UP SCALING THE APPLICATION OF LOW CARBON AND RESOURCE EFFICIENT TECHNOLOGIES IN SOUTH ASIA

Key Messages

- The construction sector has a high ecological and carbon footprint
- Low carbon and resource efficient technologies exist
- Adoption of such technologies is also an important policy and implementation agenda for South Asian countries
- Implementation process and mechanisms need to be strengthened
- Technical capacity building of government officials will aid in the implementation of the policies
- Knowledge dissemination on the benefits of these technologies is essential

ASIA-PACIFIC NETWORK FOR GLOBAL CHANGE RESEARCH

Contents

1. Introduction

The construction sector is crucial for the economic development of South Asian countries. It is the second largest employer after agriculture in India, and accounted for 8.2% of its GDP in 2011-2012 (Planning Commission, 2013). The sector grew at a rate of 18% per annum from 2004-07 in Pakistan (Nielson, 2010). At the same time, it is also one of the primary drivers of climate change, making up for 10 - 24% of greenhouse gas (GHG) emissions in India and Pakistan (Parikh *et al*., 2009). 80% of these GHG emissions are generated by construction materials, such as steel, bricks, cement and lime. Raw materials used in construction are produced using inefficient technologies that consume large amounts of coal and release high carbon emissions. The carbon footprint of Nepal is also high due to its dependency on import from India and China. The extraction of these materials have an adverse impact on the natural resources as well as on agricultural yield (i.e., exerting pressure on food security) due to conflicting uses of fertile top soil between agriculture and brick making.

Both economic growth and increasing urbanisation in the region have resulted in a surge in construction activity. The current affordable housing shortage in Urban India (2012-2018) stands at 18.78 million dwelling units (Ministry of Housing and Urban Poverty Alleviation, 2012). This is expected to increase to 44-48 million units by 2022(KPMG, 2014). Similarly, housing shortages in Pakistan were estimated to be 7.57 million in 2009; 6 million of these are concentrated in BPL groups (Nenova, 2010). In the case of Nepal, it has been estimated that an additional 1 million urban houses will be required by 2021 to meet the housing demand (UN-Habitat, 2011). Apart from the housing shortage, reconstruction due to disasters and extreme weather events along with renovation and aerial expansion of buildings will result in increased demand for materials from the construction sector. For example, floods alone have led to the collapse of over 2 million homes since 2010 in Pakistan.

While the above numbers are baffling, they also mean that the social and affordable housing sector in these cities and towns represent a tremendous and untapped potential for the mainstreaming of green building practices in South Asia. Cleaner technologies exist, and could substantially reduce the ecological footprint of the sector. Adoption of fly ash in bricks, Vertical Shaft brick kilns in brick sector and coke dry quenching technique, DC Arc technology etc. in the steel industry can significantly improve resource efficiency. Alternative building materials, like micro-concrete roofing tiles, stabilised concrete earth blocks and prefabricated roofing elements can reduce the resource consumption by 25-30% (DA-CDKN, 2013). Energy consumption can also be reduced by 30-80% in new and existing buildings by commercially viable technologies (UNEP SBCI, 2007).

2. Low Carbon and Resource Efficient Technologies In South Asia

In the South Asian context the drivers and barriers for adoption of low carbon and resource efficient technologies, more specifically in the countries of India, Nepal and Pakistan do not differ greatly. For Governments to promote sustainable practices in design, construction and operations of buildings, it is essential that focus is given to three major aspects:

- Creation of an enabling policy environment to promote sustainable construction materials and housing
- Strengthen supply chains for sustainable construction materials
- Stimulate demand for sustainable housing

In the comparative regional analysis, case studies of low carbon construction material and technologies were selected for each country. Each case study was looked at through the economic, technological and policy frame, so as to define the critical elements for promoting low carbon development pathways in the construction sector.

2.1 India

Prefabrication: In India, the precast building construction industry is still in its nascent stage. The method of 'prefabrication is an industrialized construction method whereby mass-produced components are assembled into buildings. Such a method of construction is estimated to reduce the generation of construction waste, greenhouse gas emissions, thus making it resource and energy efficient. These materials are used in concrete as cement replacements and which can reduce the amount of cement used by up to 60 percent, thereby reducing the CO_2 emissions produced during the production of cement. Precast concrete has a high thermal and acoustic insulation properties that can result in significant savings by up to 25 percent on heating and cooling costs. The use of this technology is also estimated to bring down the construction cost by 10-15%.

With regard to promotion and usage of this technology, the various stakeholders including Government, private sector, research institutes and financial institutes have played a vital role. National policies like the National Urban Housing and Habitat Policy, 2007 and Housing for All, have played a major role in the promotion of the use of prefabricated products in construction of affordable housing. Further, the Bureau of Indian Standards, have formulated a series of precast products that are available for use in the construction sector.

While, these policies have generated awareness and promoted the use of such materials, it has mainly been the investments made by the private sector that have resulted in the increase in the use of prefabricated products in the construction industry.

Bamboo: Bamboo belongs to the grass family and has been associated with various names such as 'poor man's timber', 'green gold', 'cradle to coffin' because of its various documented applications. Bamboo is widely recognized as highly renewable, fast growing, economic raw material. Bamboo products (bamboo boards, bamboo veneers, bamboo mat corrugated roofing sheets, etc.) due to their physical and mechanical performance in terms of harness, stability and strength are gaining attention with large opportunities in emerging markets. According to the Forest Survey of India (FSI), bamboo grows in 8.96 million hectares of forest area, which constitutes about 12.8% of the total forest area of the country (National Bamboo Mission, 2013).

The National Mission Bamboo Application (NMBA) under the Department of Science and Technology has developed and commercialised technology and applications in the segments of developing bamboo based wood substitutes, development of pre-fabricated bamboo based housing structures and other technological applications of bamboo.

Table 1: State Policies for Promotion of Bamboo

Name of the Policy	Objectives	Approach	Achievements
Tripura Bomboo Policy, 2001	To develop bamboo sector in the State Provide an impetus to conservation; Develop the resources, both in forest and farm areas Improve the utilization of bamboo and Develop effective marketing for the bamboo-based products.	Adopting scientific means (tissue culture) Practicing improved cultivation and management using community based initiatives Establishing small and large enterprises	Inauguration of bamboo Tiles factory Increase in turnover to Rs. 115 crores Setting up of bamboo park Online B2B[2] & B2C[2] marketing through indiamart.com and ebay.com 40,591 persons trained
Tripura Bomboo Mission, 2007	Sustain growth in bamboo sector Increase turnover form Rs. 95 crores to 200 crores Provide production and commercial infrastructure, technology, marketing support, capacity building and product diversification Provide livelihood and employment opportunities	Develop institutional structure Building enterprises on commercially sustainable models Mobilization of private investment in bamboo sector Promoting Plantation	
Kerala Bomboo Policy	Protect and conserve biodiversity Enhance resources Improve bamboo productivity improve and promote traditional bamboo houses and establishment of modern bamboo houses Promote bamboo sector development	Database Development Protection and conservation of Biodiversity Sustainable Management of Resources Resource Resource Enhancement Development of bamboo based industries Livelihood Security of the Bamboo Dependents Enactment of Grower Friendly Rules and Regulation Environmental protection Skill development Scientific Input and Research Activities Publication and Awareness	Approval to conduct Kerala bamboo fest every year. Treatment facilities being inducting Preparation of a data base in the form of an annotated bibliography of bamboo literature.

While the above policies have proliferated the growth of bamboo production in the country, there continue to policy barriers that hinder in the path of the bamboo sector to flourish. These include the Indian Forest Act, 1927, the Forest Conservation Act, 1980, Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 which have posed trade and transit restriction on bamboo. For example, The Forest Conservation Act, 1980 is responsible for the trade restriction of bamboo, as it empowers the central government in directly managing the country's forest and restricts the allotment of forest land for non-forest purposes (i.e. breaking up or clearing of any forest land for cultivation of crops including bamboo).

In addition to hindrance at the policy level, lack of awareness and as well as lack of quality control continue to be key barriers in the mainstreaming of bamboo products and their usage in the construction sector in India.

Flyash bricks: 163. 56 million tonnes of fly ash was generated in India in 2012-2013 (CEA, 2014). Concern over the safe disposal of fly ash has been a priority for the Indian Government. Interestingly, fly ash is a useful raw material that can be used in the construction sector. Its prime use is in the production of Portland Pozzolana cement. Its use in the manufacturing of bricks has resulted in the marketing of fly-ask bricks as an alternative to red bricks. These bricks not only contribute to the conservation of the top soil, but also result in the emission of greenhouse gases during the production process.

According to recent estimates, 2800 fly ash units are present in India which produce close to 6.65 billion bricks annually. The increase in the use of these fly ash bricks has been significant, however, disproportionate across the country. In this regard, the Central and State government have played a vital role in the formulation and implementation of policies and schemes to promote fly ash brick technology. The notification numbered S.O. 763 (E) of Ministry of Environment, Forests and Climate Change and the Fly Ash Mission of the Department of Science and Technology have played a crucial role in the uptake of the technology, through technology demonstrations, easy access to fly ash and mandatory use of fly ash bricks in construction. At the State levels, initiatives by the State government include incentives for fly ash units under their policies and preferential procurement of fly-ash bricks for public construction.

Thus the success in the uptake of this technology has mainly been through the formulation of a coherent policy both at the central and state level. However, for better enforcement of these policies is required for the penetration of this technology into the market.

2.2 Nepal

Hollow Concrete Blocks (HCB): These are a walling material which are used for both load bearing and framed structure buildings. They are essentially precast concrete blocks produced from a mixture of cement, sand and aggregates. HCB uses very little cement to bind the sand and chips and is a good alternative walling material to brick, since it is produced locally and can be produced on a large scale. Further, HCB result in lower GHG emissions than fired bricks and the walls made of HCB have good thermal and sound insulation.

While HCB blocks continue to be more sustainable than fired bricks, their use and penetration into the market is weak. The main reason for this is the stereotype mentality that only bricks constitute as strong structures. Such strong sentiments are true of housing constructions in Nepal. A case in point is the low cost housing initiative of the Government of Nepal. The Government under the 'Housing for People' program aimed at supporting the poor and the marginalised groups and promotion of eco-friendly and cost effective housing in districts of Sarlahi, Mahottari, and Surkhet. However, the initiative failed due to lack of awareness among the communities on the advantages of HCB. The general impression of low cost housing among the people, which includes the lack of awareness on the technology and its benefits, was that low costs meant, lower quality of housing. Thus the community demanded that the government needed to make quality houses using cement mortar and burnt bricks.

Compressed Stabilised Earth Blocks (CSEB): These blocks are manufactured construction material formed in a mechanical press that forms a compressed block out of a mix of fairly dry inorganic soil, non-expansive clay, aggregate and small amounts of cement. These blocks are also good alternatives to fired bricks, and can be cost effective due to their local availability and increased efficiency in production. The wait-time required for the availability of these blocks is minimal as the blocks are readily available after pressing and a short drying period.

As in the case of HCB, CSEB has also not picked up in Nepal in spite of the building material being cost effective and environment-friendly. Here again, the main reason for lack of penetration of this material in the market has been the prejudice in the minds of the people, as earth is considered an inferior material as compared to materials like fired bricks and cement.

Bamboo housing: Traditionally, bamboo along with wood and other materials have been used in building houses in Nepal. While, tradition houses continue to be built with bamboo, in the recent years, the need for building more stable houses has resulted in the increase of houses built of concrete and bricks. Further, while international codes for bamboo buildings has been approved by the International Standard Organisation (ISO), there continues to be a lack of national building codes for bamboo buildings in the country. Without the national building codes, recognising, bamboo buildings, bamboo application in Nepal has failed to penetrate the market. Thus, there continues to be lack of acceptance among the people in bamboo housing, in comparison to acceptance of concrete or brick based housing.

2.3 Pakistan

Vertical Shaft Brick Kilns: As mentioned earlier, the most common construction material that is used is fired bricks. With rising housing demands, the construction industry in 2004-07 grew at a rate of 18% per annum. This is directly proportionate to the increasing demand on the production of fired bricks. While being the backbone of the construction sector, the brick manufacturing industry unfortunately consumes large amounts of top soil, and coal, thereby contributing greatly to the carbon emissions released into the environment. Most of the brick kilns in Pakistan are owned by small scale entrepreneurs, and use inefficient technologies.

Given this pretext, under the Swiss Development Corporation project, Vertical Shaft Brick Kilns were introduced in selected areas of Pakistan. The Vertical Shaft Brick Kiln (VSBK) is an energy efficient technology which used in the production of fired clay bricks. Carbon dioxide emissions of a VSBK are 30% to 50% lower than other kilns, and there is 80% reduction in suspended particulate matter, which is the principle cause of air pollution.

In the case of Pakistan, while environmental impacts of road transport, cement factories, crushers, and solid waste are considered a threat to the environment and human health; discussion around the adverse impacts of brick kilns on the environment is not discussed with much urgency. There is thus a need for not only generating awareness among regulatory agencies, builders/ architects and the general public on the ill-effects of the brick kilns, but also the cost effectiveness and the environmental sustainability aspects of VSBK.

Hydraulic Lime and Earth: Soil stabilization is the process whereby soils and related materials are made stronger and more durable by mixing with a stabilizing agent. In this case lime binders have been proved to offer strength and resilience to building constructions, in addition to greater ecological benefits. Efficient small scale production of lime binders is estimated to have less embodied energy than cement, and easy access to lime since it is locally available, thus reducing transport cost. In addition lime re-absorbs carbon dioxide from the atmosphere during its setting process.

Health and Nutrition Development Society (HANDS) a NGO working to reconstruct damaged or destroyed houses in the most affordable, resilient and energy efficient manner in collaboration with DFID, set out to understand the synergies between disaster risk management and low carbon construction via the use of hydraulic lime. This was a community led programme on generating awareness and as well as capacity building on the use of different disaster resilience and low carbon methods of construction. However, while the intervention was successful, key barriers to the adoption of hydraulic lime were mainly lack of acceptance and willingness to adopt such methods. The main reason for this was the lack of awareness among the people, along with little to no research and development on such materials, and very little support from government bodies and institutions.

Bamboo: The final case study illustrated the architectural, structural, environmental and technical performance of bamboo as a low carbon and disaster resilient alternative to conventionally used material such as steel, cement and bricks. A case in point was the work done by Heritage Foundation- an organisation pioneering the work on bamboo construction in Pakistan via their Green Karavan Ghar initiative. The first project undertaken was in Swat where 300 *Green Karavan Ghar* were constructed in remote mountainous areas from October 2010 to February 2011. Also, over a 100 *Green Karavan Ghar* were also built in a perennially flooded area in Khairpur. Heritage Foundation also constructed floating bamboo structures on stilts as women centres, schools and health facilities. These structures endured the 2011 floods, providing refuge to the community on the upper level while the waters flowed through the stilts – proving that such green structures are not only environmentally friendly, but disaster resilient as well.

2.4 Measures to Accelerate Adoption of Low Carbon Materials and Technologies

Thus given the above context, the overall study has aimed to analyse the drivers and barriers towards adoption of low-carbon, resource efficient and disaster resilient construction alternatives in South Asia.

Policy and Regulatory Norms

India, Pakistan and Nepal are committed to promote alternate and low carbon technologies in the construction sector. However, outdated policies like the Housing Policy of Pakistan (2001) and absence of codes and guidelines are one of the major barriers in the promotion of low carbon construction technologies. Policies and initiatives of India like the National Housing Policy, the 12th Five Year Plan (2013-2017) and the National Action Plan on Climate Change advocate the use of alternate technologies in construction. However, the translation of the mandate to policies and schemes has been minimal.

To remedy this, guidelines should be developed to include the aspects of green construction in policies and schemes. This includes inclusion of standards and specifications of low carbon building materials, low carbon building materials in the Schedule of Rates, adherence to quality standards through eco-labelling systems and mandatory procurement guidelines for the government.

Adaptation and mitigation measures should also be incorporated into local municipal planning and service delivery to promote low carbon construction practices. Carbon considerations should be taken into account in risk reduction, relief and reconstruction would contribute to the potential 'greening' of the sector. This is an important dimension for recognising the benefits that a low carbon economy can bring to developing countries (Ervin, Adhikary & Chand, 2012).

Technology and Capacity

Currently, the construction sector suffers from lack of appropriate technologies and the support by efficient technology transfer. Innovation of low carbon and resource efficient technologies is essential for the transformation of this sector. Several aspects need to be addressed for the successful adoption of these technologies. They include collaborative research, technology demonstrations, access to information and capacity building of workforce. Research on alternate technologies should be encouraged to mainstream them in local context.

The lack of technical capacities is one of the largest barriers facing the sector. Policies should focus on addressing this by organising technical training of masons and engineers on a regular basis. Capacity building of officials for the proper implementation of these policies should be promoted (TARA, 2014).

Market and Finance

The disaggregated nature of this sector throws up challenges with respect to strengthening the supply chain of materials and services. Continuous supply of construction materials can be ensured by setting up micro enterprises. Fiscal incentives and priority financing for Small and Medium Enterprises (SMEs) should also be initiated to facilitate setting up green building material production facilities. Partnerships with banks and other financial institutions should be explored to facilitate easy access of finance to the entrepreneurs.

Quality is a key component in the aggregation of green construction services. Standardised curriculum and a system for certified skills for masons and artisans will go a long way in monitoring and assuring quality. Further, common interest groups and guilds can be leveraged to strengthen this cadre of skilled personnel.

Partnerships
It is vital to promote public-private partnerships (PPP). In such partnerships, the services are delivered by the private sector, while the responsibility of providing service rests with the government. PPP would not only help in commercialisation of low carbon technologies, it would also aid stricter implementation of these policies.

User acceptance of these technologies is the key to its acceptance. However, popular public perception is that low cost means low grade. There is also lack of readily accessible and reliable information comparing alternative structural materials and systems, the benefit of these technologies, its viability in the local context, and the operation processes hinders its growth. Awareness generation targeting users is the need of the hour.

2.5 Conclusion
Thus overall, the several case studies on low carbon and resource efficient materials and technologies from across South Asia, have revealed that the construction sector as a whole is these countries is disaggregated with complex interlinks among both the public and the private stakeholders. While low carbon materials and technologies do exist, their adoption and mainstreaming of these materials and technologies continues to be an uphill task. While policies and markets need to be strengthened, capacity building and more importantly awareness generation is crucial for the successful adoption of these techniques. Thus attention needs to be paid to all stakeholders in the value chain, their coordination and cooperation for mainstreaming the use of low carbon and resource efficient construction materials and technologies, which will thus result in the transition towards more green and inclusive economies.

3. References

http://www.pisd.org.pk/ClimateChangePDF/Climate%20facts%20about%20Pakistan.pdf

DA-CDKN (2013). *Construction Manual for Artisans and Masons*. Development Alternatives; and Climate and Development Knowledge Network

Darko*et al*. (2013). *Green Buildings: A Case Study*. Development Alternatives; Overseas Development Institute

Ervin, B., Adhikary, N., & Chand, B. (2012). Preparation of bamboo reinforced cement composite slab. ABARI Adobe and Bamboo Research Institute. Retrieved from http://www.academia.edu/3719348/Bamboo_Architecture

Girija, Shankar (2011). *Energy Efficiency Initiatives in Buildings*. Bureau of Energy Efficiency

MHUPA (2012). Report of the Technical Group on Urban Housing Shortage (TG-12) (2012-2017). Ministry of Housing and Urban Poverty Alleviation, New Delhi

Nenova, Tatiana (2010). Expanding the Housing Finance to the Underserved in South Asia: Market Review and Forward Agenda. World Bank, Washington DC

Neilsen,. (2010). Study on Construction Trends. Retrieved from
http://www.eebp.pk/PDf/Study%20on%20Construction%20Trends%20in%20Pakistan_1.pdf

Parikh, J., et al. (2009). *CO_2 Emissions Structure of the Indian economy*. Integrated Research and Action for Development

Planning Commission (2013). *'Twelfth Five Year Plan (2012-17) Economic Sectors', Volume II*. New Delhi: Government of India.

TARA (2014). Building Materials and Green Economy. Technology and Action for Rural Advancement and New Economic Foundation

UNEP SBCI (2007). *Buildings and Climate Change: Status, Challenges and Opportunities*. United Nations Environment Programme, Nairobi.

Published by:

Development Alternatives

B-32, Tara Crescent, Qutab Institutional Area, New Delhi – 110 016, INDIA
Tel.: +91-11-26564444, 26544212, Fax: 91-11-26851158
Website: www.devalt.org