Synthesis Report

Environmental Benefits and Vulnerability Reduction through Mahatma Gandhi National Rural Employment Guarantee Scheme

by

Indian Institute of Science, Bangalore

in collaboration with

Ministry of Rural Development, Government of India and
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

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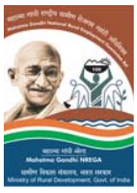

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Participating Institutions

Indian Institute of Science (IISc), Bangalore, Karnataka
Central Research Institute for Dryland Agriculture (CRIDA), Society for Community Organization and People's Education (SCOPE), Andhra Pradesh and Rural Development and Panchyat Raj Department, Karnataka
Indian Institute of Forest Management (IIFM), Gramin Vikas Trust (GVT), and Rural Development Department, Madhya Pradesh
Foundation for Ecological Security (FES), Bhilwara and Department of Rural Development, Rajasthan
Voluntary Health Association of Sikkim (VHAS), and Rural Management and Development Department, Sikkim
Deutsche Gesellschaft für International Zusammenarbeit (GIZ), New Delhi
Ministry of Rural Development (MoRD), Govt. of India

The study on the environmental benefits of MGNREGS and reduction of vulnerability to climate risks was initiated at the request of the Ministry of Rural Development (MoRD), Government of India. MoRD representatives participated in consultation workshops and provided guidance and inputs for the study. We acknowledge the support provided by the Rural Development Departments of the States of Andhra Pradesh, Karnataka, Madhya Pradesh, Rajasthan and Sikkim in identifying study areas, providing vital insights both during the conduct of the study and the state level workshops.

GIZ provided technical inputs as well as the financial support for the study. GIZ team participated in all the consultation workshops for designing the study, joined field visits during the study period, and contributed to the analysis of the results.

Indian Institute of Science developed the methodology and guidelines for conducting study on the environmental benefits and vulnerability reduction potential of MGNREGS programme. IISc also coordinated the study and prepared the synthesis report with support from all the partner institutions. The institutions and the research teams involved in the studies are given below.

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Executive Summary

The Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) aims at enhancing the livelihood security of people in rural areas by guaranteeing 100 days of wage-employment in a financial year to a rural household whose adult members volunteer to do unskilled manual work. The Act also seeks to create durable assets to augment land and water resources, improve rural connectivity and strengthen the livelihood resource base of the rural poor. The Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) works are largely focused on land and water resources, which include: water harvesting and conservation, soil conservation and protection, irrigation provisioning and improvement, renovation of traditional water bodies, land development and drought proofing. These MGNREGS works have the potential to generate environmental benefits such as ground water recharge, soil, water and biodiversity conservation, sustaining food production, halting land degradation and building resilience to current climate risks such as moisture stress, delayed rainfall, droughts and floods (Tiwari et al., 2011; MoRD, 2012).

Objectives and study area: The main objective of this assessment was to generate empirical evidence from different parts of India with diverse agro-climatic and socio-economic characteristics, to assess the potential of MGNREGS to deliver environmental benefits to promote conservation of natural resources, sustained water supply and food production, in addition to sustained employment and livelihoods. The study is also aimed at assessing the potential of MGNREGS works to reduce vulnerability to climate risks. Here the findings of studies assessing environmental benefits generated through implementation of MGNREGS works and their implications for reducing vulnerability to climate risks, conducted in the 4 districts of the selected 4 states namely, Andhra Pradesh (Medak), Karnataka (Chitradurga), Madhya Pradesh (Dhar) and Rajasthan (Bhilwara) are presented. The total size of the beneficiary sample households included in the study is 2057. A case study of South District, Sikkim is presented separately since the types of MGNREGS works implemented are distinctly different from the 4 other states and also the scale of the works is small. In contrast to many other studies, the focus of this study is not on the institutional, social, equity, financial transparency and accountability aspects of MGNREGS.

Institutions involved: This synthesis report prepared by Indian Institute of Science (IISc), is based on the five state studies conducted by different institutions; Andhra

Pradesh (Central Research Institute for Dryland Agriculture and SCOPE), Karnataka (Indian Institute of Science, JRDS and SRUDS), Madhya Pradesh (Indian Institute of Forest Management and GVT), Rajasthan (Foundation for Ecological Security and IISc) and Sikkim (Voluntary Health Association of Sikkim and IISc).

Explanation for the study: "Ecosystem service" is the ideal concept to be adopted but it has a very broad scope incorporating regulatory, provisional, supporting and cultural services. Thus, in this study, the term "environmental benefit" is used to include the impacts of MGNREGS works related to natural resources and production systems. Natural resources include soil, ground water, surface water, grazing lands, forests, etc., and production systems include crop, livestock and plantations. The MGNREGS 'works' include all the activities or programmes implemented under MGNREGS.

Methods: The study is composed of mainly two components namely; i) assessment of the impacts of MGNREGS on environmental benefits, and ii) assessment of implications of MGNREGS works in reducing vulnerability to climate risks. However, a limited institutional assessment was conducted to gain insights into how institutional arrangements can further be improved to enhance generation of environmental benefits through well implemented MGNREGS works. The study included an assessment of ecological, physical and socio-economic indicators. The methods included bio-physical measurements (such as ground water, soil organic carbon and biomass estimation), household survey and PRA of the beneficiaries of MGNREGS (employment generated, increased area irrigated, crop yields, etc.), and use of secondary data (area irrigated, afforested area, etc.).

The environmental benefits of MGNREGS: works were assessed based on firstly, survey of selected MGNREGS beneficiaries - where they were asked to compare the current or post-MGNREGS implementation scenario (during 2011-12) with the average pre-MGNREGS scenario (around 2006-07); and secondly, measurement of indicators such as soil organic carbon, soil erosion, ground water level, biomass, etc., in MGNREGS implemented locations based on comparison of pre- and post-MGNREGS conditions or with control plots (plots not subjected to the works). In the present study, a conscious effort was made to select only direct beneficiaries of the MGNREGS works (such as farmers with crop fields where silt was applied or those with wells that got recharged as a result of check dams), as well as assets created under MGNREGS to ensure that the study reflects principally the impacts of MGNREGS works and beneficiaries from other developmental programmes were excluded.

Limitations: This study is based on a rapid assessment conducted during 2012 and refers to conditions during 2011, subject to several limitations. Firstly, there was no baseline or benchmark or pre-MGNREGS scenario data or information for comparison with the post-MGNREGS implementation scenario. The assessment is based on single-point measurement or survey and assessment of environmental benefits would require periodic time-series monitoring (soil erosion, soil organic carbon content, tree growth, etc.). Secondly, for many villages, secondary data was not readily available for various indicators (such as change in area irrigated and area afforested). Thirdly, in this report vulnerability index has been developed on the basis of observed reduction in vulnerability of beneficiaries at the village level due to enhancement in their adaptive capacity and reduced sensitivity, for example exposure of drought is realized to a lesser extent due to availability of irrigation facility. Finally, the study is based on an assessment of a sample of beneficiaries of selected MGNREGA works in 10 villages from each identified district of the 4 states. In Karnataka and Andhra Pradesh, 2 adjacent blocks were identified while in Rajasthan and Madhya Pradesh villages were selected from a single block. Thus it may be difficult to draw implications at the state or national level due to large variations in bio-physical and socio-economic conditions and therefore impacts. A large study covering more states, districts, blocks and villages and a long-term study over say 2-3 years, could provide more insights.

Major Conclusions of the Study

Dominance of water and land related MGNREGS works: Under MGNREGS, bulk of the works (about 80%) implemented in the four districts are linked to natural resources such as surface water, ground water, croplands, soils and wastelands (for forestry).

Impact of MGNREGS on water resources: Implementation of MGNREGS works such as water conservation and harvesting works, drought proofing, irrigation provisioning and improvement works, and renovation of traditional water bodies have contributed to improved ground water levels, increased water availability for irrigation, increased area irrigated by ground and

surface water sources and finally improved drinking water availability for humans and livestock.

i) ***Impact on ground water levels:*** MGNREGS works such as check dams, percolation tanks and desilting of tanks have had positive impacts on ground water depth in the study villages where ground water level was measured during 2012 and it is in the range of depth recorded by Central Ground Water Board (CGWB) for the pre-MGNREGS period (2006-07). Ground water levels have either increased or remained at the pre-MGNREGS level despite continued and perhaps increased extraction. It is well known from studies that the ground water level is declining in most parts of India (GOI, 2010). It is possible to conclude that MGNREGS works have contributed positively to the ground water level in the study villages, despite continued expansion and extraction of ground water.

ii) ***Impact on water availability and area irrigated using ground water sources:*** MGNREGS works such as check dams, percolation tanks and desilting of water bodies have contributed to an increase in area irrigated by borewells and open wells, potentially leading to increased and sustained crop yields in 30 of the 40 study villages, with percentage of beneficiary households reporting an increase in the range of 7% in Bhilwara (borewells) to 100% in Dhar (open wells), and the area irrigated has increased in the range of 0.2 to 57 ha at the village level.

iii) ***Impact on area irrigated using surface water:*** MGNREGS works that focus on renovation of traditional water bodies, desilting and construction of new surface water harvesting structures have led to increased water availability, increase in area under irrigated crop production in 21 out of 30 study villages in three districts, potentially contributing to sustained and increased crop yields. The increase in area irrigated ranged from 0.5 to 58 ha among the study villages and in 2 villages of Bhilwara, the area irrigated increased by over 200 ha due to canal works carried out under MGNREGS. The beneficiary farmers selected in Medak, Andhra Pradesh, predominantly utilized ground water sources for irrigation and as such reported no impact.

iv) ***Drinking water availability:*** The survey of beneficiary households in 4 districts reported an increase in the quantity of water utilized by each household, due to increase in the number of water bodies, increased ground water levels and increased number of days of water availability from different water sources. Similarly, water harvesting structures such as check dams, stop dams, percolation tanks, ponds, etc., have not only increased ground water levels, but also improved drinking water availability for livestock. In Karnataka dedicated cattle ponds or troughs were constructed in study villages under MGNREGS.

Impacts of MGNREGS on land resources: Land development works such as land levelling, conservation bench terracing, contour and graded bunding, field bunding, pasture development, silt application and drought proofing have contributed to improved soil organic carbon (SOC) content, reduced surface runoff and reduction in soil erosion.

i) ***Enhancement in soil organic matter:*** Soil organic matter or carbon content is a very important indicator of soil fertility and land productivity. Out of the total 899 beneficiary sample plots, covering multiple works in all study villages, an increase in SOC content was recorded in 72% of the plots, as compared to control plots (or plots not subjected to the works), indicating that the works have led to improvement in soil fertility.

ii) ***Reduction in soil erosion:*** MGNREGS works such as check dams, land terracing, contour/graded and field bunding have directly contributed to reducing soil erosion in 82% of the 779 beneficiary sample plots selected for soil erosion assessment in all 4 districts, compared to the control plots, potentially increasing soil and crop productivity.

MGNREGS impacts on crop production systems: All assessed land development and water related MGNREGS works contribute directly and/or indirectly to increasing crop production as well as reducing the risk of crop failure.

i) ***Total area under cultivation:*** The change in total area under cultivation estimated through survey of direct beneficiaries of MGNREGS land development and water harvesting works showed an increase in all the 4 districts. In 3 study districts, except Dhar, previously uncultivable land is now cultivated due to implementation of land development works such as leveling, clearing, etc. In Dhar district of Madhya Pradesh, agriculture was predominantly rainfed, and croplands were cultivated only once a year. However, post implementation of water conservation and harvesting works, beneficiaries also cultivate croplands in *Rabi* season, increasing the gross area cultivated by 43.5 to 102.5%.

ii) ***Crop diversity and crop yields:*** Multiple MGNREGS works seem to have impacted crop yields positively. It is not possible to attribute increase in crop yields to any single work or only to MGNREGS works. Among many factors determining crop yields, increased water availability for irrigation, land development and improved soil fertility resulting from works implemented under MGNREGS seemed to have positively impacted crop yields. Average crop yields increased by 46 to 100% across districts and crops.

- Increase in crop yield is reported for all the crops – both irrigated and rainfed.
- The yield increase is particularly notable for rainfed crops such as cereals, minor millets and pulses in all the districts.
- Several new crops are being cultivated due to higher water availability as a result of MGNREGS works implemented.

Impacts of MGNREGS on forests, plantations and fruit orchards: Under MGNREGS, drought proofing works such as afforestation and reforestation, and horticulture development activities have been implemented. In 31 of the 40 study villages, forest (*Dalbergia*, Neem, etc.) as well as fruit yielding (Mango, Guava, Jackfruit, Lemon, etc.) tree species have been planted on individual farm lands and common property resources under MGNREGS. The forest tree species have the potential to yield fodder, fuelwood and non-timber forest products and similarly fruit trees provide fruits, flowers and nuts, generating additional income and diversifying livelihoods, contributing to reduction in vulnerability to climate risks, especially in rainfall-deficit years. Some of these tree species planted had not reached the fruit-bearing stage when this study was undertaken.

Potential Impacts of MGNREGS on carbon sequestration: Several MGNREGS works leading to increase in soil organic carbon, and raising of tree plantations and fruit orchards leading to carbon sequestration in biomass and soil, potentially contribute to mitigation of climate change. In the study villages, it was found that in 72% of the 899 beneficiary sample plots, covering all the MGNREGS works, higher soil organic carbon content was recorded as compared to control plots. Similarly, in 31 of the 40 villages afforestation works were undertaken and horticultural plantations have been raised. These forest and fruit trees sequester carbon in biomass and soil. However, in the study villages, the forest plantations and fruit orchards were too young to estimate the biomass carbon accumulation, but have the potential to sequester carbon in the long-term.

MGNREGS impacts on employment and migration: Employment generation is the most important goal of MGNREGS. Implementation of all MGNREGS works especially those related to land and water created direct employment for those who participated in the works implementation and indirect employment through increased irrigation provisioning, increased area under crops, increased crop production, etc.

i) ***Employment generation:*** The average number of days of employment increased in all the 40 study villages due to MGNREGS works' implementation, in the range of 34 to 73%, including both direct, and indirect employment that resulted from increased irrigated area and cropping intensity leading to increased crop production and processing.

ii) ***Migration:*** Migration of landless or unskilled labourers has reduced in 29 out of 40 villages (by 8 to 100%) due to increased employment availability locally in the villages as a result of MGNREGS implementation.

Agricultural and livelihood vulnerability reduction due to MGNREGS: MGNREGS works related to water and land development have been shown in this study to have contributed to generation of environmental benefits such as ground water recharge, increased water availability for irrigation, increased soil fertility, reduction in soil erosion, and improved tree cover. These environmental benefits derived from MGNREGS works have contributed to reducing the agricultural and livelihood vulnerability in the post-MGNREGS implementation period, compared to the pre-MGNREGS period and further have the potential to not only build resilience to cope with current climate risks but also build long-term resilience to projected climate change.

Recommendations

MGNREGS is a rights-based, demand driven, bottom-up and decentralized programme, aimed at generating employment. However, the studies in the four selected districts, belonging to four states, have demonstrated that MGNREGS works could potentially generate long-term environmental benefits. Majority of the MGNREGS works aimed at improving the land, water and biomass resources of villages, have been shown to deliver environmental benefits such as soil and water conservation, increased area under irrigation, improved tree cover and soil fertility improvement. It is therefore necessary to explore opportunities for further enhancing and sustaining the environmental benefits and reducing the vulnerability to climate risks through MGNREGS works. Some of the potential recommendations to enhance and sustain environmental benefits and to reduce vulnerability to current climate risks and future climate change under MGNREGS are largely derived from the findings of the current study and also from the perspectives of village communities elicited through PRA in all the study villages. In addition, findings from UNDP-MoRD (2013) study on "Greening MGNREGS" and MoRD (2012) report "MGNREGS Sameeksha" were also considered.

- ***MGNREGS to focus on natural resources:*** The key natural resources in rural areas are cropland, water, forests, and grazing land. MGNREGS works should continue to focus on these resources as they are critical for improving and sustaining water supply and soil fertility - contributing to increased agricultural production, further leading to sustained employment. Further, investment in natural resources such as soil, water and forests also contributes to reduction in vulnerability to climate risks as well as sequestration of carbon. MGNREGS should focus less on physical infrastructure, barring exceptional cases, since there are other developmental programmes that can take care of such infrastructure requirements.
- ***Priority for community resources or asset creation under MGNREGS:*** MGNREGS should on priority focus on community resources such as check dams, irrigation tanks, canals, community grazing lands, forests, wastelands, etc., to ensure sustained flow of benefits to the largest number of households in a given village, for a given level of investment. Investment on community resources also promotes equity and generates sustained employment.
- ***Asset maintenance to be an integral component of MGNREGS:*** Physical structures constructed and trees planted under MGNREGS are assets requiring maintenance or protection. Maintenance is necessary to sustain delivery of environmental benefits such as continued ground water recharge from a check dam or yield of fruits in a fruit orchard. Maintenance is therefore very critical and should be an integral part of decision-making and approval process under MGNREGS. However, community upkeep of public assets such as ponds is limited, possibly due to ambiguity over ownership and usage rights (MoRD, 2012). Thus there is a need for clarity on the ownership of different assets created.
- ***Generate and create access to information under MGNREGS:*** Currently, village communities *(Gram Sabhas)* have little or no access to organized information on the status of natural resources, factors contributing to their degradation or the potential impacts of MGNREGS works. Generation and access to information and maps on natural resources, cropland, irrigation bodies, grazing land, livestock, forests, etc. would facilitate and improve decision-making in *Gram Sabha* and *Panchayats* with respect to the type of MGNREGS works to be implemented on a priority basis, facilitate maintenance of the structures created and monitor the impacts of works and interventions.
- ***ICT-enabled decentralized decision-making:*** MGNREGS should remain a bottom-up and community-driven decision-making programme, requiring minimal administrative or institutional structures. ICT-enabled informed decision-making process at the *Gram Sabha* and *Panchayat* level is critical for ensuring MGNREGS works that deliver higher and multiple environmental benefits are selected, implemented, maintained and monitored. This requires generation and creation of access to information on natural resources and MGNREGS works to the local decision-makers using ICT.
- ***Technical support for selected MGNREGS works:*** Not all MGNREGS works require technical inputs. However, some works such as check dams, minor irrigation works and canal construction require technical assistance for designing the structure and site selection. The importance of good technical design has been highlighted as it contributed to low failure rates - in the case of Madhya Pradesh, as low as 5% (MoRD, 2012).

- ***Enhance capacity of Gram Panchayats and Gram Sabhas for decision-making and monitoring under MGNREGS:*** The *Gram Panchayats* and *Gram Sabhas* have a critical role to play in selection, implementation and maintenance of the MGNREGS works. There is a need for enhancing capacity at *Gram Panchayat* level to access information and to use ICT to monitor the programme implementation and its performance.
- ***Harness MGNREGS works for vulnerability reduction to climate risks:*** The rural communities are exposed to current climate variability and risks and are likely to be increasingly vulnerable to future climate change. The present study has demonstrated the potential of MGNREGS to reduce agricultural and livelihood vulnerability. This shows that MGNREGS could be further strengthened as an approach to reducing vulnerability of crop production systems and livelihoods in the short and long-term, in the context of increasing climate variability and climate change. Vulnerability could be reduced under MGNREGS through conservation of soil and moisture, increased irrigation, increasing soil fertility and agro-forestry, leading to stabilized crop yields and incomes, and diversification of income and employment sources. Long-term environmental benefits from MGNREGS works such as ground water recharge, improved soil fertility, reduced soil erosion and improved tree cover have the potential to build resilience to current climate risks as well as long-term climate change.
- ***Monitoring to enable enhanced delivery of environmental benefits under MGNREGS:*** Baseline scenario generation and monitoring of the status and changes in natural resources, impacts of MGNREGS works, and environmental benefits is critical for decision-making on MGNREGS works, maintenance of assets, and ensuring the delivery of socio-economic as well as environmental benefits. Monitoring of environmental and socio-economic impacts should be an integral part of implementation of MGNREGS works at the village level. It is necessary to identify green metrics and methods for monitoring. Information generated from monitoring should be made accessible to *Gram Sabhas, Gram Panchayats* and local MGNREGS administrators to facilitate decision-making on future MGNREGS work selection, maintenance of the assets and enhancing the generation of environmental benefits and also to ensure that no negative impacts accrue from the works; such as increased soil erosion, depletion of ground water and loss of tree species.
- ***MGNREGS works to promote global environmental benefits:*** Some MGNREGS works such as afforestation and horticultural orchards have the potential to generate regional and global environmental benefits, such as biodiversity conservation through reduced pressure on forests and carbon sequestration.
- ***Recognize, incorporate, mainstream and communicate the concept of environmental benefits under MGNREGS:*** It is necessary to incorporate or mainstream the concept of generation of environmental benefits into MGNREGS guidelines at the national and state levels. Further, these guidelines have to be communicated to states, districts and *panchayats*. Finally, demonstration of the synergistic feature of environmental benefits and sustained employment and livelihood generation through pilot projects and case studies is necessary.

Suggested Good Practices

Based on the main conclusions and the recommendations presented in this study, an illustrative set of good practices that could be considered in designing, selection, implementation and monitoring of MGNREGS works is given below:

- Assessment of status of village ecosystems, production systems and natural resources; soil, water, forests, and crop, livestock and forest production systems
- Assessment of the extent of degradation of cropland, grassland, water resources, etc., and the drivers of degradation, and sharing of such information with the village communities
- Prioritize interventions to conserve and regenerate natural resources; land reclamation, soil fertility improvement, water conservation and forestry are examples of such interventions
- Focus on community resources or assets; irrigation tanks, canals, grazing land and forests
- Gram Sabha must have primacy in decisions on

selection of works – decision making should be based on knowledge and information about the status of natural resources, impacts of MGNREGS works, etc.

- Generate and provide access to information through application of ICT to Gram Sabha and Gram Panchayat on status of village resources (land, water, forests, etc.), weather projections, soil and water conservation technologies, etc.
- Technical assistance to be provided only for specific works such as check dam construction, minor irrigation works and canal construction.
- Ensure completion of works initiated through continuous monitoring
- Ensure maintenance of all assets created; civil structures, forests and plantations through provision of contingency funds to Gram Panchayats for maintenance of assets created
- Mainstream adaptation or enhancement of resilience to climate change in the MGNREGS works by focusing on conservation and restoration of natural resources; soil, water, forests and grassland.
- Prioritize works leading to diversification of livelihoods as insurance against drought, crop failure, etc. and also to promote resilience to climate risks; promotion of agro-forestry, fruit trees, forests and grazing land development
- Capacity building of the panchayats and taluk level MGNREGS administrators; generating and creating access to information, monitoring, maintenance, etc.
- Provide incentives for village communities for conservation and restoration of community natural resources
- Monitor the status of natural resources, works implemented, impacts of works, and status of assets created and create access to monitored information to Gram Sabha and Gram Panchayat

Future Direction

The present study has clearly demonstrated the potential of MGNREGS works to deliver environmental benefits and reduce vulnerability to climate risks. Some of the suggested follow up steps based on the lessons learnt from this study are as follows:

- Generate and create access to information on natural resources, production systems, environmental impacts of MGNREGS works, status of the assets created, etc., to assist in village-level resource planning, designing and implementation of MGNREGS works.
- Demonstrate technically sound MGNREGS works and how they generate durable assets and thereby strengthen environmental benefits.
- Develop and demonstrate mechanisms to promote maintenance and management of assets created under MGNREGS.
- Identify capacity development needs of Gram Sabha, Gram Panchayats and local MGNREGS administrators, develop guidelines and approaches for enhancing capacity and demonstrate in selected locations.
- Develop guidelines and approaches for monitoring environmental benefits generated through MGNREGS works.
- Assess, suggest and demonstrate the institutional arrangements and management systems to optimize the flow of sustained socio-economic and environmental benefits, synergistically.
- Develop and demonstrate a strategy for diversifying employment and livelihood sources under MGNERGS, to enhance the resilience of rural communities to current climate risks and build adaptive capacity to cope with long-term climate change.

1. Introduction and Objectives

The Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), introduced on 7th September 2005, is aimed at enhancing the livelihood security of people in rural areas by guaranteeing 100 days of wage-employment in a financial year to any rural household whose adult members volunteer to do unskilled manual work. The main focus of Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) is to provide employment to all those who seek work, especially during the lean season. The focus of MGNREGS is not directly on improving natural resources or production systems, delivering environmental benefits or reducing vulnerability to climate risks.

MGNREGS works are largely focused on land and water resources, which include; water harvesting and conservation, soil conservation and protection, irrigation provisioning and improvement, renovation of traditional water bodies, land development and drought proofing. These MGNREGS works have the potential to generate environmental benefits such as soil, water and biodiversity conservation, enhancing food security and building resilience to current climate risks such as moisture stress, delayed rainfall, droughts and floods (Tiwari et al., 2011; MoRD, 2012).

A multidisciplinary, scientific rapid appraisal study in Chitradurga district of Karnataka to understand the impacts of MGNREGS in enhancing environmental benefits and reducing vulnerability to climate variability was conducted by Tiwari et al. (2011). The findings of this study and others (Kareemulla et al., 2009; Verma, 2011; UNDP, 2010) indicated that MGNREGS provided multiple environmental benefits and also reduced vulnerability to current climate risks, apart from providing employment to rural communities. Firstly, there are a limited number of studies assessing and quantifying the implications of MGNREGS works on generating environmental benefits, building natural assets, and reducing vulnerability to current climate risks (MoRD, 2012) and secondly, some of them are based on case studies of a few villages conducted during the initial years of MGNREGS implementation. Further, a longer period of 5 to 7 years of post-works implementation is needed to understand the full extent of environmental benefits generated, and the potential for vulnerability reduction, given the longer gestation period involved in ecological, hydrological and soil processes. MGNREGS is already 7 years old and the works implemented in the initial years can be expected to have made a significant impact on natural resources and production systems.

1.1. Objectives of the current study

There is a need for generating increased empirical evidence from different parts of India, to quantify the potential of MGNEREGA to deliver environmental benefits to promote conservation of natural resources, sustained water supply and food production, in addition to sustained livelihoods. Thus, the main objective of this study is to assess the environmental benefits generated, natural resources conserved and socio-economic benefits accrued through the implementation of the MGNREGS works. Here the findings of studies on environmental benefits generated through implementation of MGNREGS works and their implications for reducing vulnerability to climate risks, conducted in the 5 districts of the selected 5 states are presented. The states and respective districts selected for the present assessment are, Andhra Pradesh (Medak), Karnataka (Chitradurga), Madhya Pradesh (Dhar), Rajasthan (Bhilwara) and Sikkim (South).

"Ecosystem service" is the ideal concept to be adopted but it has a very broad scope incorporating regulatory, provisional, supporting and cultural services. Thus, in this study, the term "environmental benefit" is used to include the impacts of MGNREGS works related to natural resources and production systems. Natural resources include soil, ground water, surface water, grazing lands, etc., and production systems include crop, livestock and forests. The MGNREGS "works" include all the activities or programmes implemented under MGNREGS.

This synthesis report prepared by the Indian Institute of Science is based on the findings of the 5 state level studies conducted by different institutions; CRIDA and SCOPE in Andhra Pradesh, IISc, with assistance from JRDS and SRUDS in Karnataka, IIFM with assistance from GVT in Madhya Pradesh, FES in collaboration with IISc in Rajasthan and VHAS in collaboration with IISc in Sikkim.

The study is largely focused on the status and the impacts of MGNREGS works for the reference year 2011-12. The environmental benefits were assessed based on a set of indicators comparing the pre-MGNREGS period (largely for the period around 2006-07) and post-MGNREGS period (2011-12). The impacts of MGNREGS works on environmental benefits or in reducing vulnerability are assessed based on a household survey of the direct beneficiaries of MGNREGS works (example: pre and post-MGNREGS area irrigated) within a village, Participatory Rural Appraisal (PRA) of the MGNREGS beneficiaries and bio-physical measurements (example: soil carbon estimates in afforested plots and control plots) in the village. This report presents the results from 4 states namely, Andhra Pradesh, Karnataka, Madhya Pradesh and Rajasthan. The results of Sikkim are presented as a separate case study, since the types of works implemented are distinctly different and the scale of implementation is also very different from the other 4 states.

An illustrative list of potential environmental benefits generated due to MGNREGS works implementation is presented in Table 1.

Table 1: **Natural resources impacted by MGNREGS works, potential environmental benefits and illustrative indicators**

Resources impacted	MGNREGS works and sub-works	Potential environmental benefits and vulnerability reduction	Illustrative indicators
Water	Water conservation and harvesting, irrigation provisioning and improvement, renovation of traditional water bodies and flood control works	Ground water recharge, soil moisture retention and protection (erosion control), provisioning of water for irrigation, improved drinking water availability and soil quality (nutrient cycling)	1. Ground water levels 2. Surface run off 3. Irrigation water availability from different sources 4. Irrigation intensity 5. Water storage capacity of water bodies
Land	Land development such as, land levelling, conservation bench terracing, contour and graded bunding, field bunding, pasture development, silt application, drought proofing, flood control	Reclamation of degraded land for agriculture, improve soil fertility, improve soil moisture retention and protection (erosion control) in cultivated fields, in turn improving crop productivity and increasing crop yields	1. Soil Organic Carbon (SOC) content 2. Soil erosion rates 3. Surface run off 4. Change in area under cultivation 5. Change in biomass/carbon stock
Crop production systems	Water conservation and harvesting, irrigation provisioning and improvement, renovation of traditional water bodies, flood control and land development works	Increasing the availability of water for irrigation, reclaiming degraded lands for agriculture, improving soil moisture retention, protection (erosion control) and improving soil quality on cultivated lands, flood control for crop protection, etc. All of these directly impact area under cultivation, area under irrigation, crop productivity, cropping patterns and crop yields	1. Change in area under cultivation 2. Crop diversity 3. Crop yields 4. Cropping intensity 5. Cropping pattern 6. Irrigation intensity 7. Extent of area cultivated during different seasons
Forests	Drought proofing works such as, afforestation/tree plantation, boundary and block plantation, agroforestry, mixed plantation of trees having minor forest product and medicinal value, pasture development/silvipasture, etc.	Conservation and regeneration of biomass and carbon stock, improves soil moisture retention and protection (erosion control), aids flood control, improves soil quality, regulates local climate and also provides an alternate source of income for those households dependent on minor forest products, fodder and fuelwood	1. Area afforested/planted 2. Area and composition of agroforestry species 3. Survival rates of afforested trees 4. Changes in NTFP availability and usage 5. Changes in the biomass/carbon stock 6. Change in fodder availability

1.2. Limitations of the current study

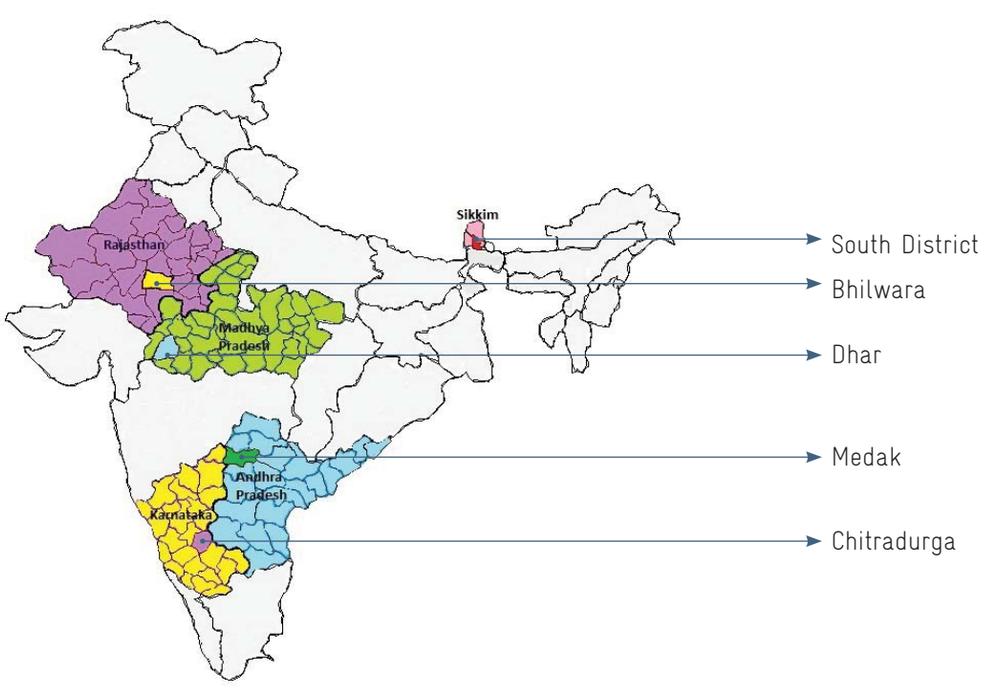
This study is based on rapid assessment conducted during 2012 and refers to conditions during 2011, subject to several limitations. Firstly, there was no baseline or benchmark or pre-MGNREGS scenario data or information for comparison with the post-MGNREGS implementation scenario. This assessment is based on single-point measurement or survey and a comprehensive assessment of environmental benefits would require periodic time-series monitoring (soil erosion, soil organic carbon content, etc.). Secondly, for many villages, secondary data was not readily available for various indicators (such as change in area irrigated, area afforested). Thirdly, the impact of MGNREGS works on environmental benefits are largely assessed for the direct beneficiaries of the works and conscious effort was made to exclude beneficiaries, if any from other developmental programmes. Fourthly, in this report vulnerability index has been developed on the basis of observed reduction in vulnerability of beneficiaries at the village level due to enhancement in their adaptive capacity and reduced sensitivity, for example exposure of drought is realized to a lesser extent due to availability of irrigation facility. Finally, the study is based on assessment from a sample of 10 villages each from 4 districts (6 blocks) of 4 states, even though within a block or a district there could be large variations in bio-physical and socio-economic conditions and therefore impacts.

Attribution of the recorded and observed environmental benefits to MGNREGS interventions is always a challenge. There could be many factors which could impact the delivery of environmental benefits. This could include rainfall or drought, and implementation of other developmental programmes. In the present study, a conscious effort was made to select only the direct beneficiaries (households whose cropland, water and other resources were impacted) of the MGNREGS works, as well as the assets created under MGNREGS, to ensure the study reflects the impacts of MGNREGS only. However, in some cases, the impacts recorded or perceived could have been a result of other past or ongoing developmental programmes in the region. However, in the selected villages, there was little evidence of convergence of multiple developmental programmes. The study has not assessed the downstream and upstream impacts of MGNREGS works implementation. A large study covering more states, districts, blocks and villages and a long-term study over 2-3 years could provide more insights.

2. Selection of Districts, Villages and MGNREGS Works for Estimation of Environmental Benefits

The approach for selection of the districts, blocks and villages is presented in this section. The districts, blocks and villages selected are presented in Table 2 and the location of the study districts is given in Figure 1.

Figure 1: Location of selected states and districts for this assessment



Selection of states and districts: The 5 states taken up for the study were identified by the Ministry of Rural Development. One district was selected from each of the 5 states for the rapid assessment of the environmental benefits of MGNREGS works (Table 2). The main basis for selecting the district was the year of initiation of MGNREGS works and the extent of implementation of MGNREGS works. The districts with high level of implementation of works and also the districts where the works were implemented during the first phase of the programme were selected.

Selection of blocks: The blocks selected within each of the selected study districts for the assessment of environmental benefits and potential vulnerability reduction through MGNREGS works are given in Table 2. Depending on criteria for selection of villages, 1-2 blocks with high level of implementation of MGNREGS works was selected for the study.

Selection of villages: The selection of villages was based on the extent of implementation of the works and 10 villages with high levels of work implementation were selected. Table 2 provides the states, districts, blocks and villages selected for the study.

Size of sample for the study: The number of households selected in a study village depended on the works executed in that village and the number of beneficiaries for each of the selected works. The total number of sample households or beneficiaries selected in the study blocks or districts is given in Table 2 and the total size of sample households or beneficiaries ranged from 342 in Dhar district of Madhya Pradesh to 666 in Bhilwara district of Rajasthan, with the total across all districts being 2057 beneficiaries.

Table 2: Districts, blocks and villages selected for the assessment of environmental benefits of MGNREGS

States	Districts	Blocks	Villages selected for the study	Number of beneficiaries selected for household survey
Andhra Pradesh	Medak	Zaheerabad	Anegunta, Buchenelli, Govindapur, Hoti-K Mannapur and Ranjole	323
		Kohir	Gotigarapalli, Kavelli, Maniyarpalli, Parsapalli	192
Karnataka	Chitradurga[1]	Challakere	Parashuramapura, Nagaramgere, Nelagetanahalli, Rangavanahalli, Siddapura	266
		Hiriyur	Dharmapura, Gowdanahalli, Kallahatti, Maradihalli, Talavatti	268
Madhya Pradesh	Dhar	Sardarpur	Barmandal, Khutpala, Baramkhedi, Chotiyabalod, Kotrakala, Hanumantya kag, Phulgawri, Morgow, Minda, Machaliya	342
Rajasthan	Bhilwara	Mandalgarh	Baroondni, Devipura, DhamanGati, Beekran, Jalamki Jhonpariyan, Rooptalai, Ganoli, DhakadKhedi, Dhanwara, Bhatkheri	666
Total number of beneficiaries selected for the study				**2057**

[1]In Chitradurga, two neighbouring blocks selected by an earlier study (Tiwari et al., 2011), were selected

Selection of MGNREGS works: The potential for implementing an activity (or work) varies from one village to the other, due to differing resource endowment which determines its potential to deliver environmental benefits and reduce vulnerability. The main criterion was to select all works which would have made an impact on environmental benefits in the context of the gestation period involved and also the high scale of implementation of works, enabling assessment of the impacts. Selection of MGNREGS works was based on:

- ***The year of implementation:*** MGNREGS works that were at least 2-3 years old or older, to enable assessment of impacts due to the gestation period involved in delivering the benefits
- ***Extent of implementation:*** Level of expenditure and scale of implementation (area covered, number of beneficiaries, etc.).

At least 6 major natural resource-based works implemented in the study villages were selected, considering the above criteria. Availability of such works (at least 6 works per village) in turn determined the selection of study villages for this assessment.

3. Methods

To assess the impacts of MGNREGS works on environmental benefits, a set of indicators were developed for each of the works and impacts. The study included an assessment of ecological, physical and socio-economic indicators. The methods to assess the indicators included bio-physical measurements (for indicators such as ground water, soil organic carbon and biomass stock) and socio-economic surveys (for indicators such as employment, increased area irrigated, crop yields, etc). The study is composed of mainly two components namely; i) assessment of the impacts of MGNREGS on environmental benefits, and ii) assessment of MGNREGS works in reducing vulnerability to climate risks. However, a limited institutional assessment was conducted to elicit suggestions for improved MGNREGS implementation. Methods adopted for assessing the indicators are presented in the results section of the report and in Table 3.

Table 3: Methods for assessing the indicators

Indicators	Methods
Irrigation water availability from different sources, crop diversity, crop yields, extent of area cultivated during different seasons, area and composition of agroforestry species, changes in NTFP availability and usage, change in fodder availability, cropping pattern, irrigation intensity, cropping Intensity, change in area under cultivation, etc.	Household survey, secondary data
Water storage capacity of water bodies (Area irrigated by water bodies - command area), area afforested/planted, cropping pattern, irrigation intensity, change in area under cultivation, etc.	PRA, secondary data
Change in biomass/ carbon stock	Field measurements, allometric equations
Changes in ground water levels	Conductivity method
Changes in soil quality – Soil organic carbon	Soil Sample collection and Walkley Black Rapid Titration method
Changes in the soil erosion rates	Universal soil loss equation parameters

i) ***Assessment of the impacts of MGNREGS on environmental benefits:*** The general approach to estimate the environmental benefits generated by MGNREGS works is summarized in Figure 2.

Figure 2: Approach for assessment of environmental benefits generated by MGNREGS works

Step 1: Selection of location (districts, blocks and villages)

↓

Step 2: Selection of MGNREGS works implemented for assessment

↓

Step 3: Identification of potential environmental benefits for each of the MGNREGS works selected for assessment

↓

Step 4: Selection of indicators for each environmental and socio-economic benefit; ecological, physical, social and economic indicators (Table 1) – Single or multiple indicators for each service

↓

Step 5: Selection of methods for measurement (PRA, household survey and bio-physical measurements)

↓

Step 6: Field surveys, measurements and laboratory analysis

↓

Step 7: Data analysis, interpretation and reporting

ii) ***Assessment of the impact of MGNREGS works in reducing vulnerability to climate risks:*** The current climate risks which impact water availability, crop production, forest regeneration, etc., include low or delayed rainfall, droughts and floods and extreme temperature events. In the present study, vulnerability of agriculture production and livelihoods are compared between the pre- and post-MGNREGS periods. Vulnerability assessment is a method of risk management or assessment. Vulnerability has been assessed by developing agriculture and livelihood vulnerability indices, utilizing indicators that reflect implications of MGNREGS works on water availability, crop yields, soil fertility, employment, migration etc., which contribute towards overall vulnerability reduction against climate risks.

IPCC vulnerability assessment method involves disintegrating the concept of vulnerability into elements of exposure from an external disturbance factor, sensitivity i.e., the change brought about by the exposure in the system, and the capacity of the system to absorb or adjust itself to minimise the damage i.e. the adaptive capacity of the system. The enhanced adaptive capacity modifies and reduces both, sensitivity as well as the level of exposure. For example, with availability of irrigation facility, which enhances the adaptability under exposure of drought, the sensitivity of crop production to drought is reduced and the intensity of exposure is felt less. In the present study, concept of vulnerability was applied as an approach to reduce risk of beneficiary households through works under MGNREGS. Under MGNREGS, largely the land and water based interventions have been made with the objective of strengthening the asset and livelihood base in the study villages, which reduces the vulnerability of the beneficiary households by enhancing their adaptive capacity. The approach adopted for vulnerability assessment – the index-based method is given in Figure 3 and is derived from Ravindranath et al. (2012).

Figure 3: Approach adopted for vulnerability assessment

Step 1: Identification of **sectors** (agriculture and livelihood), **scale** (village level) and **period** (pre- and post-MGNREGS implementation)

↓

Step 2: **Identification and definition of indicators** – Indicators are selected based on expert consultation, local context and previous studies. These were further refined based on autocorrelation considerations, expert judgment, baseline considerations, limitations and proxies

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Step 3: **Quantification of indicators** through primary and secondary data sources, household surveys, PRA, and bio-physical measurements

↓

Step 4: **Normalization of indicators to a dimensionless unit** – The numerical values of indicators are in different units (ha, meters, percentage, tonnes, etc.) and in order to compare them, they are normalized and rendered dimensionless for aggregation. The change in the value of indicators was calculated as a percentage of the pre-MGNREGS values

↓

Step 5: **Assigning weights to indicators** – Indicators could have varying significance in impacting the vulnerability. Weights were assigned based on MGNREGS beneficiary perceptions (*see explanation given in Figure 3 subtitle)

↓

Step 6: **Aggregation of indicators to obtain AVI and LVI** – The indicators are aggregated to obtain vulnerability indices - *Agriculture Vulnerability Index (AVI) and Livelihood Vulnerability Index (LVI).* The percentage change indicator values were multiplied by their weights and aggregated as AVI and LVI

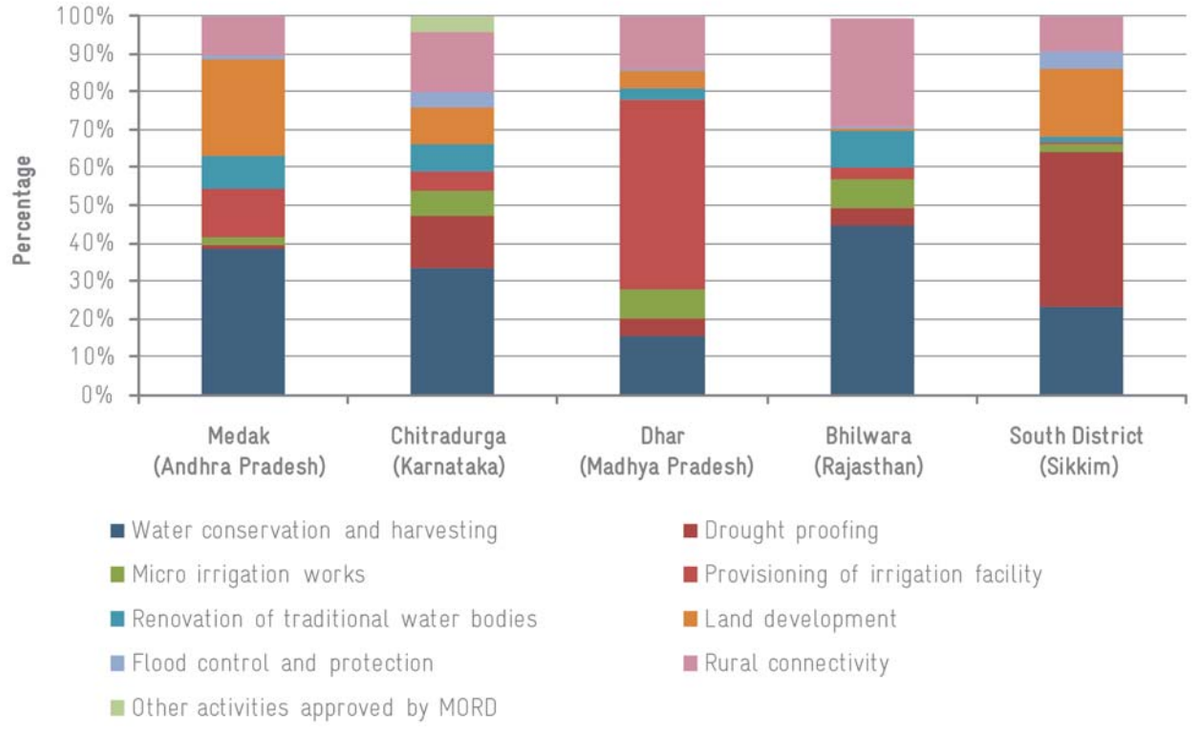
**Note: As part of the vulnerability assessment exercise, indicators were provided to the beneficiaries to assign weights on a scale of 1 to 5, based on the significance of a particular indicator (1=no significance, 2=less significance, 3=moderate significance, 4=high significance, 5=very high significance), and its relevance in helping cope against climate risks. This exercise was carried out as part of a PRA conducted in the study villages.*

iii) ***PRA for eliciting suggestions for improved performance of MGNREGS:*** PRA involving Gram Panchayat members, farmers and agricultural labourers was conducted to elicit suggestions from the stakeholders for improving the performance of MGNREGS.

4. Extent of Implementation of MGNREGS Works in the Selected Districts

The extent of implementation of MGNREGS works in the selected districts is presented in Figure 4. It can be observed from Figure 4, that in all the 5 districts the dominant works implemented are related to water conservation, irrigation provisioning, land development and drought proofing. Water related works over four districts accounted for 64% (ranging from 52% in Chitradurga to 76% in Dhar) and land related works accounted for 17.6% of the total works (excluding South District of Sikkim). Thus, the bulk (about 80%) of the MGNREGS works are linked to natural resources such as surface water, ground water, cropland soils and wastelands (for forestry).

Figure 4: MGNREGS profile in the selected districts of 5 states with percentage of works implemented



The implications of these MGNREGS works are presented in the following sections. Few studies have conducted rigorous scientific analysis on the actual productive performance of these assets (MoRD, 2012). The impact of MGNREGS works was assessed using the indicators developed, which reflect the impact of a particular work on natural resources and production systems. The assessment was focused on the 10 study villages, where the intensity of implementation of MGNREGS works was high. The impacts of MGNREGS works are presented according to different natural resources and production systems, such as ground water, irrigation water availability, crop production, soil fertility and erosion, forest regeneration, carbon stocks, and socio-economic indicators such as employment and migration.

5. Impact of MGNREGS on Water Resources

In this section, the impacts of MGNREGS works such as water conservation and harvesting works, drought proofing, irrigation provisioning and improvement works, renovation of traditional water bodies on – ground water levels, irrigation water availability, incremental area irrigated by borewells/open wells, water storage capacity of surface water bodies and drinking water availability for humans and livestock are discussed.

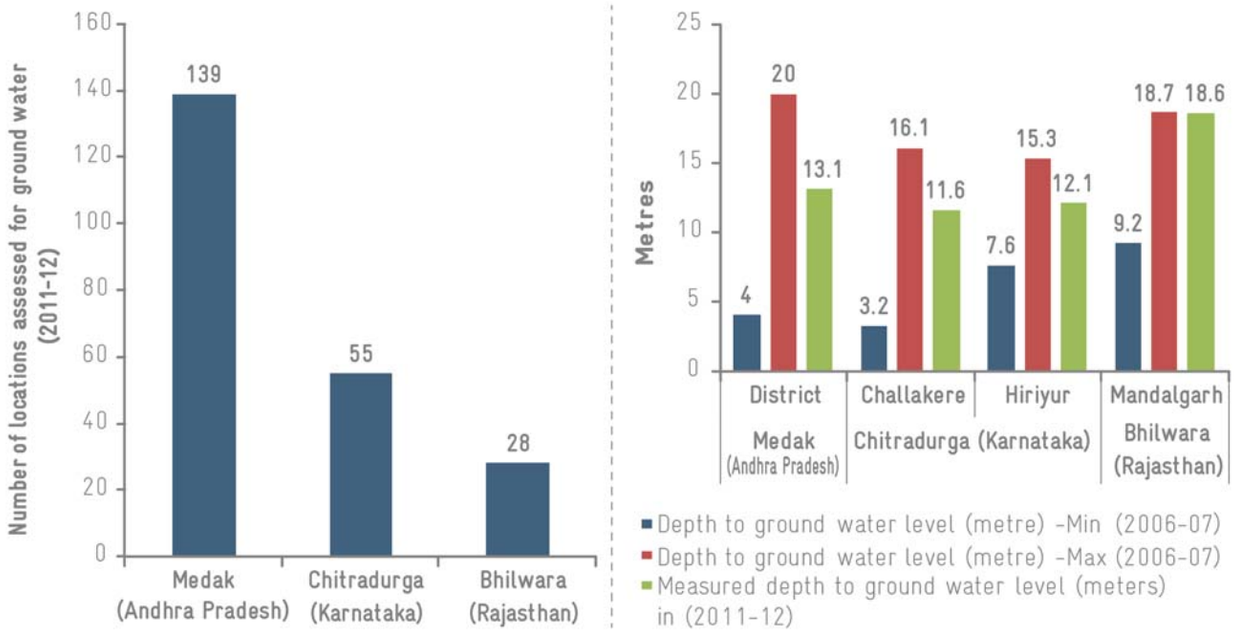
5.1. Impact on ground water levels

MGNREGS works such as check dam construction, pond works, percolation tank construction and desilting of tanks are likely to have an impact on checking surface water runoff and soil erosion, and increase percolation of water leading to increased ground water recharge. The ground water levels were measured in borewells owned by MGNREGS beneficiaries, during the pre-monsoon season of the study year and compared with the average ground water levels during the pre-MGNREGS period (also pre-monsoon ground water levels), obtained from the records of the Central Ground Water Board (CGWB). This was further substantiated by the beneficiary survey of the changes in ground water levels.

It can be observed from Figure 5, that in the study blocks where ground water levels are measured, the average depth during the post-MGNREGS period was within the range of depth recorded by CGWB for the pre-MGNREGS period (2006-07) at the block level. Further in Bhilwara, the average measured depth of ground water in 2011-12 was close to the maximum depth recorded by CGWB for 2006-07 in the study blocks.

Ground water levels have either increased or remained at the pre-MGNREGS level. The number of borewells has increased in most locations and water extraction for irrigation from borewells has continued since 2006. In such a case, one would expect the ground water level to decline with extraction of ground water from increased number of borewells. Thus it is possible to conclude that MGNREGS works have contributed positively to the ground water level in the study villages, despite continued expansion and extraction of ground water. This is in line with studies quoted in MoRD (2012), which also showed that ground water levels have increased as a result of MGNREGS works implemented.

Figure 5: Impact of MGNREGS works on ground water levels in irrigation borewells



Note: *In Dhar district (MP), ground water levels were not estimated, as beneficiary farmers owned open wells under the Kapil Dhara scheme, and the implications are assessed for these open wells and the resulting area irrigated*

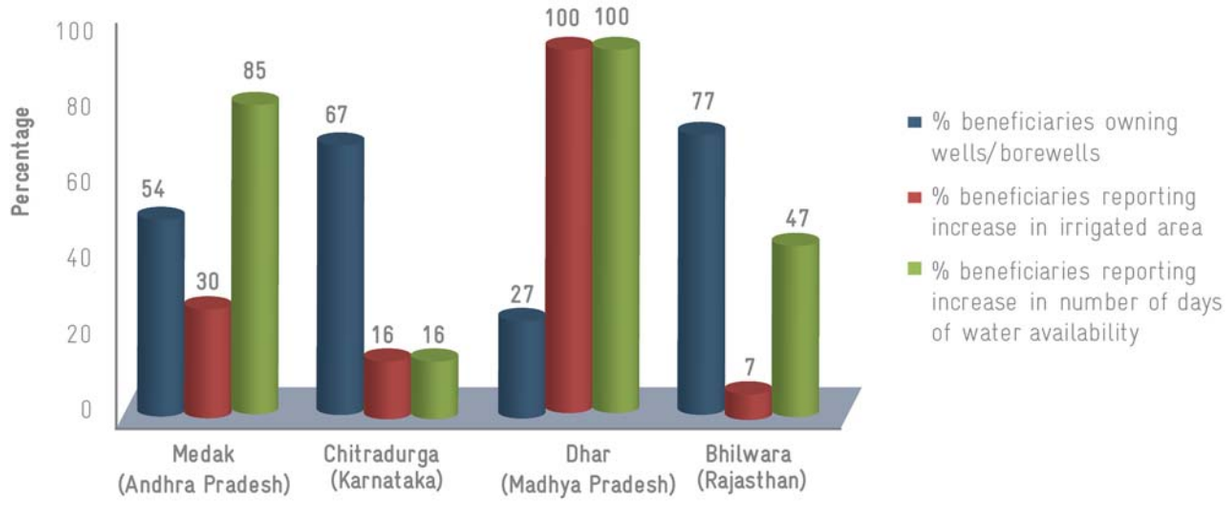
5.2. Impact on water availability and area irrigated using ground water sources

MGNREGS works such as check dams, percolation tanks and desilting of water bodies lead to increased ground water recharge and ultimately increased water availability in borewells and open wells, leading to increase in area irrigated. Area irrigated is taken as an indicator of the improved ground water availability for irrigation. Data on the impact of MGNREGS works on area irrigated was obtained from survey of beneficiary households for the pre and post-MGNREGS periods.

The change in area irrigated and number of days of water availability due to MGNREGS works is presented in Table 4 and Figure 6.

- It can be observed that in 30 out of the 40 villages studied, there is an improvement in the extent of area irrigated by beneficiaries using ground water sources such as borewells and open wells (Figure 6).
- The percent of beneficiaries who reported increase in ground water level in the borewells (or open wells in Dhar district) ranged from 7% in villages of Bhilwara district to 100% in Dhar district (Figure 6).
- The increase in area irrigated (Table 4) is highest in the villages of Medak district in the range of 12.4 to 57 ha, followed by Chitradurga (1.7 to 44 ha).
- Villages in Bhilwara displayed the least increase in irrigated area by ground water, since beneficiary households mainly depended on surface water for irrigation.

Figure 6: Impact of MGNREGS works on area irrigated using ground water and number of days of water availability



Note: *The percentage of beneficiaries reporting increase in area irrigated and number of days of water availability represent the percentage of beneficiaries owning borewells and open wells included in the study*

Table 4: Impact of MGNREGS works on area irrigated using ground water (borewells and open wells) and number of days of water availability

District (state)	No. of villages reporting increase in irrigated area	Increase in irrigated area (ha)*	No. of villages reporting increase in the number of days of water availability	Increase in the average number of days of water availability*
Medak (Andhra Pradesh)	4	12.4 – 57.0	10	13–88 days
Chitradurga (Karnataka)	8	1.7 - 44.1	5	5–45 days
Dhar (Madhya Pradesh)	10	0.9 – 5.8	10	190–365 days
Bhilwara (Rajasthan)	8	0.2 – 2.3	7	30–90 days

**as reported by beneficiaries*

- In Madhya Pradesh, a unique project called Kapil Dhara is being implemented under MGNREGS, which has contributed to increase in the area irrigated in all the 10 study villages. The increase is in the range of 0.9 to 5.8 ha. Kapil Dhara implementation has also resulted in perennial water availability across the agricultural seasons in about 70% of the villages and consequently, a significant improvement in cropping patterns and crop area (MPISSR, 2010; MoRD, 2012).
- It can be observed from Figure 6 that the number of days of water availability increased in all the 4 districts, and in 32 out of the 40 villages (Table 4). The increase was highest in Dhar district (190-365 days), due to Kapil Dhara scheme implemented under MGNREGS.

Thus MGNREGS works implemented in all the 4 selected districts have contributed to increase in area irrigated by borewells and open wells, potentially leading to increased and sustained crop yields. Further, there was an increase in the water availability for irrigation in all the study districts, due to implementation of water related works.

5.3. Impact on water availability and area irrigated using surface water

MGNREGS works such as desilting have the potential to enhance water storage capacity of existing surface water bodies such as tanks, anicuts and ponds, leading to increase in area irrigated within the water

body's command area. In addition, desilting of canals leads to improvement in flow of water for irrigation. Construction of surface water harvesting structures such as stop dams can also increase the area under irrigation. The impact of such MGNREGS works on area irrigated was obtained from survey of the beneficiary households for pre and post-MGNREGS periods. Table 5 and Figure 7 present the impacts of MGNREGS works on area irrigated by surface water bodies.

- In Chitradurga, desilting works were carried out in 4 of the 10 study villages and in all the 4 villages, area irrigated using water from desilted tanks increased in the range of 0.8 to 49%. Also the number of days of water availability for irrigation from these sources increased by an average of 30 days, in 3 out of the 4 villages (Figure 7).
- In Dhar, stop dam and pond construction as well as renovation of existing ponds led to increased area under irrigation in all the 10 study villages, in the range of 35 to 100%, and water availability increased in the range of 108 to 240 days.
- In Bhilwara, water from check dams and anicuts is rarely used for irrigation. However, in 2 out of the 6 villages where desilting of check dams was carried out under MGNREGS, increased water storage capacity of the check dams was reported, and as a result area under irrigation increased by 25 and 100%, respectively, in Dhaman Gati and Dhanwara villages. Similarly, canal desilting led to increased irrigation provisioning leading to increase in the area irrigated. In 7 out of the 10 villages, the area irrigated increased (Table 5) in the range of 3.9 to 60%, according to the beneficiaries of canal repair and desilting works.
- In Medak, desilting work was carried out below the sill level of tanks (controlled outlet of tank) which do not have direct impact on its command area but there was an indirect impact by bore well recharge that improved water availability and quantity in open well/or borewell.
- Overall 18 out of the 30 villages reported increase in area irrigated (Figure 7).
- Increase in area irrigated varied from one village to the other. In some villages it was as low as 0.4 ha and in some others it was as high as 58 ha. Even in Chitradurga and Bhilwara districts, where no Kapil Dhara type of work was implemented, increase in area irrigated was substantial and in some villages it is as high as 25 or 32 ha. In two villages of Bhilwara, 207 and 290 ha were brought under irrigation due to canal works.

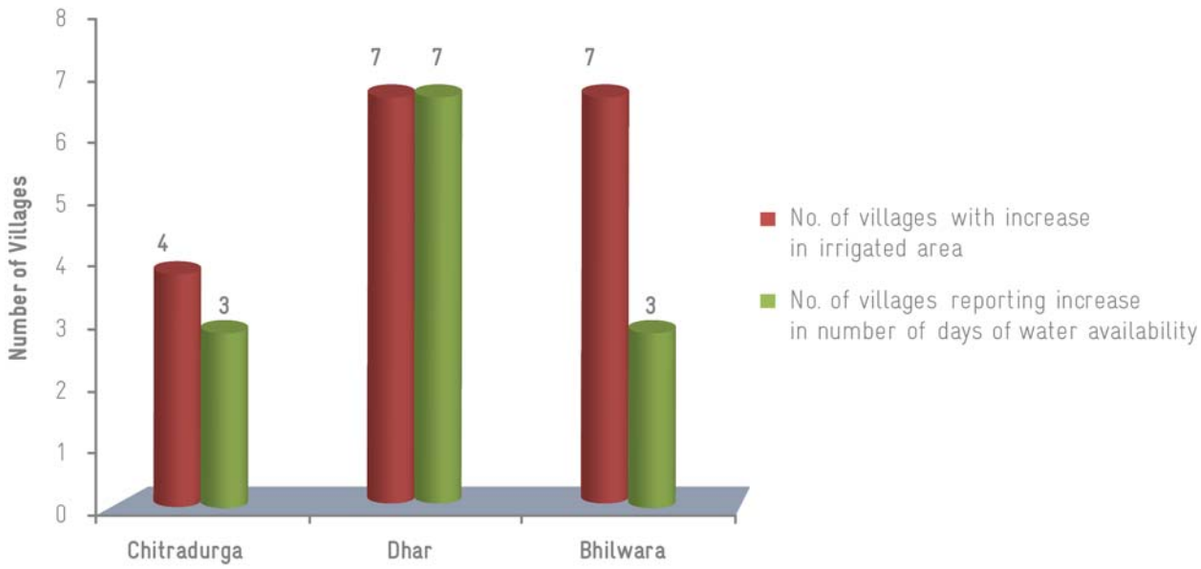
Thus it can be concluded that MGNREGS works that focus on renovation of traditional water bodies, desilting and construction of new surface water harvesting structures have led to increased water availability, increase in area under irrigated crop production, potentially contributing to sustained and increased crop yields. However, one of the weaknesses is the excessive concentration on excavation and desilting of ponds without corresponding work on treating their catchment areas or on the construction of dams based on earthen engineering (MoRD, 2012). Lack of technical support to communities has also been a key factor in non-completion of water related works (World Bank, 2011).

Table 5: Impact of MGNREGS works on area irrigated using surface water bodies

District (state)	Incremental increase in area irrigated by surface water bodies (ha)	Percentage increase in irrigated area*	Increase in the number of days of water availability* (days)
Chitradurga (Karnataka)	4–32.4	0.8–49.8	20–40
Dhar (Madhya Pradesh)	0.4–58.3	34.9–100	108–240
Bhilwara (Rajasthan)	1.6–25.8#	3.9–60	15–90

**as reported by beneficiaries during a PRA*
 # 2 sample villages in Bhilwara reported a large increase in area irrigated due to canal works; Jalamki Jhonpariyan – 290ha and Rooptalai – 207ha. In these 2 villages, large-scale canal works were implemented.
• Source- Beneficiary PRA

Figure 7: Impact of MGNREGS works on area irrigated using surface water and number of days of water availability



**In Medak, desilting work was carried out below the silt level of tanks, with no impact on irrigated area.*
**Number of study villages is 10 each in all the districts.*

Case study of Kapil Dhara in Dhar district of Madhya Pradesh

Kapil Dhara is one of the largest MGNREGS interventions in Dhar district and by far the most demanded and executed activity for individual beneficiaries. The scheme involves construction of dug wells on individual farmlands of beneficiaries, which lead to improvement in water available for irrigation, drinking and other domestic requirements. The sub-schemes of Kapil Dhara include irrigation water provisioning to SC/ST/BPL/LR & IAY beneficiaries through the construction of dug wells, farm ponds, check dams and stop dams.

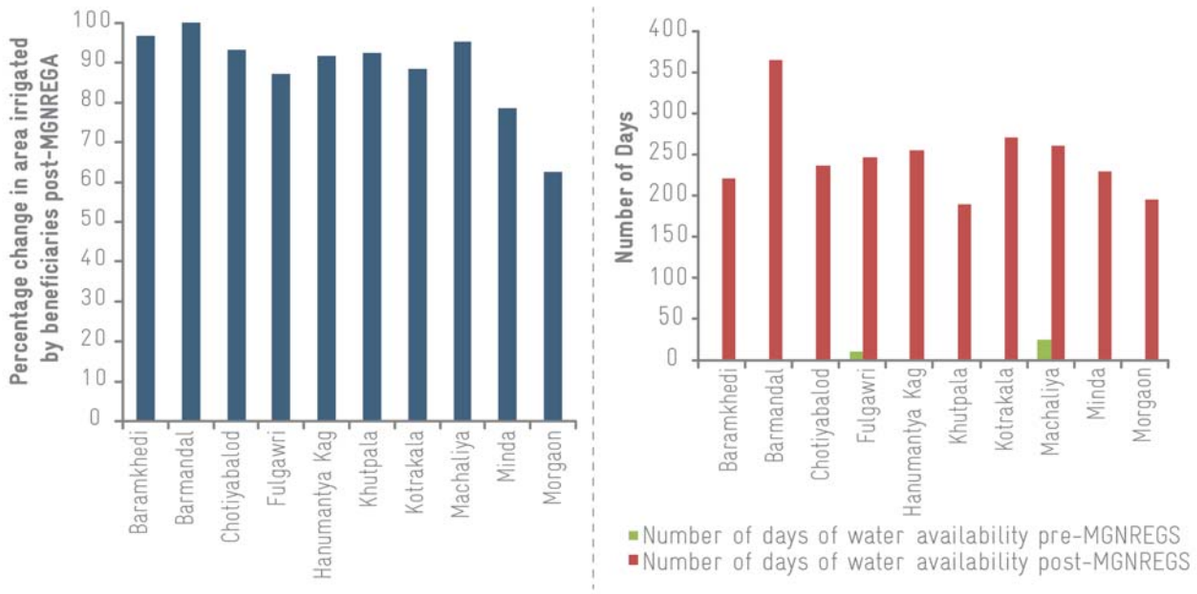
Well construction and pumping of water, though may lead to increased area under irrigation and crop production, may not be sustainable, unless water recharge works are also implemented. In the study villages of Dhar, percolation tanks, ponds, bunds (around the farm of the beneficiary with wells) and plantation works have been carried out, potentially contributing to water recharge into the Kapil Dhara wells, to some extent.

This scheme has been implemented in all the 10 villages of Dhar district selected for this study. Kapil Dhara wells have higher irrigation potential (as compared to ponds and percolation tanks) and enabled cultivation of an additional crop in *Rabi* season.

The impact of Kapil Dhara was assessed based on the survey of beneficiary households. A total of 78 exclusive Kapil Dhara beneficiaries were surveyed, to assess the impacts of this work on the area irrigated by dug wells, ponds, check dams and stop dams constructed.

The impact of Kapil Dhara on the area irrigated by beneficiaries in the 10 study villages is given in Figure 8 and the results show that all the 10 villages reported an increase in the area irrigated in the range of 62.5% to 100% and an increase in the number of days of water availability in the range of 190 to 365 days. Further, 7 out of 10 villages where no irrigation existed pre-MGNREGS, have started cultivating irrigated crops. Due to this increase in irrigation water availability, beneficiaries of Kapil Dhara are able to cultivate *Rabi* crops, increasing the cropping intensity and crop diversity, thereby contributing to increased crop production.

Figure 8: **Percentage change in area irrigated by Kapil Dhara beneficiaries post-MGNREGS compared to Pre-MGNREGS (left panel) and number of days of water availability pre- and post-MGNREGS (right panel)**



5.4. Impact on drinking water availability

MGNREGS works related to land and water, have the potential to improve ground water resources and water availability from borewells and open wells, providing drinking water. In the selected districts several drinking water programmes are being implemented that are not associated with MGNREGS and thus attribution of impacts of MGNREGS works to drinking water is difficult. However, the beneficiaries of different MGNREGS works in all the 4 districts were surveyed to assess the impacts of MGNREGS works on drinking water availability at the household level and for their livestock.

The survey of beneficiary households in 4 districts reported an increase in the quantity of water utilized by each household, due to increase in the number of water bodies, increased ground water levels and increased number of days of water availability from different water sources. Similarly, according to the same beneficiaries, the water harvesting structures, such as check dams, stop dams, percolation tanks, ponds, etc., constructed under MGNREGS have not only increased ground water levels, but have also improved drinking water availability for livestock. In Chitradurga, dedicated cattle ponds were constructed in 7 out of the 10 study villages under MGNREGS, which provided an additional source of drinking water for livestock, allowing farmers to sustain livestock production and potentially providing them with alternate sources of income. Traditionally water ponds were constructed for cattle in villages, a practice which has declined in the recent past. However, MGNREGS has revived the traditional practice.

Drinking water availability in Dhar district

MGNREGS works related to water and land, have the potential to increase water availability for human and livestock. In Dhar district of Madhya Pradesh, there was an improvement in drinking water availability in all the study villages and about 25 to 39% of the beneficiaries of MGNREGS works reported an increase in the quantity of water collected for domestic purposes. This increase can be attributed to the increase in the number of sources of drinking water (open wells constructed under Kapil Dhara scheme) and also an increase in the number of days of water availability from these sources. Due to this increase in number of drinking water sources, the distance travelled and the time required for water collection has also decreased drastically in all the 10 study villages. The distance travelled has decreased by 44.2 to 63.2% and the time required for water collection has decreased by an average 20% in all the 10 study villages.

6. Impacts of MGNREGS on Land

Land development works implemented under MGNREGS are likely to have a direct impact on different land categories. MGNREGS works such as desilting of water bodies is implemented along with utilization of silt for croplands. Desilting and silt application to crop fields contributes to not only increasing the water storage capacity, leading to increased ground water levels, but also improves the soil quality through improved soil structure and organic carbon enhancement, which contributes to increased crop yields. In order to quantify the impacts of MGNREGS on land resources; SOC content and soil erosion rates were estimated for land categories subjected to MGNREGS works and compared with control plots (similar land areas where no such activity is undertaken).

6.1. Soil organic carbon

Soil Organic Matter or Soil Organic Carbon (SOC) is a very important indicator of soil fertility, land and crop productivity. SOC is estimated for all the sample plots (or parcels that are impacted by MGNREGS activities such as silt application and afforestation, and compared with control plots (plots/land parcels that are not subjected to MGNREGS activities) within the study area.

To estimate percentage SOC in a particular plot, soil samples were collected from multiple 25 X 25m quadrants on croplands or afforested plots. Five samples were collected, of approximately 500 gm each at a depth of 0-15 cm. These samples were then mixed thoroughly and divided, such that 500 gm of composite sample of soil was collected, representing the entire plot. The percentage SOC in the soil samples was estimated using Walkley Black Rapid Titration method.

Table 6 provides the changes in SOC content post-MGNREGS work implementation, compared to control plots.

- In the study, all soil conservation and protection works were selected for assessment of SOC, and from each work, all the beneficiary plots were selected for soil sampling. Thus in all 899 sample beneficiary plots were selected for assessment of impact of MGNREGS works on SOC.
- It can be observed that the range of beneficiary plots impacted by check dam works showed an increase in SOC in the range of 62% of the plots in

Bhilwara to 85% in Chitradurga.

- Silt application was the one of the major MGNREGS works assessed in Medak and Chitradurga and 33 and 90% of the beneficiary plots, respectively showed an improvement in SOC content, in the range of 0.3 to 1.73%.
- Plantations/afforestation work was implemented in 12 out of 40 villages. SOC content increase has been recorded in 70 to 75% of the beneficiary plots in Bhilwara and Dhar district.
- On the whole, 72% (out of 899 samples) of the beneficiary plots subjected to MGNREGS works' implementation reported increase in SOC content.

Thus from this assessment we can conclude that MGNREGS works have led to increase in SOC content in majority of the sample plots, leading to improved soil fertility and crop productivity across various works such as silt application, land, plantation and pasture development.

Table 6: Impact of MGNREGS works on soil fertility; soil organic carbon content

District (state)	Number of sample villages	MGNREGS work selected	Number of villages where works have been implemented	Number of sample beneficiary plots selected	Percentage of sample plots showing increased SOC (%)	Range of increase in SOC (%)
Medak (Andhra Pradesh)	10	Silt application	10	50	33	0.30 - 1.13
		Trench cum bund barrow pits	4	61	64	0.30 - 1.48
		Horticulture development	8	54	50	0.31 - 0.49
Chitradurga (Karnataka)	10	Check dams	10	264	85	0.49 - 1.65
		Irrigation facility	3	68	88	0.59 - 1.03
		Silt application	5	66	90	0.40 - 1.73
		Land development	3	14	80	0.65 - 1.57
		Other*	5	10	90	0.65 - 1.46
Dhar (Madhya Pradesh)	10	*Kapil Dhara*	10	49	83	0.54 - 0.62
		Percolation tanks	4	16	70	0.56 - 0.58
		Plantations	4	7	75	0.49 - 0.68
		Pond works	9	56	65	0.55 - 0.58
Bhilwara (Rajasthan)	10	Check dams	10	119	62	0.38 - 1.16
		Contour development	3	11	75	0.48 - 1.14
		Canal construction	5	24	60	0.24 - 1.36
		Pasture land development	6	18	88	0.24 - 1.02
		Plantation / afforestation	4	12	70	0.26 - 1.02
			Total	**899**	**72**	

** Other includes farm pond, pipeline, horticulture, feeder channel, and outlet development.*

6.2. Soil erosion

MGNREGS works such as land terracing, and contour/ graded and field bunding have the potential to reduce soil erosion and thus help maintain or increase soil productivity. Soil erosion rate was calculated in the sample villages of Chitradurga and Bhilwara using the Universal Soil Loss Equation, which considers percentage SOC, soil type factor, slope, crop type factors, and support practices like tillage methods, presence of contours, bunds, etc. Due to data limitations, only the trends rather than the magnitudes are important.

Table 7 reports the results of the soil erosion rates estimated in sample plots of different MGNREGS works after comparison with selected control plots (soil erosion in t/ha/year). Soil erosion measurement was made in all the 4 study districts.

- In Medak district, 36 works were selected and reduction in soil erosion due to the works was assessed.
- In Chitradurga, Dhar and Bhilwara districts, beneficiary plots were selected for assessing the reduction in soil erosion and a total of 743 beneficiary plots were sampled.
- When Chitradurga, Dhar and Bhilwara districts are considered, 62 to 100% of the beneficiary plots showed a reduction in soil erosion with an overall reduction in soil erosion in 78% of the beneficiary plots (743 plots). In Medak district, all the works implemented showed a reduction in soil erosion.
- The extent of reduction in soil erosion due to MGNREGS works is in the range of 0.07 to 4.3 t/ha/ year in Medak district, and 0.01 to 7.9 t/ha/year in the beneficiary plots of Bhilwara, Chitradurga and Dhar districts.

Thus we can conclude that all MGNREGS land and water related works directly contributed to reduction in soil erosion and soil protection, potentially increasing soil and crop productivity.

Table 7: Impacts of MGNREGS works on soil erosion

District (state)	Number of villages	MGNREGS works	Number of sample villages in which works have been implemented	Total number of sample sites selected for measurement	Percentage sample sites showing reduction in soil erosion (%)	Range of reduction in soil erosion (t/ha/year)
Medak (Andhra Pradesh)	10	Check dams	7	11#	100	0.11 - 3.43
		Percolation tanks	6	16#	100	0.07 - 0.22
		Farm ponds	1	5#	100	0.17 - 0.29
		Trench cum bunds	4	4#	100	2.07 - 4.38
Chitradurga (Karnataka)	10	Check dams	10	264	67	0.45 - 2.80
		Irrigation facility	3	68	71	0.36 - 0.49
		Desilting	5	66	69	0.21 - 1.24
		Land development	3	14	77	0.18 - 0.49
		Other*	5	5	100	0.19 - 1.85
Dhar (Madhya Pradesh)	10	Kapil Dhara	10	43	84	0.11 - 7.89
		Percolation tank	3	15	70	0.01 - 1.13
		Plantations	4	4	100	0.09 - 1.25
		Stop dam	2	10	80	0.65 - 3.63
		RES Pond	4	35	82	0.31 - 0.93
		Other*	6	35	86	0.20 - 6.08

District (state)	Number of villages	MGNREGS works	Number of sample villages in which works have been implemented	Total number of sample sites selected for measurement	Percentage sample sites showing reduction in soil erosion (%)	Range of reduction in soil erosion (t/ha/year)
Bhilwara (Rajasthan)	10	Check dams	10	119	62	0.03 - 3.41
		Contour development	3	11	66	0.03 - 0.39
		Canal construction	5	24	80	0.03 - 0.30
		Pasture land development	6	18	71	0.05 - 1.43
		Plantation/ afforestation	4	12	75	0.06 - 1.14
			Total	**779**	**82**	

**Other includes farm pond, horticulture, feeder channel, outlet development, pond desilting, and storage tank.*
#These sample plots are not beneficiary plots, but work sites (soil conserved by structures).

7. Impacts of MGNREGS on Crop Production Systems

All assessed land development and water related MGNREGS works contribute directly and/or indirectly to increasing crop production as well as reducing the risk of crop failure. Water conservation and harvesting works implemented under MGNREGS lead to increased water availability for irrigation. Land development works such as land levelling, terracing, bunding, silt application, etc., bring degraded lands under cultivation and also improve bio-physical properties of soil by increasing SOC content, reducing soil erosion and checking surface runoff from croplands, thus increasing the productivity of lands. Such activities could potentially lead to increased area under cultivation, irrigation and cropping intensity, ultimately leading to increased crop production.

7.1. Total area under cultivation, crop diversity and cropping intensity

Area under cultivation: The change in total area under cultivation was estimated through survey of direct beneficiaries of MGNREGS land development and water harvesting works. All the 4 districts reported an increase in the area under cultivation (Table 8). The percentage of beneficiary farmers reporting increase in area under cultivation is in the range of 7% in Medak to 98% in Dhar. The increase in area was in the range of 0.9 to 1.2% in Chitradurga, 2.0 to 16.9% in Medak and 0.9 to 9.2% in Bhilwara compared to the pre-MGNREGS period. In the case of these 3 districts, previously uncultivable land is now cultivated due to implementation of land development works such as levelling, clearing, etc. In Dhar, the area under cultivation increased (in the range of 43 to 101%), due to increased water availability as a result of large-scale implementation of irrigation provisioning, water conservation and harvesting works.

Cropping intensity and crop diversity: Increased water availability has the potential to increase cropping intensity through cultivation of additional crops in *Rabi* or summer seasons.

- Cropping intensity has increased in 3 of the 4 study districts.
- In Medak, 25% of the beneficiaries reported an increase in the cropping intensity, while in Dhar district, it is 100%. In Dhar, increased water availability has led to increased cropping intensity, with the introduction of *Rabi* crops in the study villages of Dhar.

- In the study villages, a change in cropping pattern as well as introduction of new crops due to improved irrigation water availability is reported.
  - In 5 study villages of Chitradurga district, MGNREGS beneficiaries reported change in cropping pattern by shifting to perennial garden crops such as Arecanut, Banana, and Coconut.
  - In Bhilwara, post-MGNREGS implementation, the farmers have started cultivation of Soya bean, Black Gram and Barley during *Rabi*, Cotton during *Kharif* and Green Gram, Chilly and Groundnut during *Zaid*.
  - Mango and sugarcane crops were introduced by some of the beneficiary farmers in 6 out of the 10 study villages of Medak district, Andhra Pradesh.
  - Wheat, gram and vegetables were introduced as *Rabi* crops in the study villages of Dhar District, Madhya Pradesh, by beneficiaries of Kapil Dhara works, due to increase in irrigation water availability

Table 8: Impact of MGNREGS works on area under cultivation

Districts (state)	Percentage of farmers reporting increase in area under cultivation (%)	Percentage increase in area under cultivation (%)	Number of villages reporting increase in cropping intensity	Percentage of farmers reporting increase in cropping intensity (%)	Percentage increase in cropping intensity (%)
Medak (Andhra Pradesh)	7	2.0–16.9	9	25	0.9–15.9
Chitradurga (Karnataka)	22	0.9–1.2	3	1	5.8–26.7
Dhar* (Madhya Pradesh)	98	43.5–101.2	10	100	53.9–123.1
Bhilwara (Rajasthan)	10	0.9–9.2	0	0	0

**In Dhar district, the large increase in area under cultivation is due to cultivation of an additional crop in the Rabi season due to increased irrigation water availability*

7.2. Crop yields

A number of factors determine crop yields, such as date of sowing, crop variety, density of planting, fertilizer and manure application, weeding, rainfall, etc. However, crop yields could also be determined by increased water availability for irrigation and improved soil quality, which are direct impacts of various MGNREGS works. Information on crops grown and changes in crop yields was obtained through household survey of the direct beneficiaries of MGNREGS. Impacts on crop yields are presented in Table 9.

- 32 out of 40 study villages from the 4 districts reported an increase in crop yields. The remaining 8 villages reported no change in crop yields, probably due to absence of irrigation provisioning works or small scale of the works and even marginal impact of the MGNREGS works.
- The increase in crop yield is reported for all the crops – both irrigated and rainfed.
- The percentage of farmers reporting increase in yield range from 46 to 100% across the study districts for different crops.
- The yield increase is particularly notable for rainfed crops such as cereals, minor millets and pulses in all the states.
  - When cereals are considered, the percentage of beneficiary farmers reporting an increase in crop yields is 76% in Medak, 54% in Chitradurga and 74% in Bhilwara.
  - The percentage of farmers reporting increase in yield of pulses is 60% in Bhilwara and 79% in Medak.
- Large increases in crop yields are also reported for vegetable and cash crops.

Table 9: Impact of MGNREGS works on crop yields

District (state)	Number of study villages	Crops grown	Number of villages reporting yield increase	Percentage of farmers reporting increase in yields	Range of increase in yield (%)
Medak (Andhra Pradesh)	10	Sugarcane	10	91	41 - 45
		Pulses	10	79	12 - 158
		Cereals	10	76	14 - 100
		Vegetables and cash crops	10	79	100 - 186
Chitradurga (Karnataka)	10	Cereals and minor millets	5	54	15 - 39
		Cash crops and vegetables	10	56	12 - 33
Dhar (Madhya Pradesh)	10	Soyabean	9	46	5 - 43
		Cotton	4	62	11 - 100
		Maize	5	50	2 – 42
Bhilwara (Rajasthan)	10	Cereals	10	74	4 - 27
		Pulses	5	60	21 - 57
		Cash crops	7	100	5 - 50
		Oil seeds	8	62	1 - 30

Multiple MGNREGS works seem to have impacted crop yields positively. It is not possible to attribute increase in crop yields to any single work or only to MGNREGS works. Bassi et al (2011) state that variables such as crop yield, water availability for irrigation, increase in crop area and productivity of agricultural land can be influenced by external factors such as rainfall, floods, and economic shocks such as inflation. However, improved water availability and improved soil fertility which are the direct impacts of MGNREGS works could have contributed significantly to the reported increase in crop yields.

Agriculture is the dominant activity involving the landed and the landless in rural areas. Any impact on agricultural crop production has wider implications. One of the most important implications of MGNREGS works implementation on environmental benefits should be on crop yields and crop production. The study has shown that in most of the study villages, crop yields have increased significantly. This has implications for quality of life, health and employment generation, ultimately reducing the vulnerability of rural communities to climate risks.

8. Impacts of MGNREGS on Forests, Plantations and Fruit Orchards

Under MGNREGS, drought proofing works such as afforestation and reforestation, and horticulture development are the activities carried out for improving the vegetation cover and biomass availability in the villages. In this section, the impact of MGNREGS on area under forests, plantations and fruit orchards is assessed. Table 10 presents the results of household surveys conducted for beneficiaries of plantations and orchard works under MGNREGS.

- In 31 out of the 40 study villages, afforestation, plantations and fruit orchards activities have been implemented under MGNREGS. Afforestation was carried out in 17 out of 30 villages in Chitradurga, Dhar and Bhilwara.
- In Medak and Chitradurga, fruit yielding tree species such as Mango, Guava, Jackfruit, Lemon, etc., have been raised under MGNREGS.
- Area brought under afforestation/plantations is in the range of 1.3 to 100 ha in the study villages. The area brought under orchards in the study villages of Medak and Chitradurga is in the range of 0.8 to 20.5 ha.
- In the afforested areas of Chitradurga, Bhilwara and Dhar, the survival rates are high (30 to 80%).
- Biomass stock increased in the range 27 to 100% in the afforested plots compared to control plots.
- The percentage of farmers/beneficiaries reporting fruit yield in Chitradurga is 62%, while in other districts, the fruit trees are yet to yield.

Table 10: Impact of MGNREGS forests, plantations and fruit orchards

District (state)	Number of villages	MGNREGS works implemented	Increase in area planted (ha)	Species planted	Survival rate (% range)	Range of increase in biomass stock over control plots (%)
Chitradurga (Karnataka)	5	Afforestation	1.3 – 9.9	*Pongamia, Azadiracta, Jatropha,* Tamarind, Sisal, *Eucalyptus, Cassia siamea, Gliricidia sepium*	32 - 74	40 - 100
Dhar (Madhya Pradesh)	6	Plantations	1 - 100	Anola, Kathal, Neem, Khenjira, Babool, *Tectona, Ficus spp., Prosopis, Jatropha,* Ber, *Dalbergia sissoo,* Jamun, Gulmohar, Ashok, Kaner, Bamboo, Mahua	30 – 80	Too young to measure
Bhilwara (Rajasthan)	6	Afforestation	2.5 – 41.6	*Acacia nilotica, Acacia catechu, Butea monosperma, Shorea, Dalbergia sissoo, Neem, Prosopis cineraria, Delonix regia*	40 - 80	27 - 72
District (state)	**Number of villages**	**NREGA Work**	**Increase in area planted (ha)**	**Species planted**	**Percentage beneficiaries reporting fruit yields**	
Medak (Andhra Pradesh)	5	Fruit orchards	2.5 – 20.5	Mango, Guava	0	
Chitradurga (Karnataka)	9	Fruit orchards	0.8 – 10.6	Arecanut, Pomegranate, Banana, Coconut, Sapota, Orange, Mango	62	

MGNREGS works related to afforestation and horticultural plantations have been implemented in majority of the study villages. These included both forest tree species as well as fruit yielding tree species. These afforested plantations and fruit orchards have the potential to increase income from fruits and biomass, and also diversify the livelihoods, particularly in the rainfed areas and reduce their vulnerability to climate risks (Tiwari et al., 2011). Given that afforestation works make up around 10% of the total MGNREGA works, there is potential for increased carbon sequestration (MoRD, 2012).

9. Carbon Sequestration Potential under MGNREGS

MGNREGS works such as drought proofing works (afforestation, horticulture development, pastureland development) potentially contribute to mitigation of climate change through carbon sequestration in biomass and soil, while land development works (contour/field bunding, silt application and terracing) lead to increase in soil organic carbon. In the study villages, it is shown that in 72% of the 899 beneficiary sample plots, covering all the MGNREGS works, higher SOC content was recorded as compared to control plots. Similarly, in 31 of the 40 villages where afforestation and horticultural plantations have been raised, forest and fruit trees sequester carbon in biomass and soil. The forest plantations and fruit orchards were however very young to estimate biomass carbon accumulation, during the study period but have the potential to sequester carbon in the long-term.

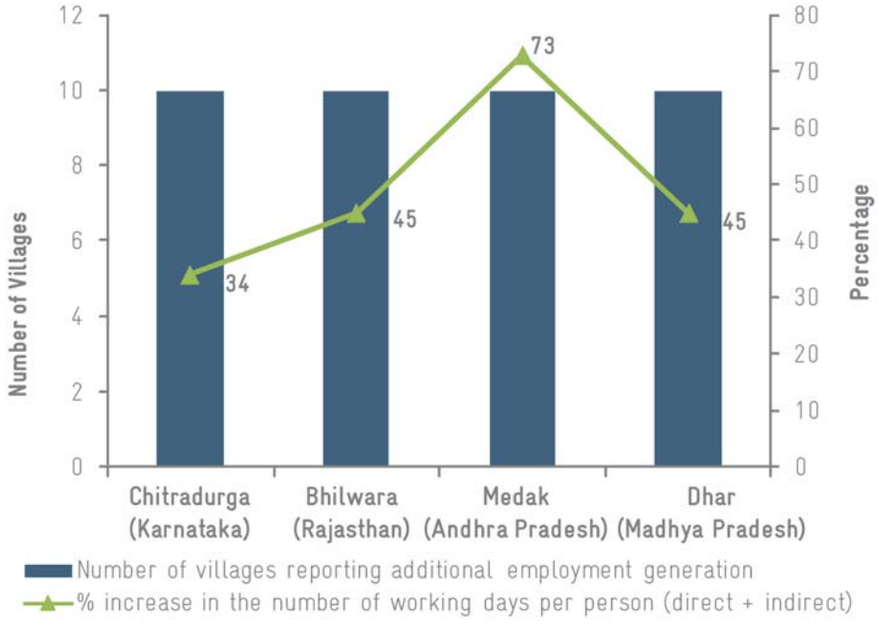
10. Impacts of MGNREGS on Employment and Migration

Implementation of all MGNREGS works especially those related to land and water create direct employment for those who participate and indirect employment through increased irrigation provisioning, increased area under crops, increased crop production, etc. Increased employment can potentially lead to reduction of migration. In the study villages, the extent of employment and migration was obtained from survey of beneficiaries and through PRA.

Employment Generation: It can be observed from Figure 9 that in all 40 study villages, average number of days of employment increased due to MGNREGS works implementation in the range of 34 to 73%, including direct and indirect employment.

Migration: Due to increased employment availability locally in the villages through MGNREGS implementation, migration of landless labourers or unskilled labourers has reduced in 29 out of 40 villages. Reduction in migration is in the range of 8 to 100% in the study villages. In some of the villages of Bhilwara, Medak and Dhar, the reduction of migration is in the range of 92-100% (Table 11).

Figure 9: Enhanced employment generated due to MGNREGS



**Number of study villages is 10 each in all the districts*

Table 11: Percentage change in migration due to MGNREGS

District (state)	Number of study villages	Number of study villages reporting migration reduction	Percentage migration reduction (%)
Chitradurga (Karnataka)	10	9	8 to 43
Bhilwara (Rajasthan)	10	8	20 to 100
Medak (Andhra Pradesh)	10	7	40 to 98
Dhar (Madhya Pradesh)	10	5	20 to 92

Thus MGNREGS seems to have contributed to increased employment generation and reduction in migration. Many micro level studies have assessed that MGNREGS has had a positive impact on reducing distress migration (Haque 2011; Verma and Shah 2012; Kumar and Prasanna 2010; Mistry and Jaiswal 2009; Kareemulla et al 2009). Positive relationship between the implementation of soil and water conservation works and the reduction in migration of farmers have also been observed by other studies, particularly in the case of Ananthapur district in Andhra Pradesh (Krishnan and Balakrishnan, 2012).

11. Vulnerability Reduction to Climate Risks through MGNREGS

According to studies such as Tiwari et al. (2011), Kareemulla et al. (2009), and MoRD (2012), etc., MGNREGS activities have the potential to reduce the vulnerability of agricultural production, water resources and livelihoods to uncertain and low rainfall, water scarcity and poor soil fertility conditions. Here, findings of vulnerability assessment for the 4 study districts are presented.

Vulnerability Indices: Agricultural and livelihood vulnerability indices were computed for the present study. Indices are composed of several indicators that were quantified through household surveys (values provided by beneficiaries and their perceptions), PRAs at village level, bio-physical measurements and secondary data sources. The method of calculating and aggregating vulnerability indices is described in Figure 3.

- ***Agricultural Vulnerability Index (AVI):*** Indicators included for construction of this index are ground water depth, cropping intensity, irrigation intensity, net area irrigated, number of days of irrigation water availability, area under food grain production, crop yields, livestock population, soil organic carbon and soil erosion, all linked to crop production system.
- ***Livelihood Vulnerability Index (LVI):*** The indicators included in this index are number of individuals migrating, wage rates, percentage change in the number of days of employment, net area irrigated, livestock population and cropping intensity. Indicators relating to agriculture are also included in this index as agriculture is a major source of livelihood in the study villages.

11.1. Agricultural vulnerability index (AVI)

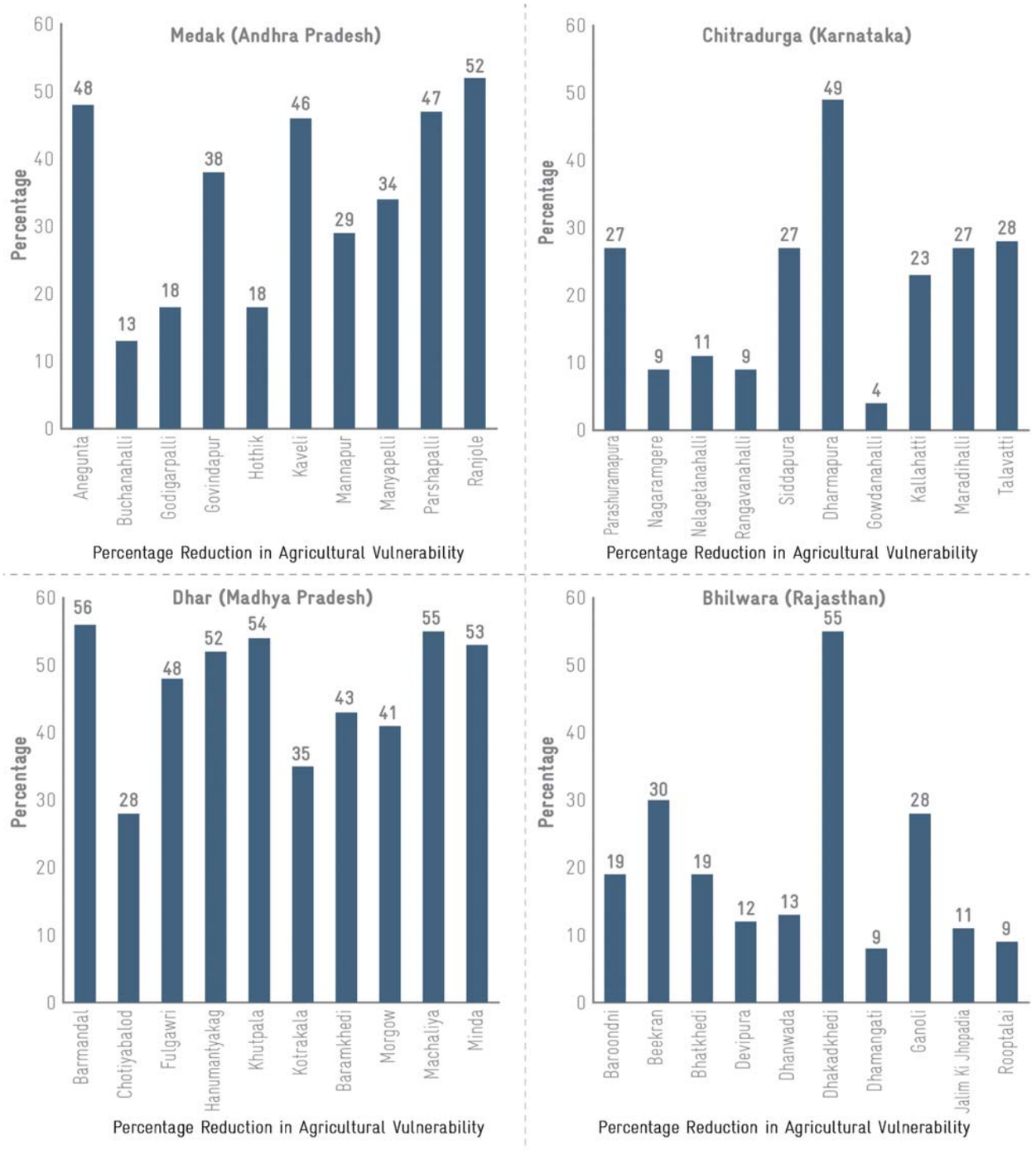
Figure 10 presents percentage reduction in agricultural vulnerability as a result of implementation of MGNREGS in the four study districts.

- ***Medak:*** The agricultural vulnerability in the 10 study villages of Medak district, Andhra Pradesh, decreased in the range of 13 to 52%. This reduction was due to significant increase in the net area irrigated in all the study villages, as a result of increased ground water levels, leading to increased crop yields.
- ***Chitradurga:*** In Chitradurga district, Karnataka, the agricultural vulnerability decreased in all the 10 study villages, in the range of 4 to 49%. This decrease was a result of increased ground water

levels and increased area under irrigation, due to desilting and SOC improvement as result of silt application.

- ***Dhar:*** A reduction in the range of 28 to 56% in the agricultural vulnerability can be observed for Dhar district, Madhya Pradesh. AVI reduction in Dhar was more than 30% in 6 out of the 10 study villages. This reduction was mainly due to increased crop yields and cropping intensity in all the 10 study villages, due to implementation of Kapil Dhara.
- ***Bhilwara:*** In Bhilwara district, Rajasthan, AVI declined in the range of 9 to 30%. In Dhakad Khedi village, the reduction in AVI was 55%, mainly due to significant increase in irrigation intensity post-MGNREGS implementation. The reduction in AVI in all the study villages can be attributed to increased ground water levels, area under crop production and livestock population.

Figure 10: Percentage reduction in agricultural vulnerability of villages in study districts

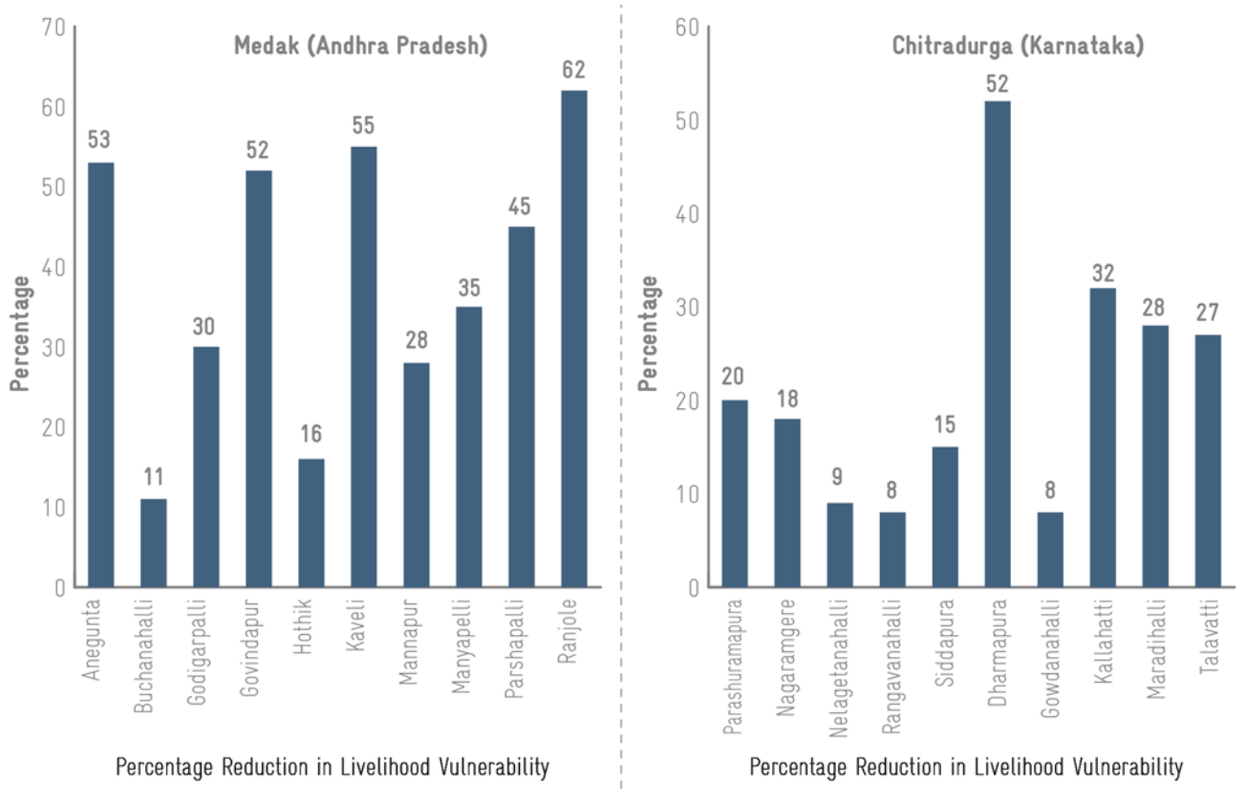


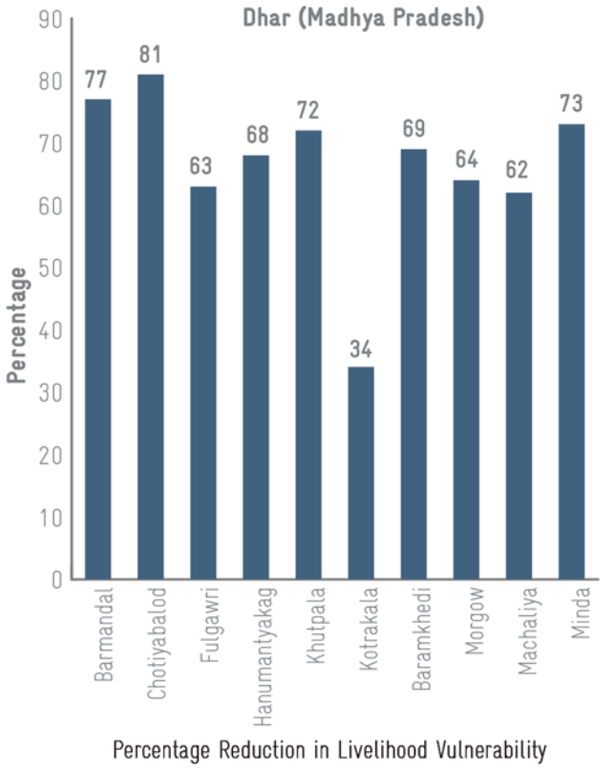
11.2. Livelihood vulnerability index (LVI)

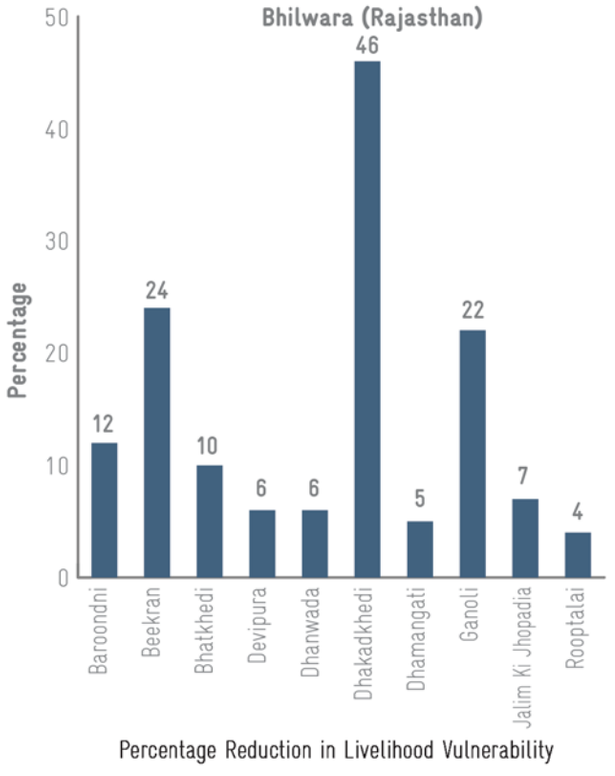
- ***Medak:*** LVI declined in all the 10 study villages of Medak district, Andhra Pradesh, in the range of 11 to 62% (Figure 11). This reduction was due to significant increase in the net area irrigated and the number of days of employment created by MGNREGS in the study villages.
- ***Chitradurga:*** In Chitradurga district, Karnataka, LVI decreased in the range of 8 to 52% in all the 10 study villages. This reduction was a result of increase in the area under irrigation post-MGNREGS implementation, increased number of days of employment and wage rates.
- ***Dhar:*** A reduction in the range of 34 to 81% in LVI was computed for Dhar district, Madhya Pradesh. This reduction could be attributed to increased crop yields, number of days of employment, wage rates and decreased migration in all the study villages.
- ***Bhilwara:*** In Bhilwara district, Rajasthan, LVI declined by 4 to 46% in all the study villages (Figure 11). This reduction can be attributed to significant increase in the net area under irrigation, livestock population and reduction in migration in all the study villages.

MGNREGS works related to water and land development have been shown in this study to have contributed to generation of environmental benefits such as ground water recharge, increased water availability for irrigation, increased soil fertility, reduction in soil erosion, and improved tree cover. Such environmental benefits have been shown to be critical for reducing the vulnerability of agricultural production and livelihoods. These environmental benefits derived from MGNREGS works have the potential to not only build resilience to cope with current climate risks but also build long-term resilience to projected climate change, especially due to improved soil fertility, ground water recharge, reduced soil erosion, and so on.

Figure 11: Percentage reduction in livelihood vulnerability in villages of study districts




Dhar (Madhya Pradesh)
Percentage
90
80
70
60
50
40
30
20
10
0
77
81
63
68
72
34
69
64
62
73
Barmandal
Chotiyabalod
Fulgawri
Hanumantyakag
Khutpala
Kotrakala
Baramkhedi
Morgow
Machaliya
Minda
Percentage Reduction in Livelihood Vulnerability


Bhilwara (Rajasthan)
Percentage
50
40
30
20
10
0
12
24
10
6
6
46
5
22
7
4
Baroondni
Beekran
Bhatkhedi
Devipura
Dhanwada
Dhakadkhedi
Dhamangati
Ganoli
Jalim Ki Jhopadia
Rooptalai
Percentage Reduction in Livelihood Vulnerability

12. Environmental Benefits and Vulnerability Reduction to Climate Risks; Case Study of Sikkim

A case study of Sumbuk block of Sikkim assessing the environmental benefits generated under MGNREGS, and their potential to reduce vulnerability to climate risks is presented here.

Case Study of Sumbuk Block, South District, Sikkim

Introduction

Sikkim state and in particular the South district is characterized by mountainous terrain where agricultural practices and irrigation systems are different from the four other states included in this study. Further, the average rainfall in Sikkim is around 3,580 mm, whereas the other four study districts are in arid and semi-arid regions. Thus the results of the assessment for Sikkim are presented separately as a case study, since the types of works implemented, the scale of implementation as well as the rainfall are distinctly different from the other 4 study states.

Selection of study location: South Sikkim is one of the districts with high level of implementation of works and also where the works were implemented during the first phase. Within South Sikkim, Sumbuk block was selected. The results for the five study villages, for which complete data was available, are presented.

Study villages: Lunchuk Kamarey, Melli Dara, Sadam Suntalay, Sumbuk Kartikey and Turuk

Works assessed: The works implemented in South Sikkim mainly included; *Jhora* training works, Dhara Vikas (springshed development) works, minor irrigation channel construction, water source development, protective works, catch water drain construction, stone drywall construction, water harvesting tanks and raising of plantations of China Teak, Orange and fodder grass. A total of 169 direct beneficiaries of 30 natural resource based MGNREGS works were assessed in the 5 study villages of Sumbuk block.

Methods: The methods adopted for estimation and quantification of environmental benefits and vulnerability assessment are the same as those employed in the other 4 states – beneficiary household survey, PRA, bio-physical measurements and secondary data collection. The baseline year in the case of Sikkim is 2007, as MGNREGS works were initiated only in that year.

MGNREGS Impact on Water Resources

The results of the assessment of the impacts of MGNREGS works on availability of water from springs for irrigation and drinking purposes are presented in this section. *Dhara Vikas* and catch water drain construction under MGNREGS are likely to have impacts on checking surface water runoff, increasing percolation of water and thus increase ground water recharge, drinking water availability and area under irrigation.

Impact on ground water levels: The impact of MGNREGS works such as *Dhara Vikas* on ground water in terms of water availability for drinking and irrigation purposes was assessed. *Dhara Vikas* involves the construction of ground water recharge structures such as staggered contour trenches, percolation tanks and check dams on sloping lands that are not affected by landslides.

A one point measurement of water discharge rate (liters/minute) from a spring (*Malagiri Dhara*) was conducted in 2012 and compared to spring discharge rates previously measured at the same spring in 2010 by Tambe et al. (2012), as *Dhara Vikas* work was carried out in only one (Lunchuk Kamery) out of the five study villages selected.

- Beneficiaries reported an increase of 10 to 15% in the quantity of water collected from springs for domestic purposes, throughout the year.
- Discharge measurements conducted in May 2012, for *Dhara Vikas* work aimed at rejuvenating the spring in Lunchuk Kamarey, reported an average discharge rate of 6.5 liters/minute. A study previously conducted by Tambe et al. (2012), reported that the springshed development approach to revive springs using rainwater

harvesting and geo-hydrology techniques resulted in increased spring water discharge rates from 4.4 to 14.4 liters/minute in 2010-11 during the lean season (March to May), which corresponds to the finding of this study.

- Construction of minor irrigation channels – MICs (a permanent irrigation conduit), as an irrigation provisioning and improvement work under MGNREGS was observed in 4 out of the 5 study villages. According to direct beneficiaries of MICs, area under irrigated cultivation using ground water has remained constant; however, an increase in water availability for irrigation by an average of 5 to 20 days is reported. Further, the number of hours of irrigation/day for a crop is reported to have increased by an average of 2 hours.

Thus, according to beneficiary perceptions as well as bio-physical measurements of ground water discharge Dhara Vikas has led to ground water recharge, by increasing percolation rates and checking surface runoff. Further, irrigation provisioning has led to improved water availability for irrigation, potentially leading to increased crop production and crop yields.

MGNREGS Impacts on Land

Soil organic carbon: Table A presents the changes in SOC content post-MGNREGS work implementation, compared to control plots in the 5 study villages. In 86% of sample locations, SOC content increased in the range of 0.1 to 2.2%.

Table A: Impact of MGNREGS works on soil fertility; soil organic carbon content in Sumbuk block

MGNREGS works	Number of sample locations	% of locations reporting SOC increase	Range of increase in SOC (%)
Jhora training works	11	63	0.1 – 0.2
Protective works	9	72	0.4 – 1.8
Catch water drain	4	100	0.4 – 1.5
Plantations	4	100	0.2 – 2.4
MIC	22	66	0.2 – 1.7
Dhara Vikas	5	100	0.96
Water source development	8	83	0.7 – 1.0
Land development	1	100	2.2

Soil erosion: An average of 41.7 t/ha/year of soil erosion was estimated from sample plots when compared to 50.3 t/ha/year, from control plots. This average reduction of 8.7 t/ha/year in soil erosion can be attributed to implementation of afforestation, horticulture development, Jhora training works and other soil and land protective works, implemented under MGNREGS.

Soil protection and conservation practices have been shown to directly lead to increased soil fertility and reduced rate of soil erosion in most of the locations wherein MGNREGS works have been implemented.

MGNREGS Impacts on Crop Production Systems

PRAs were conducted in the study villages to understand the impact of MGNREGS works on crop production.

Total area under cultivation, crop diversity and cropping intensity

- In all the 5 study villages, the area under cultivation increased in the range of 4 to 8%. According to beneficiary households, this additional area brought under cultivation was a result of MGNREGS land development works such as clearing of land, land levelling, terracing, etc.
- There is a change in the cropping pattern among dryland farmers, with cultivation of broom grass and fodder grass along with continued cultivation of Maize, Ginger, Soybeans and Pulses.
  - Area under broom grass cultivation has increased in the range of 5 to 40 ha in 4 out of the 5 study villages.
  - Area under fodder grass production has increased in all the study villages in the range of 50–100 ha.
- Due to increased irrigation water availability, farmers have now started cultivating vegetables like Beans, Radish, Cauliflower, Cabbage and Chilies, along with Paddy and Tomatoes.

- Some farmers have started cultivating perennial garden crops like Orange, Banana, Guava and Litchi, since 2008, post-MGNREGS implementation.

Crop yields: Impact on crop yields according to beneficiary survey is presented below

- An average 18% increase in crop yields is reported by the beneficiary households from all the study villages
- Crop yield of dryland crops such as Maize, Ginger, Soyabeans and Pulses increased by about 11% in the study villages
- There is an increase in crop yields by about 25% for irrigated crops such as Paddy, Tomato and vegetables like Beans, Radish, Cauliflower, Cabbage and Chilies in the study villages

Multiple MGNREGS works seem to have impacted crop yields positively.

MGNREGS Impacts on Forests, Plantations and Fruit Orchards

Afforestation works were undertaken and fruit orchards have been raised in all the study villages, under MGNREGS.

- 5000 tree saplings were planted in each of the 5 study villages and as a result, the area under forest tree cover increased by an average of 5 ha in all the study villages.
- Species such as *Terminalia myriocarpa, Duabanga grandiflora, Tectona grandis, Bassia butyracea,* etc., have been raised in plantations. Survival rate of 35 to 40% was recorded in all the 5 villages.
- Biomass stock was higher in plantations compared to control plots in all the villages.
- SOC content in plantation plots is estimated to be higher than in control plots (Table A).
- Lands subjected to plantations, water conservation and harvesting works, *Jhora* training works, etc., have increased carbon stock when compared to control plots in the range of 26 to 42% (Table B).

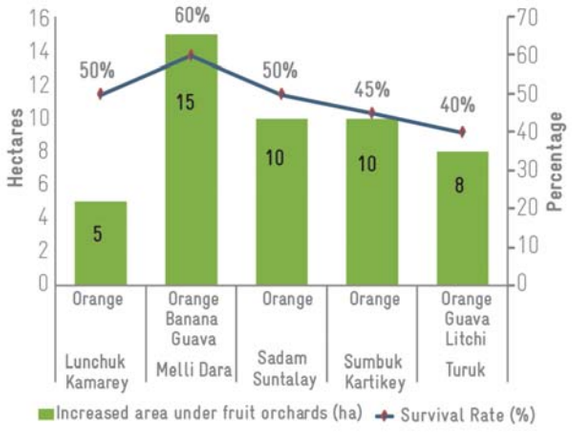
Table B: Impact of MGNREGS works on carbon stock enhancement in existing plantations/ forests in Sumbuk block

Village	Biomass stock (t/ha)		% change in carbon stock
	Control plots*	Post-MGNREGS forestry plots	
Lunchuk Kamarey	75	102	26
Melli Dara	51	87	41
Sadam Suntalay	15	26	42
Sumbuk Kartikey	8	13	38
Turuk	82	115	29

**exisiting forests, plantations and degraded land*

- Implementation of horticulture development as well as implementation of irrigation provisioning facilities under MGNREGS has led to increase in area under fruit orchard cultivation in the study villages, in the range of 5 to 15 ha, with a survival rate ranging from 40 to 60% as reported by the beneficiaries of these works. The fruit tree species cultivated, the increased area under fruit orchards, as well as the survival rates of trees planted are given in Figure A.

Figure A: Impact of MGNREGS works on fruit orchards; area, diversity and survival rates in study villages



Fruit tree cultivation and afforestation is a major work implemented under MGNREGS in the selected study villages and has the potential to generate multiple environmental and socio-economic benefits.

MGNREGS' Impacts on Employment and Migration

The two socio-economic indicators assessed include employment generation and migration.

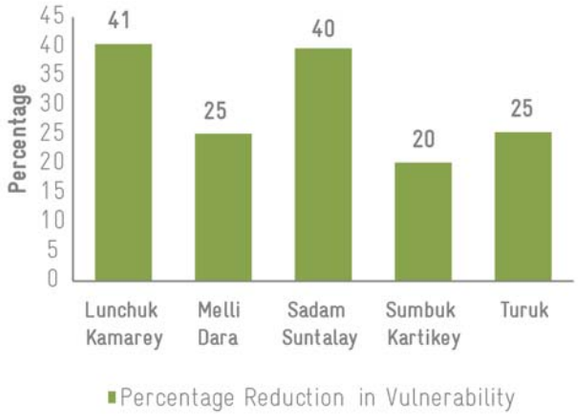
Employment generation: According to beneficiaries in all the selected villages, the additional direct employment created due to MGNREGS work implementation has increased in the range of 27 to 37 days per year. Further, household incomes have increased by an average of 30% due to employment provided under MGNREGS. Normal wage rates have been reported to have increased by Rs. 50/day, post inception of MGNREGS in all the 5 study villages.

Migration: Due to increased employment availability through MGNREGS implementation, and indirect increase in income from agriculture and fruit trees, migration of landless or unskilled labourers has decreased by 100% in all the 5 study villages.

Vulnerability Reduction to Climate Risks through MGNREGS

The overall vulnerability of the 5 study villages was estimated by calculating a Composite Vulnerability Index (CVI) comprising of socio-economic as well as agricultural indicators such as change in wage rates, number of individuals migrating per year, cropping intensity, increase in area under food grains, and major crops, soil organic carbon and soil erosion rates. These indicators were quantified through household survey, PRA, bio-physical measurements or secondary data sources for two time periods – pre-MGNREGS (2007) and post-MGNREGS (2011). The percentage change of indicator values between the two time periods was estimated and this was multiplied with respective weights assigned to them by the beneficiaries. The values were aggregated to obtain CVI. Figure B provides overall percentage reduction in vulnerability due to MGNREGS implementation for the 5 study villages.

Figure B: Composite vulnerability index for the 5 study villages of Sumbuk block



All the study villages showed lower vulnerability in the post-MGNREGS scenario as compared to pre-MGNREGS in the range of 20 to 41%. This reduction in vulnerability is largely due to land development and water related MGNREGS works implemented, which contributed to increased water availlability for irrigation, improved soil fertility and increased employment.

13. Perspectives of Village Communities for Improved and Sustained Environmental Benefits from MGNREGS

In the study the suggestions of local communities for improving the performance of MGNREGS were elicited through PRA conducted at the village level, including multiple stakeholders such as Gram Panchayat members, women, landless and farmers. The communities were asked to provide their suggestions with respect to: i) selection of works; ii) implementation and supervision; iii) awareness and capacity building; and iv) long-term environmental benefits. A synthesis of the suggestions that emerged from the PRA is provided in Table 12.

- Natural resource management should be given priority, and technical feasibility of works should also be considered, with the Gram Sabha having the final say in the selection of works.
- Training, supervision of work implementation and monitoring is critical for improved performance of the programme.
- Capacity building, improved access to information for periodic monitoring and access to technical guidance is necessary.
- Need to ensure sustained flow of benefits, particularly from water-related works to enhance crop production, which can contribute to enhanced employment in the long-term.

Table 12: Perspectives of village communities for improved selection of works, implementation, supervision and delivery of long-term environmental benefits

Issues	Compilation of suggestions
Selection of Works	1. A committee should be formed at the village level which should receive training in order to properly select works and propose these to the Ward *Sabha/ Gram Sabha* 2. A prior notification to all the villagers about the selection of works to be implemented under MGNREGS 3. The plan of action put forth by the *Gram Sabha* should be given priority over other available works 4. Works should be selected or approved by voting in the *Gram Sabha* 5. Technical feasibility should be the criterion for the selection of works 6. Natural resource management should be given top priority 7. Basis for the beneficiary selection should be economic status instead of caste
Implementation and Supervision (e.g. technical guidance)	1. A special team for monitoring and evaluation should be deputed 2. Technical guidance should be given by engineers at regular intervals during and after completion of works 3. Training should be conducted before the announcement of the scheme 4. Supervision from *Gram Panchayat*, *Taluk Panchayat* and *Zilla Panchayat* officials should be improved by providing them with the required training 5. A plan for private land works should be prepared based on the actual field conditions 6. The material-labour ratio should be made flexible for certain kinds of works that are necessary for the village communities because their budgetary provisions are not available in other programmes 7. The provisions for shade and drinking water at the workplace needs to be increased 8. Whenever pasturelands development/closure/plantation works are implemented, provisions for a village level committee to be established for the maintenance of the works should be compulsory 9. There should be provisions for a contingency fund at *Gram panchayat* level for maintenance

Issues	Compilation of suggestions
Awareness and capacity building	1. Advertisement of the scheme should be done by speakers, booklets and leaflet distribution 2. List of works completed could also be located on village maps and periodical assessment of the works could be put as a regular activity of the programme 3. Capacity building and orientation should be provided to the local youths and graduates for better monitoring and technical guidance to the field assistants 4. One Junior Technical Assistant to be posted for every 2-3 *Panchayats*. The Junior Technical Assistant should be trained in civil engineering. 5. Provisions should be made for photo documentation
Long-term environmental benefits	1. All community assets created must be maintained to ensure sustained flow of benefits. 2. Plantation activities should be made compulsory with the implementation of any water related assets. 3. The status of the assets created and the flow of benefits should be periodically monitored. 4. Sustained water availability will lead to improved crop yield and fodder production, ultimately contributing to enhanced opportunities for employment. 5. Clarity on ownership and user rights for community assets created

14. Conclusions

MGNREGS is one of the largest rural development programmes implemented in India. The present study aimed at quantifying and generating empirical evidence on the potential of MGNREGS to generate environmental benefits, and reduce vulnerability to climate risks. The empirical evidence from the 5 study districts representing 5 states, with diverse socio-economic and environmental conditions, shows that MGNREGS is generating multiple environmental and socio-economic benefits; leading to improved water availability and soil fertility resulting in increased crop production. Increased area under plantations and orchards potentially contributing to alternate incomes, increased employment generation and reduced migration. Further the implementation of MGNREGS works has contributed to reducing vulnerability to climate risks. The key findings and recommendations are presented in the Executive Summary.

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