A mitigation strategy for the natural disaster of poverty in Bangladesh

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Abstract

Purpose – Aims to bring attention to the problems faced by rural Bangladeshis. Several objectives for the paper were identified. First, to illustrate that Bangladeshis suffer from acute levels of poverty, a lack of clean drinking water and regular flooding and cyclonic conditions. Second, to establish the failure of western "handout" aid provision to address these problems. Third, to evidence the possibilities for the production of more durable building materials utilising regionally available waste materials and proven solar technologies. Finally, to present strategies in which solar technologies could contribute to the reduction of poverty and improvements in health standards.

Design/methodology/approach – The ongoing development and testing of the innovative solar technology concepts reported in the paper were informed by a literature review covering solar cookers and solar kilns. The methodology and detail of the testing of that solar technology is currently considered commercially sensitive. With regard to the poverty alleviation strategies proposed within the paper, their development was underpinned by a methodology combining a thorough review of the relevant literature with input from practitioners in Bangladesh.

Findings – Utilising aid moneys for the establishment of solar technology-based small-scale production of vernacular building materials could address poverty by affording access to wealth-generating activities in the sale of goods and clean drinking water from rainwater harvesting. Additionally, such activities would enable Bangladeshi society to be better able to withstand and then recover from natural disasters, by possessing more resistant shelters, and being more economically resilient.

Research limitations/implications – The experimental component of the research is ongoing and considered commercially sensitive. No limitations have thus far been identified within this component. The implications of the research regarding solar technologies are potentially considerable in that the innovative approach under examination, if underpinned by positive results, represents a new area of activity and has both social and technical implications.

Practical implications – Current aid is not significantly alleviating the problems experienced by Bangladeshis resulting from poverty, arsenic contamination of deep water aquifers and regular flooding. The technology and strategies proposed address the fact that the current vernacular shelters provide little resistance to flooding, and are unsuitable for rainwater harvesting, whilst also allowing participation in wealth-generating activities. Such a combination has the potential to reverse the trend for Bangladesh to increasingly rely on "hand-out" aid.

Originality/value – The value of the paper is largely in the area of bringing new possibilities to the attention of the research and practitioner communities dealing with both solar technologies and developing world poverty alleviation.

Keywords Disasters, Materials management, Rainfall, Solar power, Wealth and income, Bangladesh

Paper type Research paper

Disaster Prevention and Management
Vol. 14 No. 2, 2005
pp. 223-232

0965-3562
DOI 10.1108/09653560510595218

Introduction to the region and its problems

Bangladeshis face problems of low income, a lack of assets such as land and permanent housing, shortages of clean water and adequate food, and an inability to participate in commercial activity (Maxwell, 1999). The average income per capita in 1998 was cited as $266 per annum (British Council, 2002), well below the World Bank's stated absolute poverty mark of $1 per day set in 1985. Population density is approximately 800 persons/Km^2, which when combined with, 65 per cent of the population rely upon agriculture to support them, results in land-use problems (Asian Development Bank, 1999).

Much of the country is less than 5 metres above sea level. Annual flooding covers 20 per cent of the landmass, and in the floods of 1992 over 50 per cent was under water (ISDWC, 2002). These floods wash away crops, pollute groundwater stocks and destroy the vernacular mud-brick and palm-leaf buildings (BSHF, 2001). Changes in global climatic conditions are set to extend their severity (Christian Aid, 2003).

Between 1980 and 2000, Bangladesh has received the equivalent of $38 billion in aid (Benson and Clay, 2003), and yet poverty is actually on the increase (Kazi, 1999). Majumdar (2001) criticised the "dependency" nature of aid to Bangladesh as creating a mindset of "... the more aid we receive, the more we seem to need." If aid is to be effective it may need to be focused upon wealth generation activities. Christian Aid (2003) states that effective disaster mitigation needs to be undertaken from within the community. It also responds to a factor identified by Benson and Clay (2003), that the flooding of 1987, 1988 and 1998 resulted in reductions in development funding as monies become diverted towards reconstruction. Reconstruction of this type will not encourage general wealth creation to offset the resultant depression in agricultural activity. Nor do they represent significant self-help opportunities. Thus, an alternative approach is required.

The Overseas Development Institute suggests that prior to any issuing of aid, participatory poverty assessments (PPAs) should be established (ODI, 2001). PPAs include a broadening of stakeholder involvement and support. Bangladeshis need to benefit from advances in technology, thus requiring aid targeted at self-help initiatives. A historic lack of stakeholder initiative in aid has failed to maximise its effect, and created a dependency culture (Norton *et al.*, 2001). One method of engaging stakeholder activity is by encouraging activities leading to long-term quality of life improvements. The posited approach links both wealth and health improvements through improved standards of shelter (and the quality of materials used) and the supply of safe drinking water.

Poisoned drinking water

Bangladesh's soil is enriched by waterborne silts (ISDWC, 2002). These can contain levels of arsenic higher than the safe limit set by the World Health Organisation of 0.05mg per litre. This has contaminated deep water aquifers drained by long-running extraction of drinking and irrigation water through tube wells. Levels exceeding the safe limit were found in two thirds of the 8000 tube wells tested in the six months up to March 1998 (Islam, 1998).

The potential number of Bangladeshis affected by arsenic poisoning has increased from 65 million in 1998 to 90 million in 2000 (Islam, 2000). This evidences an escalating disaster causing Bangladeshis to revert to unsanitary water. The Islamic Relief Charity

(Islamic Relief, 2004) states that a Bangladeshi child dies from water-related disease every 8 seconds thus indicating the scale of the disaster in terms of loss of life (but without explicit identification of related economic loss) and the desperate need to find a safer alternative supply of water. An alternative supply is by rainwater harvesting. However, the effectiveness of the harvesting process depends upon various factors, one being the construction form of the roof.

Unsubstantial housing

A typical Bangladeshi house would be a small, single-celled structure, mainly constructed of locally available materials such as earth, bamboo, reed and palm leaf (Muktadir and Hassan, 1985). Building commences on a plinth of rammed earth. The earth block or woven panels walls are fixed to the plinth using bamboo poles or timber. A palm-leaf (or golpata) thatch on a bamboo frame achieves reasonable resistance to the ingress of rain, but has a short life span. The porous walls are protected from downpours by the overhang of the roof. Typically, there is no formal drainage, only the capability of the roof to shed water away from the base of the structure.

Much of the housing in rural Bangladesh is essentially temporary due to the inability of the materials used to withstand damage by floodwater. These materials are, however, indigenous, inexpensive and perceived to be in abundant supply. The perception of abundant supply is, however, starting to become erroneous. This is evidenced by a recently commissioned report claiming that stocks of some species of bamboo and rattan have almost disappeared through over-harvesting and land clearance (Nuruzzaman, 2004). The transient nature of the houses acts as a disincentive to supplying fixed services to improve their basic amenities. This is evidenced by the fact that 70 per cent of Bangladeshi families do not have access to an electricity supply (Ahsan, 2004).

Houses in Bangladesh have evolved to suit popular culture, both social and religious, The implementation of different architectural practices (such as western style housing) has not been successful in rural Bangladesh (Muktadir and Hassan, 1985)). A more realistic approach would look to improved vernacular materials that provide better moisture resistance and greater durability. Such materials have the additional potential to contribute to the alleviation of poverty through their having a market value, additional to the provision of shelter capable of withstanding flooding. This will, in turn, reduce the reconstruction cost demand.

Rainwater harvesting

Domestic roof rainwater harvesting (DRWH) is simply collecting of rainwater as it falls upon a domestic roof, prior to storing it for use as drinking water, etc. Vernacular housing has been identified as comprising neither formal rainwater goods (gutters, etc), or suitable "informal" collection surfaces. Thatch roofing, for example, is an unsuitable material to provide a DRWH collection surface for harvesting rainwater (UNDP, 2003). This is due to the fact that contact with organic matter can colour the water. Additionally, biological and chemical contaminants can not easily be removed from such surfaces, even through the flushing action achievable with man-made surfaces (DTU, 1998, 2001).

Roofs manufactured from tiles or corrugated steel sheeting are deemed most suitable. However lead contamination can be introduced by galvanised surfaces

(UNDP, 2003). These could provide a resource (clean water) that can be used directly, and thereby improve sanitation levels. It can also be used indirectly as a means of wealth generation in that clean water has a commercial value. A survey of user attitudes to DRWH cited the additional income achievable through selling water as the joint most important perceived advantage of DRWH (DTU, 2001). Furthermore, one of the problems faced during flood conditions is the absence of clean water (Howard, 2001).

If alternative roofing materials could be manufactured regionally from indigenous materials, the solution to the problem of providing durable shelters could also address the problem of poverty within rural areas, and finance improved shelters through "locking-in" (through a rudimentary property market mechanism) what wealth there is within the region. One approach to producing improved materials would be to utilise a relatively abundant resource (solar energy) through the use of solar kiln technologies

Natural disasters

Bangladesh suffers from flooding on an increasing basis. It is an irony that the most fertile soil in Bangladesh is on the chars located in river deltas (Palakudiyil and Todd, 2003). However access to such fertile soil often brings with it the certainty of flooding. In the floods of 1987 and 1988, millions of hectares of crops were lost, millions of homes were lost and an estimated 45 million people were negatively affected (Brammer, 2002). These natural disasters are compounded by the fact that the region also suffers from regular cyclonic conditions, with 14 major very severe storms occurring in the last century and an annual cyclone risk level of over 10 per cent (Benson and Clay, 2003).

These problems are not exclusive to Bangladesh, as figures show the number of people annually affected by natural disasters in Asia grew by a factor of 35 in the decade 1992 to 2001, and worldwide by a factor of 25 during the same period (Christian Aid, 2003). The reasons for the increase in natural disasters are well documented, with global warming, and the El Nino/La Nina inversion phenomena being cited by many climatologists as primary reasons. It is widely believed that sea levels are set to rise globally at an increasing rate, and this will inevitably result in additional flooding in a low-lying country like Bangladesh.

In Western countries the extent of building losses following flooding may be relatively small. However, due to the nature of Bangladeshi houses, built from thatch, bamboo, mud brick and rattan, losses are much higher as the materials offer little resistance to the flood waters. This is evidenced by reports of major flooding in the UK in 2000 which caused hundreds of millions of pounds worth of damage, but provided no mention of a homeless figure. Conversely, the flooding which affected Bangladesh in 1998 was cited as leaving 40 million people homeless, and the lesser flooding of 2000 was cited as having washed away 300,000 homes (Howard, 2001).

Disaster mitigation

Christian Aid has offered a number of definitions to key terms used when studying natural disasters. The first one is the term disaster.

"The impact of a natural or human-made hazard on a group of people, causing widespread human, material or environmental losses which exceed its capacity to cope using its own resources" (Christian Aid, 2003). On this basis, the ongoing problem of an increasing number of Bangladeshis with regard to arsenicosis (arsenic poisoning)

surely qualifies as a human-made disaster. When viewed in conjunction with the natural disaster of repeated flooding, the problem becomes of even greater significance.

This definition implies two methods of preparing for disasters. First there is preparation to lessen the negative impact of the disaster. The second would be to increase the capacity to cope, through increasing the resources, of those affected by the disaster. This second method in a Bangladeshi context would link disaster preparation directly to the alleviation of poverty, by the building of better quality dwellings, and the establishment of wealth generation schemes.

Christian Aid also defines the term vulnerability:

> The extent to which a person, group or socio-economic structure is likely to be affected by a hazard, (and this in turn is related to the affected community's capacity to anticipate, cope with, resist and recover from its impact). Vulnerability also refers to the strength of physical structures in withstanding hazards (Christian Aid, 2003).

Given that those Bangladeshis most vulnerable to disasters are those most likely to be greatest affected, one way of reducing their vulnerability is to increase the ability of their physical structures to withstand flooding. Christian Aid qualifies this by citing the use of better building materials and construction methods as a way of reducing vulnerability. However they then continue to make the point that vulnerability is mainly an economic situation. "Rebuilding a house or livelihood after an earth quake will also be much more daunting for a poor family than for one with savings and access to social benefit systems" (Christian Aid, 2003). This indicates that reducing vulnerability to flooding, through providing Bangladeshis with durable dwellings, without improving their abilities to generate wealth might not be the most effective solution for disaster mitigation in that region. Disaster mitigation is defined thus:

> Activities, often long term, which aim to reduce the hazard on vulnerable communities, and address the related conditions and their underlying causes (Christian Aid, 2003).

It has been cited that in spite of increasing international aid handouts to Bangladesh, poverty is increasing (Kazi, 1999). It is also cited that increasing poverty can increase vulnerability to disaster (Christian Aid, 2003). It is perhaps to schemes which fulfil the dual roles of alleviating poverty and reducing the effects of disaster that Bangladesh should look.

Using kilns to improve material durability

The use of materials such as brick, clay tiles, building lime (all kiln fired), and lime-based concrete in construction could reduce housing losses due to flood waters. However, such materials are both relatively expensive and attract significant debate with regard to factors such as high levels of embodied energy. Regional alternatives (limestone, silica sand and ceramic clay are local natural resources), are available, and the production of water snails and shellfish is a major Bangladeshi industry providing a waste product (shells) that can be used to produce building lime (Care International, 2002). Current approaches lead to high embodied energy levels, particularly if traditional fuel fired kilns are used. There is a need to consider alternative energy sources (solar, etc.), along with the design of appropriate kilns to utilise them in the production of durable building materials, thus addressing problems of both substantial shelter and clean drinking water. A further benefit would be if these objectives could be achieved without recourse to imported building materials.

Testing the relevance of technology "aid"

Developing countries can be characterised by a scarcity of technically-skilled people, spare parts, transport infrastructure, and funds to cover maintenance. Any technology intended for long-term use should be sustainable and maintainable in the region, beyond the period of the aid project. An example of a locally-used technology that is not sustainable is the so-called brickfields. Bangladesh has approximately 10,000 brickfields using largely wood fuel despite a ten-year-old government prohibition. Approximately 50 per cent of these production units are unlicensed and around 30 per cent of them move annually to new locations leaving ground too polluted to sustain agriculture. Large amounts of soil are also removed in order to extract clay. The government is now seeking to ban all clay brick production within the next five years (Rahman, 2003). Aid-related technology should be seeking to reduce such adverse impacts of indigenous technologies. This paper posits that the appropriate use of solar technologies would allow the continued production of clay products whilst eliminating the high levels of pollution resulting from the current production processes.

The use of solar energy

Solar energy technology has been developed in the region to provide heat for cooking (Poppen and Weiler, 2002). Additionally, work has in the past been undertaken to produce solar kilns for firing ceramics and for producing lime. This utilises the simple and robust technology of focusing sunlight using parabolic mirrors. The Laboratory for Solar Technology at the Paul Scherrer Institute (PSI) in Switzerland has successfully developed an industrial solar limekiln (lime burning requires 900°C), thus evidencing the technology's general feasibility (Maier, 2001). Heating a kiln with solar energy is technically possible. From a practical perspective, kiln capacity is a key factor. This tends to be restricted due to heat losses through the fabric of the kiln. Advances in insulation technology provide opportunities for increasing capacity, as do improvements in design capabilities.

It appears possible to achieve a capacity allowing production of sufficient quantities of quick lime or ceramic goods to enable the producers to benefit financially from the sale of some of the production, and utilise an appropriate quantity themselves. The actual product from a solar kiln depends upon natural and geological resources available (seashells, limestone, silica sand, clay, etc). Products could include building lime, roof tiles, clay pipes, domestic objects, etc. Such goods form the components of rainwater harvesting, i.e. a suitable catchment surface, guttering, pipes and storage vessels. Additional produce could include rice husk particle board and sand-lime materials, both of which require super heated steam in the manufacturing process. In examples such as Auroville, in Tamil Nadu, India, solar reflectors have been used to generate 4,000kg of steam per day for use in cooking. Feeding such energy into simple autoclaves would significantly increase the range of building products possible.

Sand lime: an alternative material

Focus on the production of clay roofing tiles has the benefit of "improving" an existing technology, but does not respond to the problem of environment degradation resulting from extraction of raw materials. An alternative approach would be to consider an abundant raw material; in this case one possibility would be waste from the shell fishing and Ger farming industries. These can be burned in a solar kiln to produce

building lime. Additional to the production of lime wash, mortar and concrete is the manufacture of sand-lime products. These may include bricks, roofing tiles and cladding panels, all produced in a process typically requiring 30% less energy than clay brick production (Contec, 2002). These materials require processing in a steam autoclave. It is therefore feasible in areas where both a source of lime and silica sand are available that solar technology could be utilised to produce alternatives to ceramic products. This possibility frees any aid scheme proposal from being restricted to areas of clay deposits and opens up other avenues for production.

Rice husk particle board

One disadvantage of manufactured roof coverings is the need for regularly shaped members in the roof structure. The small dimensions of the typical rural house result in shorter spans and required joist dimensions. However, any requirement for quantities of structural grade timbers in a country lacking lumber detracts from a totally vernacular production. Technology being developed in India uses rice husks to produce a particle board for use in building processes. It is claimed that such boards out-perform their timber-based rivals in the areas of strength, durability, moisture resistance, fire resistance and dimensional stability (NRDC, 2003). With the proviso that a moisture and biological attack resistant binding agent can be sourced locally, the availability of waste rice husks would provide an opportunity to produce another construction material that is indigenous.

Establishing production

Thus far this paper has proposed investigation of a scheme which could help reduce levels of poverty on three fronts, and provide disaster mitigation. Providing funding for schemes which purely provide disaster mitigation without wealth generation could not service loan funding. Regional production of simple building materials could enable the construction of shelters which will resist flood damage. These products could thus facilitate rainwater harvesting, reduce dependency on contaminated water supplies and ensure continuity of supply even during periods of high ground water levels. Finally the sale of surplus materials and clean water, particularly valuable during and in the aftermath of flooding, would provide additional income, which would both provide for continuity of the development funding and put the recipients in a better economic position to recover from the effects of flooding. The latter factor could determine the success or failure of any project, and its effectiveness in disaster mitigation. The raw materials proposed are mainly waste products, and the energy source utilised has few cost-in-use implications. However, supply and maintenance of the required equipment, even if subsidised by aid moneys, still carries a capital charge. In Bangladesh a number of schemes operate to fund the poorest of people in setting up wealth generating activity.

The Grameen Bank, financing the setting-up costs

The Grameen Bank provides credit facilities to the poorest Bangladeshis in schemes based not upon collateral but upon potential (Yunus, 2004). By tailoring loans to the needs of the poor, utilising unique features like not penalising borrowers who require more repayment time, caps on interest charges, not pursuing loans when the borrowers die, writing off losses due to flood damage and collecting repayments in small weekly

amounts, a Grameen loan helps the borrower develop their economic capacity. Loans are supplied on an individual basis to members of commercial groups of at least five members, suitable for building material production cooperatives. With capital in 2003 of US$ 60.98 billion and 1.195 branches (Yunus, 2004), it has the required funds and infrastructure to operate in the region.

The stated aims of the Grameen bank of improving housing, setting up small businesses, and supporting technology are also compatible with the strategy posited here (Raina, 2003). With sufficient will from the international community to provide aid, and credit facilities available for likely beneficiaries, such wealth generation schemes could succeed. However a commercial return is required. The majority of the produce would be used to provide more durable shelters and access to rainwater harvesting facilities. A pivotal factor may be the price a small producer can expect for any surplus materials, as this would be required to repay any outstanding credit. Large international construction companies are currently engaged in infrastructure and other construction projects in Bangladesh. If these companies could be persuaded to put something back into the host country's economies by supporting locally produced building materials, such a market could ensure financial success.

Conclusions

Issues of poverty alleviation and disaster mitigation in Bangladesh are twinned. One method of mitigating disasters is to increase the availability of resources, to those who are vulnerable. Another method is reducing levels of vulnerability by the production of durable shelters which better resist the effects of a natural disaster.

Many Bangladeshis are living below the absolute poverty level. Their poverty can be identified as including a lack of opportunity to engage in wealth generating activity, insubstantial shelter and a lack of access to uncontaminated drinking water. Additionally, due to its geographical location, it is regularly subjected to cyclonic weather and flooding which washes away crops and the vernacular housing. The regional production of building materials using solar energy and mainly waste raw materials could provide the basis for alleviation of some or all of these problems. This offers an opportunity for some of the poorest Bangladeshis to engage in activity which does not reduce the effectiveness of their primary agricultural activities. This attracts an economic cost, which. Some could partially be subsidised from aid monies. Additionally there are regional credit facilities suitable for purchase of equipment. There is a regional need for such schemes to be successful, the availability of the right conditions, i.e. sunshine and large amounts of waste raw materials, a will for the international community to provide Bangladesh with aid monies, and an internal facility to provide the poorest Bangladeshi with business capital. The final element is the refining of existing technology to produce solar equipment which is economically viable and sustainable in rural third world settings and materials which will provide better moisture resistance and greater durability. Such materials have the potential to contribute to the alleviation of poverty through their having a market value. Improved shelter will reduce the reconstruction cost demand.

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