28th WEDC Conference Kolkata (Calcutta), India, 2002

SUSTAINABLE ENVIRONMENTAL SANITATION AND WATER SERVICES

Sustainable infrastructure development for slums and villages

H. Parikh, D. Surkar and M. O. Zanders, India

IMPROVEMENT OF THE quality of life of communities living in urban slums and villages throughout India is an ever growing challenge. Almost 85% of the population, comprising 70% living in rural areas and 15% living in urban slums (about half of the total urban population) lack access to basic services like safe water, sanitation, roads. Even after 55 years of independence and when India's 10th five-year plan is coming into effect, the situation is far from satisfactory. Most of the people in rural India defecate in the open and women spend hours fetching (often unsafe) water. Infrastructure provision to existing settlements can transform human habitat at a fraction of the cost of rebuilding whole settlements. The catalytic government and community investment in infrastructure in turn stimulates massive community investment in its own shelter, toilets and other facilities, substantially and rapidly impacting on health, education and incomes.

Slum networking – The approach in cities

Slum Networking links slums and the natural drainage paths that influence infrastructure and environment. The slum matrix is seen as a catalyst of change for the entire city rather than isolated, problematic pockets. It exploits the slum fabric in the context of the total city for sustainable, cost effective improvement in quality of life by converging scales, activities, agencies and resources.

The concept integrates basic services like networks for house-to-house water supply and underground sewerage, storm water drainage, roads and paving, landscaping, solid waste management, and streetlighting. Implementing these components in an integrated manner, coupled with topography management ensures cost effective, sustainable systems.

The majority of cities have strong natural drainage paths. Without these, towns would drown in their own waste long before they ever grow into cities. The paths are nature's own means of disposal and, if properly exploited, are ideal routes for the infrastructure systems of sewerage, storm drainage, water supply and roads as well as providing the environmental skeleton of city green spaces and water bodies. Studies of several cities in India and in other parts of the world showed that slums are consistently located along these natural paths. Once this connection between slums, urban infrastructure and environment is understood, it is easy to see how slums can be used to transform cities. The objective is not to find solutions unique to the slums but, instead, explore the commonality between the slums and the better parts of the city, integrating the two. Slums are not the cause of urban degradation but a consequence of distorted development so solutions must treat the slums as symptoms and use them to work back into the city fabric to the origin of the problem.

The spread of slums over a city together with contiguity between slums gives an opportunity to strengthen city level infrastructure networks. Because of the close correlation between the slum locations and the natural drainage paths of a city, low cost service trunks, particularly for gravity based systems of sewerage and storm drainage, together with environmental improvements such as creation of fresh water bodies, cleaning up of polluted rivers, development of green pedestrian spines and restoration of waterfront structures can be built up. The slums benefit from the improved city level support. For the city, the slums offer opportunities of change through this symbiotic process.

Unconventional concepts such as topography management, earth regradation and constructive landscaping are used; these, coupled with the locational attributes of the slums relating to the watercourses and the marginal lands, have certain ramifications. The natural watercourses and low-lying areas tend to form nuclei around which slums cluster. By sensitive treatment, several advantages are possible. Firstly, areas prone to flooding can be improved by earth regrading at marginal costs. For example, a conventional storm drainage system for the city of Baroda, planned to alleviate the flooding would need over US$10 million. However, there is already a natural drainage system permeating deep into the city which can be activated with nominal efforts at a cost of only US$ 0.8 million. Secondly, the natural drainage paths are the most efficient routes for the gravity based city drainage with the advantage that the problems of land acquisition and demolition normally encountered in built up areas are avoided. In Indore city, by providing the missing links between the slums, it was possible to build up city level sewerage at costs less than half those of a conventional system. This in turn intercepted the sewage from polluting a stretch of the river, enabling the creation of water bodies and gardens.

Based on lessons learnt by 'Himanshu Parikh Consulting Engineers' in a city wide Slum Networking project for Indore the concept was evolved and replicated by the group in pilot projects in Baroda, Ahmedabad, Mumbai and currently in Bhopal, covering over 70,000 families. The approach won the UN World Habitat Award in 1993, was recognised as a Best Practice by UNCHS HABITAT II in 1996, won the Aga Khan Award in 1998 and has been cited as a Global Best Practice by UNHCS as well as by the Government of India in 1998.

People public private partnership in Ahmedabad

Ahmedabad, in the state of Gujarat, is a large city of 3.3 million people (about 1.5 million live in slums). The pilot project in Sanjay Nagar was a joint effort between the slum communities, Ahmedabad Municipal Corporation and Arvind Mills Ltd., a major industry. They determined the development and shared the costs. Local NGO 'Saath' and professionals from Arvind Mills were intermediaries. This combined the participating parties' strengths, with roles varying according to the nature and scale of the task. At the slum level the community played a pivotal role in the process. Consortia of industries and NGOs took up the execution on behalf of the communities within the design framework established by the Corporation. In a country where city development falls strictly within the purview of governments, this is a very bold transition, which could have far reaching consequences. The Corporation set up a parallel execution cell to bid for the works. This competition will improve the overall quality and also enable the Corporation to build up a long-term implementation structure, which is both efficient and sensitive.

The pilot project was completed successfully within a year. The actual cost of the integrated infrastructure package was Rs. 6,170 per family, of which the community contributed one third. Following infrastructure development, the residents have already invested an average of Rs. 20,000 on upgrading their own houses.

The project in Sanjay Nagar slum was studied for its impact on the 1,200 inhabitants. Incidence of illness went down considerably; death rate among the children of four years or less declined sharply from 70% to 41 %. Enrolment of schoolchildren went up, especially of girls. Average income per household within the community rose by 36%. Water has brought about a shift in daily chores. Bathing, washing clothes and mopping the floor are now daily rituals. There are no more fights over water. Having a toilet at the doorstep, people do not have to walk to go to relieve themselves or regulate toilet timings. Time saving, energy saving, improved hygiene, safety and improved surroundings are the effects of the new drainage facility.

Replicability and sustainability

Slum Networking has made a tangible impact in improving the quality of life of a large population and has demonstrated its potential with respect to upgrading the entire slum matrices within a finite time-frame and revitalising the service infrastructure and environment of the city as a whole. The projects show that the slum fabric can be used effectively from the community scale to the city level. With the proactive participation of the slums in the process, the activity of urban renewal is being weaned away from aid support to self sustenance.

Convergence is also used for resource mobilisation. With the help of NGOs, the community thrift groups are being organised into savings and loan societies. Links are established between these societies and financial institutions such as Self Employed Women's Association (SEWA) and Friends of Women's World Banking. Indeed, the pilot at Ahmedabad would not have been possible without SEWA providing the bridging finance to the community. Nationally, a housing finance body has shown willingness to finance all the partners to meet their shares of the costs.

The approach in rural areas

There are many similarities between the poor urban and rural communities in terms of the levels of infrastructure, settlement patterns and community structures. Hence 'Slum Networking' is applicable for providing integrated services in the rural areas. A typical package would consist of water supply and underground sewerage networks for individual connections, storm drainage, roads and pavings, sewage treatment plant, earthworks and soft landscaping, solid waste management, and streetlighting. Roads, storm drainage and sewerage are co-ordinated to natural gradients for economy with improved function. The relatively inexpensive measures such as cut and fill, site grading and landscaping also have substantial environmental impact. Such Village Infrastructure Development Plans have been prepared for three coastal villages in Gujarat which are part of the 'Ghogha Regional Water Supply and Sanitation Project' supported by the Netherlands Government.

Water supply

At present villagers, mostly women and girls, have to queue for water and carry it home. Lack of ownership of public taps results in neglect. To overcome these difficulties, water networks would be provided from which the villagers would be encouraged make individual connections at their own expense. The considerations are:

- Trade offs are made between the supply pressures, terminal pressures and the pipe diameters. To balance pressures across the distribution system, looped rather than branched networks should be used in. Advantage is taken of the site topography to reach towards equipotential in the systems such that the site slopes compensate the frictional losses.
- Existing sources of water such as wells and ponds should be retained so that the demands for non-drinking water can be augmented.
- For internal networks, materials are used that reduce chances of damage by providing pre-connections and with other suitable protections. Water and sewerage networks should be separated so that, in the event of leakage, the water supply is not contaminated. Sewerage is deeper than water pipes and separated in plan so that leaks do not contaminate water supply.

Sewerage

Underground sewerage is absent in most villages. Sewage, sludge and storm water collects on the street or in open drains, which are usually blocked, creating serious health and safety risks. The number of families having individual toilets is very small and there are a large number of families who defecate in the open. There is a huge demand from the families, especially from the women, for better sanitation facilities even if that entails contributions from them. It is proposed to introduce underground shallow sewerage in the villages and to encourage individual families to build their own toilets and connect. The design considerations are:

- Design sewerage for low initial supplies to attain cleansing velocities of 0.4 to 0.6 m/s. For initial runs where flushing velocities are not achievable, provide reasonable minimum slopes. To achieve shallow sewerage and yet maintain flushing, the concept of 'tractive force' is used. Shallow sewers have been successfully used in Slum Networking projects in India and have also shown success in the cities of Latin America where they have been tried.
- To achieve the cleansing velocities in the initial runs as quickly as possible, star pattern collection is suggested to accumulate the flows. At the terminal ends, once the flows have built up, the main trade off is between the pipe diameters (which must not run more than half full) and the slopes, which generate deeper excavations and dearer manholes.
- Excavation depths are reduced and pumping costs (capital, running and maintenance) be avoided by designing sensitively to the terrain.
- Expensive drop manholes, vent shafts and flushing tanks are reduced by modifications to designs.
- Small, inexpensive intercepting traps replace inspection chambers for house connections, which account for about 25% of the sewerage cost. These traps are placed at the doorsteps so that the misuse at entry points, which account for the majority of blockages, is controlled directly by individual families rather than local authorities.

Roads

The roads are proposed in cut below the surrounding ground. Normally roads are raised above the ground level and the plot holders in turn fill up their plots even higher. In the event they do not, water logging is common which, apart from physical inconvenience, is the root cause of many diseases. The roads are engineered to slope continuously down so that the water reaches the natural water courses, partly on the road surface and partly supplemented by the pipes when the storm loads increase. Internal roads or footpaths ensure that all houses have clean, paved access. The basic design considerations are:

- All roads to be placed in excavation sloping downwards. Thus sewer, storm drains and manholes remain shallow and cheap. The expense of road filling, which may be as much as 25% of the total road cost, can be avoided
- Road act as storm channels, whilst the soft margins attenuate the rain peaks. Underground storm drainage is partly taken over by roads. Road sections with curbs are more durable.
- Fill needed for earthworks is partly generated from the road excavations rather than from outside, saving transportation costs. Road base thickness can often be reduced because the virgin ground is likely to have greater bearing capacity than fill.
- Cheaper concrete paving replaces expensive asphalt where possible. Concrete roads are easier to clean and more durable provided that the expensive reinforcement is replaced by frequent movement joints. The concrete is treated like stone paving to increase its flexibility and to permit part water absorption during storms. The technology of the concrete roads is such that the local masons living in villages can participate in the construction.

Storm drainage

Underground storm drainage is minimised by using contoured roads as channels and to increase the ground recharge on road verges, to reduce the storm loads. Soft landscaping, such as grasses, is introduced as it absorbs more water and reduces its speed of flow, thus reducing the peak flows in the storm systems. Piped drains are only applied when storm water loads increase.

Rootzone Sewage Treatment Plant

Sewage treatment comprises an artificially constructed and lined wetland planted with common reeds (*Phragmites australis* or Karka). The sewage flows through a bed of either soil or gravel in which the reeds grow. The treatment is mainly biological as the reed roots break down the sewage, hence 'root-zone', though filtration through the soil bed also helps the treatment. The treatment requires considerable land but becomes an attractive option because of the negligible running costs as the reed plants are almost self-sustaining. The process is environmentally friendly and free from the nuisance of mosquitoes and smell as it is subsurface.

Earthworks and soft landscaping

An allowance for the landscaping of the road verges is made. The community would be encouraged to landscape the common areas and the verges in front of the houses. Plants can improve the microenvironment; trees shade the streets and reduce the dust in the air; decorative trees and plants add to beauty; vegetable, herb and fruit plants can supplement families' needs. Landscaping is also used as an engineering tool. By sinking the roads below the adjacent land, the excavated material can be used to fill up the low-lying areas and re-grade the slopes, helping drain water towards the roads and the storm systems instead of ponding. Grass gives a clean and firm surface at a fraction of the cost of hard paving. Compared with paved surfaces, grasses absorb more water and reduce its speed, thus reducing the peak flows in the storm systems and check silt erosion.

Solid waste management

Solid waste management is a vital service from the point of view of hygiene and environment, yet, often neglected. The problem cannot be solved by mere installation of dustbins. This project envisages landscaping to bind earth on open spaces, which reduces solid waste on streets, siltation in the pipes and improves road aesthetics and village level organisation of waste collection.

Lessons learnt

- Provision of basic infrastructure, delivered through use of partnerships between people, public (government) and private sector, is the fastest mover of development in the disaster-prone inhumane living conditions of most slum dwellers worldwide. Subsequent health and educational interventions will enhance the development of these communities even further. However, if basic facilities are not present these latter programmes would be meaningless.
- There is a strong relationship between the natural topography of settlements and infrastructure. If constructively exploited, this can deliver economic, well functioning and low maintenance infrastructure.
- People living in slums and villages should not be branded as 'poor' since it may lead to dependency. The so-called `poor' have shown that in conducive circumstances, they can mobilise huge resources for changing their own lives. This latent strength needs to be tapped for quality solutions in preference to implementing substandard measures determined through the `poverty' mindset.
- The key for community involvement is to offer tailor-made solutions. This may sound difficult for large-scale implementation but it is possible to adapt the standardised solutions into tailor-made ones through careful and rigorous design inputs.
- Water and sanitation services should be designed for individual access. Individual facilities can be offered as against community facilities with very little incremental cost. People have better control and ownership of individual facilities. They are better maintained and hence the losses are minimal.
- The systems should be designed for minimal aftercare to make them sustainable.
- Slum Networking is more capital intensive than other social development programmes. It requires several partners to work together and demands strong commitment. Due to their different backgrounds and working cultures these partnerships are vulnerable and usually do not sustain beyond the project period.
- Designs have to be worked to a detailed level, discussing community needs and technical viability, so as to avoid conflict at later stages. They may have to be revised several times before finalisation.

References

Parikh, H.H. (2001) *Slum Networking – Using slums to save cities. In Frontiers in urban water management: Deadlock or hope?*, Symposium Proceedings, IHP-V/ Technical Documents in Hydrology, pp. 238-245. UNESCO, Paris.

Parikh, H.H. (2002) *Village Infrastructure Development – An Introduction. Report for Ghogha Water Supply and Sanitation Project,* Community Management Support Unit, Gandhinagar.

Tripathi, D. and Jumani, J. (2001) *Change After Alliance – Sequel to Alliance for Change.* pp. 10-29, Tata McGraw-Hill Publishing Company, New Delhi.

UNDP-World Bank, Water and Sanitation Program – South Asia. (1999). Baroda Citizens Council. *In Credit Connections: Field Note.* pp. 11-16, New Delhi.

HIMANSHU PARIKH, India

DILIP SURKAR, India

MARIE-ODILE ZANDERS, India