Journal of Construction in Developing Countries, 19(2), 33–50, 2014

MGNREGA and Water Management: Sustainability Issues of Built Forms in Rural India

Banhi Chakraborty[1] and *Sutapa Das[2]

Abstract: Compared to urban sustainability, rural sustainability has traditionally received inadequate attention, especially in developing countries such as India. Because of their symbiotic relation with the local climate and landforms, vernacular structures of rural India are said to be inherently sustainable. However, since 2005, substantial amounts of intervention brought about by the Mahatma Gandhi National Rural Employment Generation Act (MGNREGA) have changed this situation. India's rural landscape is now intersected with numerous built forms, such as road networks, water management systems, and land development. Unfortunately, the MGNREGA's goal of addressing the substantial void that characterised rural areas and bringing about a sustainable future through the generation of the multiplier effect have not been achieved in most cases. This study was conducted to investigate the reasons for this unexpected outcome. Water management, constituting the major thrust of the MGNREGA, was examined for two purposively selected areas with distinctively different physio-climatological variations at the micro level from the state of West Bengal. The data from the MGNREGA website and from field investigations show a short-term benefit, whereas sustainability issues on a long-term basis remain a concern. Straight-jacketed norms for scheme implementation ignoring physical heterogeneity across the country appear to be a major cause. Reframing and customisation of construction specifications are recommended as a solution.

Keywords: Agro-climatic, MGNREGA, Rural structures, Sustainability, Water management

INTRODUCTION

Over the years, concern for sustainability has sought attention in various policy studies at both the national and international scales. So far, the discussions held are concentrated on the urban context and the reason for this is very clear. Because urban areas act as engines of growth and draw huge development resources, the probability of decay also tends to be high; therefore, the revival of this growth-generating inertia is always given greater importance. Nevertheless, the faster spread of urban functions eroding rural tranquillity remains unnoticeable in general (Girardet, 2001), except for in policies in a few countries, among which is the UK Government's recent approach to sustainable rural environmental protection (Lincolnshire Research Observatory [LRO], 2008). Unfortunately, similar concern is absent in India mainly because of very low occupancy rates or because of the low intensity of built environments in rural areas. However, the specific focus toward sustainable rural environment management in tandem with socio-economic up-gradation of the majority of the population still appears to be a difficult task not only for developing countries, including India, but also in general.

[1]Department of Architecture & Regional Planning, Indian Institute of Technology Kharagpur, West Bengal, INDIA
[2]Department of Architecture and Regional Planning & Department of Infrastructure, Indian Institute of Technology Kharagpur, West Bengal, INDIA
*Corresponding author: sutapa.d@gmail.com

Until recently, the Government of India (GOI) did not feel the need for a separate, specific strategy for sustainable rural development. Furthermore, no concern was shown in identifying the effect of urban sprawl on the surrounding rural areas even though this has become an emergent crisis. The approach adopted so far in this country has been Five-Year Plans to provide interim strategies for overall development, where the need for policies for sustainable infrastructure as basic elements for rural development has received the least attention (Das, 2002). However, sustainability has become a vital element in the planning process since the Ninth Five-Year Plan 1997–2002 (Planning Commission, 1997), and only after the World Summit for Sustainable Development (UN, 2002) did the government initiate a process of preparing and implementing national strategies for sustainable development with concern toward macro-level carrying capacity.

A series of environmentally concerned policies and institutions along with special attention to biodiversity protection policies were taken by the GOI as precautionary measures. However, no initiative that adopts locally sound and viable development techniques as the most essential component for sustainable development programmes was taken. In fact, rural areas are yet to be considered as important geographical entities that deserve equal attention from all other development interventions. If the growth in equity and sustainability is taken as an essential step toward a mutually supportive development process, there should be no question of any trade-off between urban and rural environments (Kearns and Turok, 2004). This research attempts to visualise the viability of a recent development strategy, the Mahatma Gandhi National Rural Employment Generation Act or MGNREGA (National Rural Employment Generation Act [NREGA], 2013), which was conceptualised as a serious intervention policy for enriching the rural economy as a sustainable economy by introducing rural infrastructural facilities, such as road connectivity, water harvesting systems, drought proofing, irrigation, de-siltation of canals, and land development.

RURAL SUSTAINABILITY

No precise definition has evolved to make explicit the idea of "rural sustainability". Considering sustainability as a universal principle for any type of development intervention with no limitations concerning time, space or community, the definition commonly used in urban sustainability contexts may also be taken as equally relevant for rural scenarios. Urban suitability was defined by Camagni, Capello and Nijkamp (2001: 128) as "the process of synergetic interaction and co-evolution among the basic sub-systems that constitute the city-namely the economic, the social, the natural and built environment – which guarantees a non-decreasing welfare level to the local population in the long-run without jeopardising the development options of the surrounding territories, and which contributes to the reduction of negative effects on the biosphere". Hence, echoing urban sustainability, rural sustainability may be perceived as "the process of synergistic interaction and co-evolution among the basic sub-systems that constitute the rural areas – namely the economic, the social, the natural and built environment – which guarantees a non-decreasing welfare level to the local population in the long run without jeopardising the development options of the surrounding territories, and which contributes to the reduction of the negative effects on the biosphere".

Similarly, the conceptual framework as defined for the development of the Alpine region in Europe may be considered relevant for the context of India's rural areas. The terminology used by Onida, Imhof and Chomienne (2011: 6) in a report for defining sustainable rural development is such that "sustainable rural development is generally recognised as the product of those human activities that use the resources of rural territories to increase the welfare. Development can be considered as sustainable if it meets the needs of the present generation without compromising the ability of future generations to meet theirs. Rural development is the key tool for encouraging diversification and innovation in rural areas. It aims to reverse depopulation process, stimulate employment and equality of opportunities, respond to growing requests for better quality, health safety, personal development and leisure, and finally improve the quality of life of Alpine populations".

Chambers and Conway (1991) have described urbanisation as a burden on poorer countries and as a threat to rural areas. They also predicted that there will be much less focus on rural areas than on urban agglomeration, which will neither reduce urban pressure nor bring sustainable livelihood to rural areas. According to the authors, sustainability means "self-sufficiency and implicit ideology of long-term self-restraint and self-reliance. It is used to refer to life styles which touch the earth lightly; to organic agriculture with low external inputs; to institutions which can raise their own revenue; to processes which are self-supporting without subsidy". Chambers and Conway (1991: 5) use sustainability in a more focussed manner in the context of livelihood as "the ability to maintain and improve livelihoods while maintaining or enhancing the local and global assets and capabilities on which livelihoods depend".

The authors also referenced the argument put forth by Brundtland (1987: 5) at the closing ceremony of the 8th and final meeting of the World Commission on Environment and Development, where it was stated that "...interventions needed to achieve sustainable development must be conceived and executed by processes that integrates environmental, social and economic considerations" and that higher priority should be given to the underprivileged. People should be included in the decision-making process at all levels.

Thus, sustainability as a term has many connotations and is subject to many interpretations. Nevertheless, it is understood that be it rural or urban, sustainability has become a top priority of policy actions globally. However, it cannot become an absolute identifiable object for economic progress without considering the means and areas of application. Hence, what is sustainable for the Arctic region may need to have entirely different criteria for the Sahara Desert even though the goal is the same. From this very basic argument, it is apparent that sustainability approaches must be defined in relation to country-specific norms, having sufficient flexibility in application and specific feasibility even at the micro-level. Although the term "customisation" is often used in the construction industry to ensure the safety and competency of sustainable built forms (Dingsdag et al., 2008), it has little basis in rural contexts. For example, customisation principles have only been adopted in the Indian rural context in the Prime Minister Gram Sadak Yojna, or PMGSY, of 2000 (National Rural Roads Development Agency [NRRDA], 2010) for connecting major nodes by paved roads through the rural landscape. Hence, understanding the relevance of sustainability with respect to the principles of customisation appears as an obligatory norm irrespective of the scale and area of operation.

Unfortunately, this rarely occurs because the forward planning is considered to be more dynamic. Onida, Imhof and Chomienne (2011) noted that "the planning profession is unlikely to be in the front-line of those encouraging sustainable rural developments of the kind envisaged" here in the sense that "sustainable forms of land-use can be implemented on any scale, and controlled with any effectiveness". However, minimal literature has addressed the impact of rural sustainable built forms (Camagni, Capello and Nijkamp, 2001). In common parlance, it refers to human-made surroundings that provide the setting for human activity, ranging from large-scale civic environments to personal structures (Moffat and Kohler, 2008). In the context of New Zealand, the built environment includes both urban and rural elements together, although the scale of elements varies from small rural service centres to large cities. However, the case of developing countries, including India, is slightly different.

India's Rural Built Environment and Critical Gaps

Rural built environments in India are traditionally characterised by smaller concentrations compared to their urban counterpart. The environments typically consist of low-density vernacular buildings along with few asphalt/paved roads, culverts, water-arresting embankments etc. Among the minor structures, water harvesting tanks and canals produce pictures mostly of earthen structures, except for the dug wells. The comparatively much lower priority of rural infrastructural needs was a major issue that contributed in retaining such undisturbed scenarios in contrast to vigorous urban growth. Because infrastructure development and economic growth are closely related (Srinivasu and Rao, 2013), the condition remaining as such has not only pushed the majority into poverty but has also enhanced urban congestion with growing migration. However, policy details as well as information concerning the achievement of programmes toward infrastructural services for rural areas have been grossly lacking until the Eighth Five-Year Plan (Planning Commission, 1992). The serious lapses that occurred in rural infrastructure services are due to a lack of comprehensive approaches in all of the last Five-Year Plans, except for piecemeal solutions performed through Community Development Works or Rural Development Programmes in different phases of earlier Five-Year Plans (Infrastructure Development Finance Co. Ltd., 2007).

Until 2000, only 40% of the roads in India were all-weather roads (concrete and asphalt), serving 825,000 villages, whereas an existing 2.7 million km of roads are on the verge of decay (Planning Commission, 2012). The major gaps in India's infrastructure services in rural areas are in the accessibility of safe drinking water, power connectivity to households, telecommunications, water and sanitation facilities and transportation services (National Council of Applied Economic Research [NCAER], 2007; Planning Commission, 2011). Since the Ninth Plan (1998–2002) introduced PMGSY (NRRDA, 2010), rural areas have observed the construction of major thoroughfares connecting to major nodes, whereas attention to arterial roads and intra-village connectivity was not considered at the time. The Bharat Nirman Programme was adopted in the later stages during 2005–

2006 to further revamp the infrastructure services, where the provisioning of electricity could be extended to 18,374 villages in the country as a whole through the newly launched programme of Rajiv Gandhi Grameen Vidyutikaran Yojana, or RGGVY (Planning Commission, 2011). Power availability in terms of number of days varies between an average of 16% in Assam to 80% in Kerala, whereas in West Bengal, it is 45% during monsoon season only. During 2003, approximately 90% of villages received public telephones, whereas inter-state variations ranged from two to 31% for accessibility (NCAER, 2007).

Regarding the water supply in rural areas, occasional attempts have been made to address the scarcity of potable water since the first Five-Year Plan (1951–1956); however, until 2005, approximately 4,588 habitations were not covered, and 50,479 were only partially covered, whereas by 2011, 55,067 new habitations were covered under the Accelerated Rural Water Supply Programme (ARWSP). However, this is partially due to the spread of peri-urban areas, and partly due to the launching of a government initiative through the reformed National Rural Drinking Water Programme of 2009–2012 (Department of Drinking Water Supply, 2010). Swajaldhara – a demand-driven programme was taken up under this programme to provide connectivity to uncovered habitations and in critical areas where the quality of water is poor. For enhancing irrigation systems, the Accelerated Irrigation Benefit Programme was launched in 2009–2010 to serve critical areas and drought-prone areas through a watershed development process (Planning Commission, 2010). In spite of these attempts, as envisaged through different schemes/programmes, deficiencies in terms of imbalances in the overall distribution in infrastructural services remain a critical issue of concern for the government.

However, only after the launching of the MGNREGA in September, 2005 has the country started to witness substantial increases in the number of rural roads, water harvesting structures, embankments and check dams. In contrast to the previous initiative of PMGSY (NRRDA, 2010), the MGNREGA has a much wider coverage for infrastructure along with other necessary developments. Hence, the relevance of understanding the implications of newly constructed built-up forms appears as a significant area of interest.

OVERVIEW OF THE MGNREGA

The MGNREGA is a novel departure from conventional welfare schemes of the GOI, with an inclusive approach of livelihood generation through the creation and restoration of natural resource endowments and the enhancement of rural infrastructure and the economy. The scheme guarantees 100 days of wage employment in a financial year to a rural household whose adult members participate in unskilled manual work. The rational of this massive and holistic mission was to serve the unserved habitations in terms of basic infrastructural needs. The list of permissible works, which include the following eight thrust areas, were initially adopted in 2005 and later expanded by many other schemes during 2013 (Ministry of Rural Development, 2005; NREGA, 2013):

1. Water conservation and management.
2. Drought proofing mainly through afforestation.

3. Irrigation canals, including micro and minor irrigation works.
4. Irrigation facility to lands owned by the underprivileged.
5. Renovation and de-silting of traditional water bodies.
6. Land development.
7. Flood control, including drainage in waterlogged areas.
8. Construction of all-weather rural roads, including culverts.

The performance of the programme in terms of coverage is good. Rural India now has 98.08 km of roads and 0.21 million water harvesting tanks with a capacity of 94.5 million cu.m. A total of 78,000 old water tanks/ponds with provisions for a storage capacity of 183.6 million cu.m have been renovated. In addition, the greening of barren or deforested lands, levelling of land for cultivation, earthen embankments (bunds) for arresting flood water, contour bunds, and the provisioning of irrigation to people from schedule castes and schedule tribes are some of the noticeable features now commonly observed in villages. This is a remarkable achievement compared to historical efforts in rural India. Table 1 details the status of the programme taken up for asset building based on 2011–2012 data.

Table 1. Physical Asset Built Under MGNREGA for the Financial Year 2011–2012

Work Category	All India	West Bengal	East Medinipur	West Medinipur
New water harvesting tanks (Numbers and volume in cu.m)	1,883,064 (691.02)	43,816 (1698.77)	4,725 (993.00)	3,245 (2989.00)
Renovated water bodies (Numbers and volume in cu.m)	395,521 (1,866.25)	35,054 (2.09)	2,097 (890.00)	7,669 (1760.00)
Flood control bunds (Numbers and length in km)	192,476 (9.34)	1169 (33.29)	1,735 (0.57)	890 (0.35)
Irrigation canals (No. and length in km)	446,053 (22.94)	11,722 (1.92)	920 (0.68)	1,040 (0.80)
Irrigation to lands of SC/ST (Nos. and area in ha)	868,483 (15.05)	15,858 (1.99)	5,391 (2.26)	2,435 (0.27)
Drought proofing (Nos. and area in ha)	886,724 (5.84)	100,194 (2.84)	1,733 (0.50)	1,145 (0.65)
Rural roads (No. and length in km)	1546875 (30.84	77,540 (0.88)	4,711 (0.59)	11,200 (0.52)
Land development (Nos. and area in ha)	686418 (9.40)	24,745 (4.61)	1,213 (0.56)	3,029 (1.23)

SC/ST = Scheduled castes/Scheduled tribes
Notes: Figures in the brackets indicate average size or length per work
Source: NREGA, 2013

Once the major issues are tackled in a phase-wise, comprehensive manner, the MGNREGA programme is expected to bring a net change in a holistic form, leading to sustainable rural livelihoods in all respects in the following manner:

1. Water resource conservation will help in adding more arable lands.
2. Furthermore, increased land capacity will be attained by increasing the green index (forestation).
3. Greater connectivity will facilitate the mobility of the people, not only by enhancing year-round activities but also by fulfilling additional infrastructural needs.

Constraints of MGNREGA

However, the expectations from the MGNREGA were not completely realised during its initial years because the returns from the assets were not uniform throughout the country (Table 1). The gains were positive in favourable pockets, but they were marginal in disadvantageous situations, the reasons being mostly generic. The works taken up during the last six years of the MGNREGA have opened up greater livelihood opportunities through the increased availability of wage income, but the issues related to physical assets and their performance levels are not sufficient. General concerns about the dissatisfactory returns (Agarwal, 2010) are discussed in the following section.

Most of the constructions are non-durable mainly due to inadequate time frames and a lack of fund utilisation (Bassi and Kumar, 2010) for basic maintenance of the facilities. The inappropriate selection of work is responsible for the partial success and cost overruns from, for example, the incorrect selection of plant varieties for drought proofing (Singh, Joshi and Joshi, 2012). Inadequate supervision during execution has added to this problem, and the main aim of the MGNREGA has been lost (Pankaj, 2012).

Return on investment (ROI) – the basic success factor for any investment, specifically construction projects, was not given equal priority irrespective of the work category. A study conducted by Verma (2011) in four states showed 100% effectiveness for the 6-year cumulative performance, whereas in the asset-wise breakdown, the ROI varied across different projects. Notably, water studies were taken as the most successful efforts, but the reliability of such findings is low because they were limited to only the best performing states. Moreover, ROI-based decisions are overly generalised, lacking precautionary measures, such as physio-climatological conditions (Verma, 2011) at micro-levels and technical expertise, which in turn determine the performance and durability of any structure. Therefore, cost recovery is also likely to be affected (United Nations Development Program, 2010). Factors related to the technical feasibility of work in relation to land quality and micro-climate were not properly addressed (Kareemulla et al., 2009).

The variations in ROI between new and renovated studies have also been observed in some cases (Verma, 2011) and are an indirect indicator of the deviation of the execution of works from the planned one. Interpreting this, it appears that the new works are usually performed on a short-term basis, as per MGNREGA mandates (limited time, employment generation and fund release), whereas the old works achieved through individual effort or as private ventures were performed with due diligence and articulation. Therefore, with minimal replenishment, those structures perform much more efficiently. Hence, the concerns or controversies identified so far through different research studies can be summarised as follows:

1. Employment generation overshadowed minimal technical criteria. Schemes formulated for universal application without allowing for adjustments based on situational variations stand as perhaps the basic constraint in achieving the MGNREGA objectives.
2. ROI (more precisely, the physical output) was affected because works were undertaken ad hoc to meet annual targets with no provisions for onsite testing for the applicability of schemes.
3. Earth structures are more susceptible to climatic conditions and hence require extra precautionary measures to ensure durability and sustainability. Unfortunately, the MGNREGA, until now, has neither adopted any measure of pre-work feasibility studies of land conditions to prescribe suitable construction specification nor has it proposed any post-construction evaluation to estimate the realisation of adequacy level.

By analysing the above consequences as well as constraints arising from the MGNREGA's norm-abided execution procedures, the present research attempts to explore the factors that impede the outcomes of sustainable built-up structures. The following issues have been taken up as major target areas of the current study:

1. Selection of the schemes and their appropriateness in relation to their site of application.
2. Identification of any gaps between prescribed construction procedures and end outcomes, i.e., the performance of built-up forms.
3. Evolution of the appropriate measures to achieve the maximum benefits.

STUDY DESIGN AND APPROACHES

Two broad approaches have been adopted to fulfil the basic objectives of this research, the primary one being the micro-level introspection for which two different areas have been critically selected to examine the implications of landform situations on the attainment of efficiency. Both the areas are in the state of West Bengal, India and are under two different Gram Panchayats, or GPs (governing body at village level), but with contrasting micro-climatic and geological structures based on soil type, ground water table etc. being examined. The basic details of the study areas are presented in Table 2.

Second, out of all eight stipulated studies of the MGNREGA schedule of 2011–2012, observations have remained limited for the water management works. The attention toward the water-conservation-related works comprising restoration of traditional water bodies, check dams for the arresting of flood water, deepening of irrigation to SC/ST, beneficiaries of Indira Awas Yojana (IAY) housing scheme and beneficiaries of land reform (LR), which are the major types of the eight listed works (up to 2011–2012). These works were given higher priority after considering the agrarian base of India. Moreover, the works were selected based on their mutual functional complementarities in achieving sustainability, which is the top priority as per MGNREGA. This is also performed with the expectation that increasing all of the above-mentioned provisions will help in creating a demand for more transactions of goods and services and will ultimately result in a multiplier effect.

Table 2. Comparative Details of the Selected Study Areas

Details	Case Study Area A	Case Study Area B
Location	District: East Medinipur Block: Patashpur-I GP: Chistipur-I (10 revenue villages)	District: West Medinipur Block: Nayagram GP: Kharikamathani (16 revenue villages)
Geo-hydrological characteristics	Low lying alluvial, riverine plain	Undulating dry lateritic terrain
Height (mean sea level)	6 m	40 m
Soil	Clayey alluvial	Coarse lateritic gravel
Climatological condition	Moist-sub humid	Semi-arid
Ground water table (min)	2.133 m	18 m–20 m (semi-critical to critical)
Slope	1%–3%	5%–7%
Run-off co-efficient	0.0–0.1	0.0–0.3
Usage	Mainly agriculture (two to three crops)	Mono-cropped, partially cultivated, barren with sketchy forest covers
Existing water source	Dug-out ponds and tube wells	Few tube wells and shallow water ponds
Infiltration/Percolation	Slow seepage	High percolation rate

Data Collection

This study is based on a detailed field investigation conducted from November 2011 to April 2012 followed by a repeat survey in September to October of 2012. This period from November to April is a lull period for cultivation and can be used as the acid test of the MGNREGA's aim to provide work during off seasons. Moreover, this timeframe allowed direct observations to be made during the execution of water management works. In addition, their efficiency could be observed after construction. Information was obtained considering both quality and quantity. For the quantitative assessments, the rationale of the distribution in terms of quantities and requirements of the area was considered, whereas for the qualitative assessment, different stakeholders of the programme were interviewed.

Investigation Procedure

An open-ended questionnaire was used to obtain the opinions of the people and stakeholders based on a "face-to-face" approach using the Delphi concept. Here, the respondents are land owners, landless-labours, non-farm workers and Panchayat chiefs, i.e., people who are responsible for implementing the MRNREGA in their area, and their beneficiary. Hence, these people at the grass-root level were considered to be the best subjects to interview to evaluate the success of the scheme. The advantage of such a procedure is that it helps the respondent groups to disseminate their individual opinions, which ultimately led to a consensus being built on a particular problem/issue, combining all the major opinions.

The procedure in this approach comprises two stages of interactions. The first stage is to obtain general observations from each group, whereas in the second stage, interactions were classified into sections based on their social identity. Because the stakeholders are from different groups, differences in opinions are supposed to emerge depending on their personal interests and benefits. The purpose of the grouping is based on two considerations:

1. The position in social hierarchy groups and stakeholders are variant, which determines to what extent the receiving dimension varies with the social positions.
2. Therefore, it is also expected that the participation or level of involvement in the developmental programme also correlates with their possibility of receiving benefits.

For example, water harvesting is more beneficial to the owner of a tank compared to landless people or those not having any access to it. Screening is performed to determine all the major concerns, and to obtain directions based on emerging concerns, on-sight investigations were performed.

Before site visits were performed, the GP records were reviewed to note work-wise estimated targets and actual outcomes. The on-site investigations included the following: (1) measuring of the structural forms with measuring tape and testing of the quality of material used (observations followed by verification from a Junior Engineer appointed for the purpose), (2) testing the level of compactness by hitting and scratching sides/slopes and surface tops of roads and (3) measuring of dug-well water levels to estimate the ground water level during both pre-monsoon and post-monsoon periods (which fall within the survey period). A similar task was adopted for measuring the water retention capacity of open water tanks. The measurement of all structures was performed both times in the first year of the post-construction period (with special attention paid during the drier period of the second year). This was performed to gauge the efficacy of water management works that are supposed to be achievable through planned management and perfect implementation. All the measurements and observations were performed at three time points: (1) prior to the execution of the MGNREGA work in December of 2011, (2) during the construction phase, i.e., in April–May of 2012 and (3) during the post-monsoon period of September–October of 2012, which was a repeat survey. The data obtained from field investigations were further compared with standard guidelines and rules (Table 3). Note that indigenous methods adopted for the quality evaluation were purposively selected considering the MGNREGA guidelines whereby the use of machines/instruments is restricted.

Table 3. Comparative Details of the MGNREGA Water Management Works in Study Areas

Details	Desirable Specification	Case Study Area A	Case Study Area B
Flood protection	Embankment height above surface > normal flood water level (1.22 m in Area A)	10 bunds 1. Avg. length 1.8 km 2. Avg. capacity 2592.56 cu.m 3. Avg. height 0.91 m	One bund 1. Length 2.96 km 2. Capacity 4946 cu.m 3. Height 0.92 m
Canal / channels	The desired basin depth is 1.22 m–1.70 m (As specified by GP office)	Three diversion canals 1. Avg. length 0.90 km 2. Avg. depth 1.26 m	Five irrigation channels 1. Avg. length 4.37 km 2. Avg. depth 0.73 m
Dug out pond / tank	Basin depth is 2.14 m in Area A and 3.05 m–3.70 m in Area B with bed lining to reduce percolation rate (CGWB, 2010)	Only two 1. Capacity 3500 and 5000 cu.m (avg. 4250 cu.m) 2. Avg. length 33.12 m 3. Avg. depth 3.83 m	27 new and six renovated 1. Avg. capacity 353 cu.m 2. Avg. length 15.2 m 3. Avg. depth 2.18 m

Avg. = Average

OUTCOMES IN AREA A

Despite this area being a low-lying alluvial tract, drought is not a prevalent problem, and no significant work has been performed to prevent this problem. Water management works here mainly include flood protection through the use of embankments, de-siltation of existing tanks and a few dug-out tanks (Table 3). The land situation as depicted in Table 2 explains the characteristics of this soil quality as being alluvial-silt. The rate of percolation, hence, is also insufficient (as mentioned in the same table). Therefore, the works shown in Table 3 are considered to be suitable for the area.

Major works are comprised of water diversion canals and flood protection measures. Because traditional water bodies are already innumerable in number in this alluvial region, only two new canals were constructed, and additional emphasis was placed on flood protection. For this purpose, a total of 10 schemes have been adopted. These are all earthen bunds made to arrest the flow of flood waters from higher elevations. The length of these bunds vary from 0.80 km–3.90 km, with the maximum width being 1.22 m. The depths in most cases are inadequate, reaching 0.61 m–1.00 m, thereby attaining a maximum of 1.00 m–1.70 m for the total height of the bunds and the average height above the surface is 0.91 m. Hence, there is a shortfall in the required height of 0.16 m–0.30 m, which is necessary to stop flood waters at 1.22 m above the surface. This may be because the excavation range of between 1.00 cu.m–1.75 cu.m per man-day is 4%–28% less than the estimated quantity.

In the case of water conservation, only three water diversion channels with earthen embankments were built (0.30 km to 1.0 km long) in three different villages. In all cases, the desirable height of 1.5 m was not achieved due to the 8%–22% lesser amount of excavation (1.20 cu.m–1.40 cu.m per man-day). The water table of the area is potentially high: 2.8 m (normal) to 20 m (during dry seasons). The clayey soil increases the water retention capacity. During heavy rain, water overflows the embankments because of their low heights. In the case of heavy flush, the top cover becomes washed away each year, removing a minimum of 21.6 cu.m of earth; hence, the structures become susceptible to further erosion during subsequent flushes. As a result, the loss of water from the upper reaches causing water logging in lower reaches has become a chronic problem and in turn causes the overflowing of water bodies/tanks. This poses additional hindrance for the local livelihood concerning fish breeding despite an ideal soil pH value of 6.6–7 being available.

OUTCOMES IN AREA B

This area is located in one of the drought-prone areas and has a characteristic hard lateritic soil with undulation. The northern side of the administrative boundary is bordered by deep forest of indigenous plants and is comparatively higher than the southern and eastern part of the rest of the Panchayat area. Because of this slope pattern (varying from 5% to 7%), there are seasonal floods every year, whereby a large part of the lands lying in the south and west are affected during certain times of the year (July–September). This situation is in stark contrast to other areas that fall under this GP where the crisis is severe. The crisis is not only limited to agricultural lands but also to potable water availability. Mostly shallow water ponds and a small number of tubewells are used to mitigate this problem. Because of the undulation of a greater part of the land surface, the runoff coefficient is also comparatively higher than in Area A, and the percolation rate is also high. The undulating land and lateritic soils combine to result in a ground water table that is too low (8 m–20 m minimum), whereas in the summer, it decreases further. The details of the area are shown in Table 2.

There were 35 water management works, including (1) the renovation of six traditional water bodies and construction of 27 new dug-out tanks, (2) one irrigation source for scheduled caste/schedule tribe beneficiaries, (3) excavation (repair) of five shallow (0.61 m–0.91 m) irrigation channels and (4) construction of one earthen bund covering almost all the 16 mouzas, or administrative zones, under the selected GP.

For the water harvesting and conservation tanks, the capacity varied from 849.86 cu.m to 3665 cu.m for the renovated tanks, but the newly excavated ponds have storage capacities of only 108 cu.m–987 cu.m. As a result, the average value of 353 cu.m falls far below the requirement of a small neighbourhood because the minimum annual requirement of a five-member household is 73 cu.m (40 litres per capita per day), as per Indian standard (Bureau of Indian Standards, 2007).

The depth was only 2.13 m–2.74 m (average 2.18 m) (Table 3), for which the storage capacity is much lower than the required amount by 26%–30%. The summer ground water table varies from 50 m–70 m. In addition, the aquifer is highly limited and discontinuous. Because of the shallow depth and the higher percolation rate of lateritic soil, the water retention capacity of these tanks is very low. At the most, water persists in the tank beds for three to four months, depending on the volume and a rarely available impervious layer. Five small- to medium-sized irrigation channels along with one three-km-long irrigation canalcum-flood-water-drainage channel were excavated, for which the depth is also inadequate.

DISCUSSION

The merits and demerits, as noted from the field study, from both of the areas were compared with relevant standard specifications. This information helped in identifying any deficiency in the programme as well as in formulating the recommendations. Because drought proofing through forestation is considered to be one of the contributing factors in the restoration of soil-water capacity, its focus has been omitted from the purview of the present work. Hence, a discussion excluding drought-proofing activities may limit the proper analysis of the effectiveness of water management works.

In Area A, aquifer-fed tanks have sustained water reserves throughout the year. Here, replenishment of water from underground aquifers is very fast, and a depth of 2.00 m–2.50 m is considered to be adequate. The scenario is altogether different in Area B, where a greater depth of 3.05 m–3.70 m is needed along with a bed lining to reduce the percolation rate (CGWB, 2010). Here, the increased seepage of water from the ponds makes them unsustainable unless there is sufficient discharge by surface runoff and unless greater excavation depths and measures for the reduction in percolation rates are jointly adopted.

The depth of the water conservation tanks depends on the catchment area and the soil quality (Baba Amte Centre for People's Empowerment, 2006). The water harvesting tanks constructed as per the MGNREGA guidelines lack these technical qualities, a problem that is prominent in Area B. A biased focus on norm-compliance for employment generation within the annual fund has resulted in mismatches between the execution process and technical adherence, the consequence of which is further reflected in the emergence of non-viable structures, as discussed in the following section.

1. Without defining the catchment areas and calculating the adequate storage capacity, disproportionate numbers of tanks are dug based on individual demand, leading to low water retention in dry regions such as Area B. Here due to high percolation rate of the soil, greater amount of run-off gets lost and only a small fragment is stored in the tanks. This can neither meet the daily water demand nor help in recharging the ground water.
2. The higher evaporation rate, especially in these dry areas, due to inadequate vegetative cover on the land surface further affects the accumulation rate of in-built storage.
3. Within budget constraints, the adequate depth of the tanks is not usually achieved, and only 12%–20% of the works are properly completed. Simultaneously, the size of ponds is limited by the small size of land under private ownership.

IDENTIFIED DEFICIENCIES IN THE MGNREGA

The in-built deficiencies of the programme design in general and technical flaws in particular are responsible for the inefficient structures being only partial successful.

Deficiency in Programme Design

Perspective planning as an integral part of the MGNREGA norm was not accompanied by any systematic study of the areas with reference to geo-hydrological variation and was not performed on an agro-climatological basis. For wage determination, the general soil condition was taken as a parameter (hard or soft), but no estimation was performed on the determination of the pond capacity in relation to the suitability of the land condition given by the soil structure and texture.

Although the maintenance of created assets is permissible under the MGNREGA, funds often become exhausted for new constructions, and almost no funds are left for maintenance, which is traditionally deemed as a "necessary evil" – an obligatory cost burden (Moua and Russell, 2001). Hence, no early intervention can be performed for early prevention; therefore, the lifespan of the assets becomes uncertain. Furthermore, because the structures are basically earthen built forms, the chance of aggravation tends to increase, thereby threatening sustainability.

Technical Deficiencies

Technical factors associated with the construction works covered in this study have been discussed in previous sections. The factor of geo-hydrological variation in the areas was not properly addressed by the MGNREGA guidelines before publication of the new MGNREGA Draft 2012 Guidelines (Ministry of Rural Development, 2012). Hence, the prior estimation of rainfall, size of catchment area, evaporation rate (min. 40% of the total rainfall), percolation rate in areas of coarser soil, and spillage in low-lying alluvial zones (Area A), all of which are considered as mandatory for estimating the dimensions of water harvesting ponds (Pacey and Adrian, 1989), remain unaddressed by implementing local GPs. Concerns about the low-quality structures and non-durability were also raised by many earlier researchers (Agarwal, 2010; Ambasta, Shankar and Shah, 2008; Bassi and Kumar, 2010). As a result, the executed construction works are mostly incomplete with reference to the defined size, capacity and manner of implementation.

SUGGESTED MEASURES

Any water conservation work must be made mandatory through a comprehensive framework of watershed planning. Instead of creating innumerable, fragmented small and non-viable ponds under individual ownership, policies should be focussed on constructing community-owned water harvesting assets in areas with a scarcity of water or with a $<10\%$ gentle slope (Pacey and Adrian, 1989). This will ensure the maximum runoff from the designated catchment area and the proper artificial recharging of the ground water table. However, the articulation at the policy level of the decision-making process may bring success even with manual labour and when using inexpensive indigenous materials if design and construction strategies are wisely formulated on a case-by-case basis.

The storage capacity of water bodies does not rely solely on the depth. Delineation of the catchment area governing the general slope pattern, vegetative cover, evaporation rate and runoff coefficients are considered as essential technical parameters. Both lateritic and alluvial soils must arrest high percolation rates, seepage and erosion. However, lateritic zones are more vulnerable. The first two issues can be addressed using proper side lining, such as using 100 to 250-micron-thick polythene sheets. Traditionally, seepage in lateritic soil is prevented by applying a 150-mm-thick mixture of white sand, silt and lime to the tank beds and sidewalls. In the lateritic areas, mulching and plantation are very effective in stopping sloughing down or subsidence of the soil of pond banks. Common species of *Cucurbitacea* plants (e.g., bottle gourd and pumpkin) cover the soil surface with larger leaves, and *Ipomoea batatas* (sweet potato) has a net-like root system that tightly grips the soil, preventing it from being denuded. In clayey alluvial zones, embankments must be stabilised with a combination of bamboo plugging and wire mesh such that a greater height can be achieved to prevent overflows of flood water.

CONCLUSIONS

The evidence discussed in the current study led to an important understanding that the planning and implementation of developmental interventions under the MGNREGA have progressed a long way insofar as transforming a declining economy into a sustainable one in the last six years. The venture has brought many positive changes to the rural environment through the investment of nearly INR 400 million a year for building a number productive stock, but it failed to bring the expected effective return.

The incorporation of schemes was essential, but these suffer from a lack of prudency in execution. A substantial number of examples of uncontrolled numbers of water structures without sufficient catchment area, inadequate sizes leading to insufficient storage capacities, and planting of non-indigenous plant species causing further depletion of water reserves in water-scarce areas can be found, ultimately resulting in low rates of return (Dreze and Khera, 2009).

The building of sound rural assets would have been a significant achievement if a plan having minimal scientific approaches were designed well in advance based on principles usually adopted in modern construction practices. Here, the concern is more about customisation based on local requirements rather than on cutting-edge design or construction techniques. For example, the minimum customisation measures adopted for road construction under PMGSY of 2000 could have been considered by the MGNREGA to produce better results. In brief, it is argued that a more diversified intervention with due flexibility or adjustability in application at the micro level is expected to bring about the novelty of the MGNREGA programme.

REFERENCES

Agarwal, H. (2010). *National Rural Employment Guarantee Act: A Review*. Available at: http://www.policyproposalsforindia.com/article.php?article_id=169&languageid=1 [Accessed on 2 November 2013].

Ambasta, P., Shankar, P.S.V. and Shah, M. (2008). Two years of NREGA: The road ahead. *Economics and Political Weekly*, 43(8): 41–50.

Baba Amte Centre for People's Empowerment. (2006). *Watershed Works Manual MGNREGA*. New Delhi: Baba Amte Centre for People's Empowerment, Samaj Pragati Sahayog.

Bassi, N. and Kumar, M.D. (2010). NREGA and rural water management in India: Improving the welfare effects. Occasional Paper No. 3–0910, Institute for Resource Analysis and Policy, Hyderabad, India.

Brundtland, G.H. (1987). *Address at the Closing Ceremony of the Eighth and Final Meeting of the World Commission on Environment and Development*. Tokyo, Japan, 27 February. Available at: http://www.regjeringen.no/upload/SMK/Vedlegg/Taler%20og%20artikler%20av%20tidligere%20statsministre/Gro%20Harlem%20Brundtland/1987/Address_at_Eighth_WCED_Meeting.pdf [Accessed on 20 December 2013].

Bureau of Indian Standards. (2007). *IS 1172 (1993, Reaffirmed 2007): Code of Basic Requirements for Water Supply, Drainage and Sanitation (Fourth Revision)*. New Delhi: Bureau of Indian Standards.

Camagni, R., Capello, R. and Nijkamp, P. (2001). Managing sustainable urban environments. In R. Paddison (ed.). *Handbook of Urban Studies*. London: Sage, 124–139.

Central Ground Water Board. (2010). *Ground Water Scenario of India 2009–2010*. Faridabad, India: Ministry of Water Resources, Government of India.

Chambers, R. and Conway, G.R. (1991). Sustainable rural livelihoods: Practical concepts for the 21st century. Discussion Paper 296, Institute of Development Studies, Brighton, UK.

Das, K. (2002). Endowments and rural infrastructure: Issues today. In S. Morris and R. Sekhar (eds.). *Indian Infrastructure Report 2002: Governance Issues for Commercialisation*. New Delhi: 3iNetwork, Oxford University Press, 188–195.

Department of Drinking Water Supply. (2010). *National Rural Drinking Water Programme, Movement Towards Ensuring People's Drinking Water Security in Rural India: Framework for Implementation*. New Delhi: Ministry of Rural Development, Government of India.

Dingsdag, D.P., Biggs, H.C., Sheahan, V.L. and Cipolla, D.J. (2008). *A Construction Safety Competency Framework: Improving OH&S Performance by Creating and Maintaining a Safety Culture*. Austria: Cooperative Research Centre Construction Innovation.

Dreze, J. and Khera, R. (2009). The battle for employment guarantee. *Frontline*, 26(1): 3–16.

Girardet, H. (2001). *Creating Sustainable Cities*. Devon, UK: Green Books.

Infrastructure Development Finance Co. Ltd. (2007). *India Infrastructure Report 2007: Rural Infrastructure*. New Delhi: 3iNetwork, Oxford University Press.

Kareemulla, K., Reddy, K.S., Rao, C.A.R., Kumar, S. and Venkateswarlu, B. (2009). Soil and water conservation works through National Rural Employment Guarantee Scheme (NREGS) in Andhra Pradesh: An analysis of livelihood impact. *Agricultural Economics Research Review*, 22: 443–450. Available at: http://purl.umn.edu/57501 [Accessed on 19 May 2013].

Kearns, A. and Turok, I. (2004), Sustainable communities: Dimensions and challenges. *ERSC/ODPM Postgraduate Research Programme Working Paper 1*. London: Economic and Social Research Council, Office of the Deputy Prime Minister.

Lincolnshire Research Observatory (LRO). (2008). *Lincolnshire: A Changing and Challenging Landscape*. Lincoln, UK: LRO.

Ministry of Rural Development. (2012). *Draft MGNREGA Operational Guidelines 2012*. New Delhi: Ministry of Rural Development, Government of India.

———. (2005). *The National Rural Employment Guarantee Act 2005 (NREGA): Operational Guidelines*. New Delhi: Ministry of Rural Development, Government of India.

Moffat, S. and Kohler, N. (2008). Conceptualizing the built environment as a socialecological system. *Building Research and Information*, 36(3): 248–268.

Moua, B. and Russell, J.S. (2001). Comparison of two maintainability programs. *Construction Engineering and Management*, 127(3): 239–244.

National Council of Applied Economic Research. (2007). *India Rural Infrastructure Report*. New Delhi: Sage.

National Rural Employment Generation Act (NREGA). (2013). *National Rural Employment Generation Act*. Available at http://www.nrega.nic.in [Accessed on 15 June 2013].

National Rural Roads Development Agency (NRRDA). (2010). *Pradhan Mantri Gram Sadak Yojna, Rural Roads Project II: Environment and Social Management Framework*. New Delhi: NRRDA.

Onida, M., Imhof, R. and Chomienne, J.P. (2011). Sustainable rural development and innovation. *Third Report on the State of the ALPS: Convention Held in March 2011*. Special Ed. Available at: http://www.alpconv.org/en/organization/conference/Documents/PC45_B6a_short_en_fin21_1.pdf?AspxAutoDetectCookieSupport=1 [Accessed on 9 April 2013].

Pacey, A. and Adrian, C. (1989). *Rainwater Harvesting: The Collection of Rainfall and Run-Off in Rural Areas*. London: Intermediate Technology Pub.

Pankaj, A. (2012). Demand and delivery gap: A case for strengthening grass-roots institution in Bihar and Jharkhand. In A.K. Pankaj (ed.). *Right to Work and Rural India: Working of the Mahatma Gandhi National Rural Employment Guarantee Scheme*. New Delhi: Sage Publication, 101–128.

Planning Commission. (2012). *12th Five-Year Plan 2012–2017*. New Delhi: The Planning Commission.

———. (2011). Bharat Nirman and flagship programmes. In *India Human Development Report 2011: Towards Social Inclusion*. New Delhi: The Planning Commission, 129–136.

———. (2010). *Annual Report to the People on Infrastructure 2009–2010.* New Delhi: The Planning Commission.

———. (1997). *Ninth Five-Year Plan 1997–2002*. New Delhi: The Planning Commission.

———. (1992). *Eighth Five-Year Plan 1992–1997*. New Delhi: The Planning Commission.

Singh, S., Joshi, V. and Joshi, K.N. (2012). Working of the employment guarantee scheme in Rajasthan: Some grass-roots experiences. In A.K. Pankaj (ed.). *Right to Work and Rural India: Working of the Mahatma Gandhi National Rural Employment Guarantee Scheme*. New Delhi: Sage Publication, 129–148.

Srinivasu, B. and Rao, P.S. (2013). Infrastructure development and economic growth: Prospects and perspective. *Journal of Business Management and Social Sciences Research*, 2(1): 81–91.

United Nations (UN). (2002). Paper presented in the *Report of the World Summit on Sustainable Development*. *UN Report A/CONF*. Johannesburg, South Africa, 26th August–4th September.

United Nations Development Program. (2010). *Impact Assessment of Mahatma Gandhi National Rural Employment Guarantee Scheme on Sustainable Asset Creation and Livelihood.* India: Institute for Development of Youth Women and Children and Embark Advisors Pt. Ltd.

Verma, S. (2011). *MGNREGA Assets and Rural Water Supply Security: Synthesis of Field Studies in Bihar, Gujrat, Kerala and Rajasthan*. Anand, India: International Water Management Institute.