, there is a growing interest in the topic, as the trade-off between climate change and development still exists, and policymakers are looking for alternatives that can bring the goals closer together. Success in implementing co-benefits related policies is strongly linked to their integration into other policies, especially sectorial policies in the areas of energy, housing, land use and transportation (Puppim de Oliveira, 2009). This requires effective government coordination and innovation in policy-making and implementation. For example, the reduction of methane emissions by landfills in São Paulo was possible through integration of the climate change policy with the waste management policy of the municipality. This integration led to building new landfills with methane collection tubes. This integration and cooperation further led to the resources from the CDM project being used in an environmental fund for new projects.

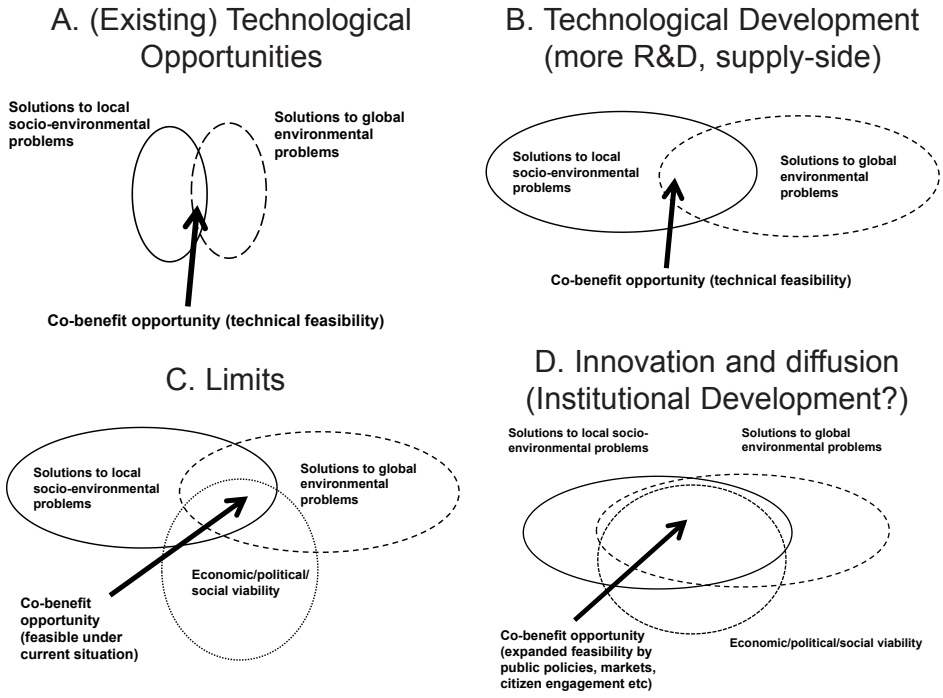
The research examined how co-benefits opportunities can be enhanced, particularly in cities in developing countries. Figure 4 explains the rationale behind the co-benefits. Frequently, there is a set of opportunities for generating co-benefits in a certain city that are technically viable (Fig. 4A). The scope for opportunities that are technically viable can be amplified by bringing in new technologies through research and development or typical technology transfer (Fig. 4B). However, the set of solutions that are economically, politically, and socially viable are more limited in the real cases, though they were technically viable (Fig. 4C). Thus, in order to promote co-benefits, in practice, we need to understand how we can expand the viability of those solutions by, for example, developing local institutions to make co-benefits more viable economically, politically and socially (Fig. 4D). In the cases in this research, cities were able to develop those institutions that enabled climate co-benefits. The technology for generating the co-benefits was an important factor for generating co-benefits in many cases, but those only happened when the local institutions and organizational capacity were in place to make the best use of the technical knowledge or equipment.

The climate policy landscape is changing rapidly within countries and internationally. There are important potential opportunities to include co-benefits in the different institutional contexts, such as the waste, transportation and energy sectors, in legislation and in international cooperation and international mechanisms such as the CDM or follow-up mechanisms of the post-Kyoto regime. Moreover, several countries are introducing climate-related policies and regulations at the different levels (country or sub-national).

On the other hand, developing countries still have a tremendous challenge in harmonizing local development and environmental issues. Urbanization processes are taking place at a rapid pace in many of those countries, leading to an increasing set of new problems and risks. There are growing pressures to solve problems, such as illustrated in the case of the Delhi court decision. Co-benefits can be integrated by aligning present and future environmental and development policies and regulations to address climate change. However, the emerging climate policies are not being aligned to the traditional environmental or development policies.

Specifically in the long-term impacts, particularly in the building and land use sectors, changes in many aspects of land use are needed to achieve the positive impacts on the local and global environment. Recent socio-political movements, such as the cases of the street protests in Brazil asking for better and more affordable public transportation, are evidence of the strengthening of civil society movements, the promotion of decentralization, and the need to improve urban governance. Several emerging initiatives to strengthen urban governance can be observed in the field of land use planning and management. They integrate different levels of governments and make links between civil society/business and governments. Some cases focus upon the challenges and opportunities in the context of urban governance, such as the establishment of the Joint Secretariat Kartamantul in Yogyakarta for metropolitan coordination, and Delhi Development Authority in Delhi, India, though in case of the latter, its selective jurisdiction is also a cause of fragmented governance in the city (Ahmad et al., 2013).

Figure 4 – Graphical Representation of the Feasibility of Co-benefits in Different Situations



However, initiatives towards urban co-benefits should be developed in the context of the country seeking to align climate policies with environmental policies, and other developmental priorities, such as generation of jobs and income. The present interest in the green economy as a result of the Rio+20 conference may be an opportunity to mainstream co-benefits into different development agendas. In some countries, approaching from the national government may be a priority, such as the case of China and Indonesia, as central governments have coordination capacity and mandates to implement urban policies, even though the actions will have to be adapted to the

local institutional context. In others, such as Brazil, a federative republic, municipalities and states have a larger mandate and are responsible for important urban sectors such as land use, building, transportation and waste management. In this case, the local environmental policy related to air pollution, for example, should be coordinated with the state governments that have this mandate.

In the international climate change landscape, it seems that the post-Kyoto regime will be based more on the NAMAs produced by each country; NAMAs will be the main reference for international and domestic action both in the government and private/NPO sector.

Based on the NAMAs, there will be three basic groups of urban co-benefits. Firstly, there are the mitigation actions that make economic and financial sense, which will be done voluntarily by governments or the private sector directly or with minimum access to credit. Many of those actions, such as improvement in energy efficiency, have important co-benefits. Secondly, there are actions that will be viable with the official or voluntary carbon trading systems, such as CDM (or whatever system replaces it), the European Union Emissions Trading Scheme or emerging carbon schemes. Those systems will bring the weight of economic self-interest to bear in facilitating implementation of some projects, such as those that the CDM has facilitated in the landfill methane utilization case. Co-benefits could be included as criteria that are considered in selecting the best available option in either voluntary or compulsory situations. Thirdly, there will be initiatives that will not make political and economic sense in the short or long-term, because of the huge opportunity costs that have to be met.

Finally, there are also the initiatives to tackle the growing consumption levels of certain groups in cities in developing countries, which lead to different kinds of environmental impacts. Such initiatives will be implemented only with national policies, with international grants/aid, or with changes in the domestic political spectrum. Several countries have strengthened their regulations and tailored their policies towards addressing climate change in different but very proactive ways. However, many countries do not have the human, technical or financial resources to implement such actions. Thus, international cooperation may play an important role in providing resources and technical advice to make such initiatives viable. Others, such as changes in consumption patterns, will require local or domestic mobilization to develop a more environmentally conscious urban population.

The growing number of organizations working on the concept of co-benefits can, in the future, help in streamlining the idea and practice of co-benefits in the domestic and international policy-making arena. Synergies with those organizations may be fundamental to promoting the co-benefits approach. Nevertheless, rapid innovative solutions are needed to change the path of urban development in the emerging economies. There is an opportunity to strengthen the institutional capacity, both technical and institutional, that could boost the effects of the co-benefits approach. Initiatives aimed at promoting policies and projects based on the co-benefits approach would have a much larger impact in the medium or long-term if they focused on key interventions to improve the innovation capacity of cities and countries and lead them to a different path of development (Glemarec and Puppim de Oliveira, 2012).

8. The co-benefits approach as the way forward for environmental sustainability

Most if not all of the cases presented in this report evaluated the co-benefits of projects that were implemented without their explicit *ex-ante* consideration. That is to say we were fitting the framework of co-benefits onto a range of existing projects in order to understand what can occur and how they could be planned strategically and more effectively from the beginning if co-benefits approaches were integrated into the planning framework. The implementation of co-benefits approaches to address a variety of environmental challenges has the potential to gradually change cities to achieve positive impacts that improve the quality of urban inhabitants' lives and the quality of the eco-sphere upon which all of us are totally and mutually interdependent. It is expected that the application of an intentional or planned co-benefits approach in different urban sectors will facilitate the development of innovative urban management technologies that provide effective and efficient tools for identifying, preventing and solving urban challenges such as population growth, waste management and an increasing demand for housing and basic infrastructure including environmental services (see Box 10).

Achieving a balance between local and global goals is an ever present challenge due to the widely considered trade-offs between climate change and economic development. Indeed the co-benefits approach should be seen as a means of integrating climate concerns into local development, which by its very nature preferentially considers the local situation. As a result, urban policymakers need to seek novel solutions that strike the right balance between the two without sacrificing either in the battle to prevent and solve environmental problems. The international dimensions have roles to play by placing co-benefits within climate and broader development agendas to strengthen the links among global policies, target setting and financing on the one hand, and the local, bottom-up actions, which must implement the changes, on the other hand. The recognition that ultimately, all implementation is local, and therefore local concerns are key drivers in implementation is central to understanding how to encourage countries to be bold in establishing and implementing climate change mitigation and adaptation measures, if their local benefits are also recognized alongside climate benefits.

The co-benefits approach is a technically feasible, suitable and applicable way to bridge the gap between present and future environmental policies and regulations. Nevertheless, its implementation in the policy arena varies in different sectors among different countries. This diversity reflects governance challenges and local urban situations (Marcotullio, 2001). Therefore, local co-benefits initiatives should be tailored based on the need of individual countries to work in concert and other developmental priorities such as job creation and income distribution (Dahiya, 2012).

The introduction of the Green Economy paradigm during the 2012 Rio+20 Conference in Rio de Janeiro, Brazil may pave the way for national policymakers to include and integrate the co-benefits approach in their development agendas. A greener economy can mitigate some of the impacts economic growth brings to the environment but this can be achieved only if it is embedded in cities (Puppim et al., 2013a).

On a final cautionary note, co-benefits should be seen in a broader context, in the sense that endlessly pursuing greater efficiency will not, by itself, solve the problems, if issues of mass consumption and rebound effects are not simultaneously addressed. Incremental improvements in energy efficiency will be meaningless if the prevailing mindset is one of ever increasing consumption. It is for this reason that the co-benefits approach can become a bridging mechanism that initially starts with a cleaner version of business as usual but ends with a reorientation of development pathways, which produces a meaningful set of visions, values and strategy changes so that societies truly live within the boundaries of sustainable ecosystem resource management.

9. Concluding remarks

In recent years, improving the urban environment has become one of the most pressing problems in developing countries due to rapid economic development and increasing urban population growth. The cases have demonstrated that a number of cities are responding to their urban challenges such as waste generation and energy inefficiency by implementing initiatives, which have resulted in co-benefits. With the right combination of visions, strategies, policies, planning tools and institutional reforms, replicating such initiatives in other cities could significantly help to achieve environmentally and socially sustainable cities.

In addition, innovative solutions are necessary not only to facilitate the required technical changes in urban development, but also to foster the diffusion of co-benefits initiatives into local policy-making settings. At the international level, the Intergovernmental Panel on Climate Change has recognized the opportunities for climate co-benefits in several sectors and the United Nations Framework Convention on Climate Change (UNFCCC) has pointed to several benefits that accrued from CDM projects (UNFCCC, 2012). There are vast opportunities for local stakeholders to strengthen their innovation capacity for optimizing the effects of co-benefits interventions. Documentation that coherent policies and projects in different urban sectors based on the co-benefits approach can be formulated and implemented encourage leaders in other cities in the developing world to do so also. This process can be strengthened through the support of co-benefits in international climate and development agendas. In the long-term, this would contribute to cities' ability to generate co-benefits at local and global levels but its impact will be limited without a serious reconsideration of the logic of the prevailing traditional development pathway.

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