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Deepening knowledge of MGNREGS' contribution to climate resilience

A study of Rajasthan and Uttar Pradesh

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The Climate Change Group works with partners to help secure fair and equitable solutions to climate change by combining appropriate support for adaptation by the poor in low- and middle-income countries, with ambitious and practical mitigation targets. The work of the Climate Change Group focuses on achieving the following objectives:

- Supporting public planning processes in delivering climate-resilient development outcomes for the poorest
- Supporting climate change negotiators from poor and vulnerable countries for equitable, balanced and multilateral solutions to climate change
- Building capacity to act on the implications of changing ecology and economics for equitable and climate-resilient development in the drylands.

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Social protection is a key tool to support the poorest and most vulnerable to adapt to climate change. This working paper explores the extent to which India's largest social protection programme – the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) – helped households prepare, cope and recover from the 2018 summer drought across Rajasthan and Uttar Pradesh. As well as providing baseline information on the climate information services accessed by MGNREGS households and officials, it offers practical guidelines for how the scheme can use climate information in its decisions and planning.

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Summary

The climate emergency continues to escalate. Without just and equitable adaptation action at scale, societies' poorest and most vulnerable people will continue to face rising climate impacts, threatening efforts to combat poverty. In India, the rural poor are particularly at risk: more than 145 million people live below the poverty line (ADB 2020) and dependence on weather-sensitive agriculture is high.

Adaptive social protection – an important tool to address the climate risks faced by the world's poorest and most vulnerable (Tenzing 2019) – brings together social protection and adaptation goals to address environmental and socioeconomic shocks. This working paper strengthens the robust evidence base behind the climate resilience contribution of social protection, by investigating India's largest social protection programme, the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS). Guaranteeing 100 days' paid wage labour to rural households that demand it and another 50 days in times of environmental shock, MGNREGS uses wage labour to build public and private rural assets.

This paper aims to fill two global research gaps, addressing the lack of both outcome data on the extent to which social protection programmes deliver climate resilience outcomes for vulnerable people and actionable guidance on how social protection programmes can integrate climate information services (CIS) to improve climate resilience outcomes. We present results from a household survey representative of more than 1.5 million MGNREGS workers across four drought-affected districts: Barmer and Jodhpur in Rajasthan and Banda and Mahoba in Uttar Pradesh. These are the first representative outcome data on the extent to which a social protection programme delivered climate resilience outcomes in the aftermath of a climate shock – in this case, the 2018 drought.

Study findings

Although we found that MGNREGS' wages and assets deliver modest climate resilience benefits across the study districts, these were overwhelmingly concentrated in Barmer, showing significant regional variations in how MGNREGS helps build household drought resilience.

Wages help 37% of households prepare for drought, but offer minimal support for coping or recovery. This aligns with earlier findings that cash transfers help households cope with short-term shocks by providing money (Tenzing 2019, Kaur et al. 2019) – in this case, to buy essential goods for household consumption and livestock fodder. However, only 4% of households said they received any additional days' drought relief wages, and delivery was delayed by approximately six months. Given MGNREGS' explicitly shock-responsive objectives, we had expected wages to contribute more to coping and recovery. We cannot conclude whether households find it sufficiently shock responsive.

Assets contributed more equally to households' ability to prepare (30%), cope (28%) and recover (21%) from drought. This also aligns with previous findings that public works programmes contribute both to absorptive and adaptive resilience (Tenzing 2019, Kaur et al. 2019). Most of the households that reported these resilience outcomes were in Barmer, where MGNREGS officials have targeted increasing water conservation in the district. Although we do not propose widespread use of top-down approaches, this showcases the positive impact that highly context-specific and landscape-based asset planning can have on resilience outcomes.

Household **participation** in MGNREGS decision making at the *gram sabha* (general village assembly) is low, with only 15% of households reporting that their preferred MGNREGS asset had been selected. Female-headed households are significantly less able to have their choices heard. Assuming that strong household participation will strengthen their agency and adaptive capacity, this indicates a weakness in MGNREGS' hallmark bottom-up planning.

Baseline for CIS use in decision making

This is the first baseline analysis of CIS use by households and MGNREGS officials since it was officially mandated for use in MGNREGS decision making. We found that more than half (58%) of households have access to CIS. Of these, 75% use very-short (<1 day) and short to medium-range (1–10 day) weather forecasts provided through the

gram sabha. Households' trust in and use of CIS declines markedly with a longer lead time, including extended (30 day) and long-range (monsoon) forecasts.

More than 80% of households with access to CIS use it in their livelihood decisions but only 25% use it to plan or select MGNREGS assets or wage labour. It is not clear whether this is because they do not understand the benefits of CIS to MGNREGS decisions or because CIS is not tailored to MGNREGS decisions and timeframes. MGNREGS officials do not use CIS in labour budget planning, drought declaration or asset planning.

There is high demand for CIS among MGNREGS households, especially for improved access to medium (87%) and extended-range (32%) forecasts. Demand for shorter-term CIS is strongest in Uttar Pradesh, while Barmer has more demand for extended-range forecasts.

Guidance for integrating CIS into decision making

With significant room for strengthening MGNREGS resilience outcomes, especially outside Barmer, and notable gaps in official use of CIS, we identified several ways CIS could benefit MGNREGS decision making. If used effectively, it could help strengthen households' short, medium and long-term capacity to prepare for, cope with and recover from drought. Our findings were informed by a thorough analysis of CIS available in India, most notably from the Indian Meteorological Department (IMD). Due to their high uncertainty, we do not recommend using extended-range (30 day) rainfall forecasts or direct climate projection outputs.

1. Integrating CIS into labour budget planning

- **Short-term labour and asset revisions:** Using seasonal long, medium and short-range weather forecasts and remote sensing data to enable shifts between labour-intensive or more strategic assets, depending on upcoming rainfall and drought risk.
- **Long-term annual wage labour budgeting:** Using historical climate information, and if viable, seasonal long-range monsoon outlooks, to improve understanding of annual and decadal trends in drought to inform labour budget peaks and troughs.

2. Integrating CIS into shock-responsive wage payments

- **Dynamic wage rate:** Based on drought and heat stress forecasts to provide households with higher daily wage payments during drought or extreme heat shocks.
- **Anticipatory wage payments** or forecast-based financing: Using long-range monsoon forecasts or remote sensing data to improve preparedness by providing households with wage payments before a drought.
- A **CIS-informed drought declaration process:** Using remote sensing drought indices to trigger faster additional MGNREGS wage days to households when drought occurs.

3. Integrating CIS into asset planning

- **Short-term asset planning:** Using monthly extended-range or seasonal long-range forecasts to make changes to more strategic assets, depending on upcoming rainfall and drought risk.
- **Longer-term asset planning:** Integrating historical climate information and climate scenarios using decadal and multi-decadal projections as guidance within a robust decision-making framework, to plan longer-term and more durable assets.

For all recommendations, CIS must be co-produced with end users, including district, block and *gram panchayat* (village committee-level) MGNREGS officials and households. This will require building household and official capacity and knowledge on using CIS in MGNREGS decision making to better understand their own CIS needs. There must be special consideration for vulnerable groups to ensure CIS access is both equitable and meaningful. Households' overall participation in MGNREGS decision making also needs to be considered, as it is currently low. The Ministry of Rural Development and state governments will need to further collaborate with IMD and remote sensing agencies to discuss the different options we present – especially long-range monsoon forecasts and alternative drought remote sensing data – to ensure information is available, useable and provided in formats that suit the needs of MGNREGS decision makers and workers.

1 Introduction

2020 looks set to be the hottest year on record (Watts 2020) and, without urgent and rapid decarbonisation, the world may surpass 1.5°C in global warming as soon as 2023 (Met Office 2020). Severe climate impacts are already being felt around the globe, disproportionately affecting the poor who are more exposed and sensitive – and have a lower adaptive capacity to respond – to slow and rapid-onset events like droughts, floods and cyclones (Hallegatte et al. 2016). There is an urgent need for just and equitable adaptation for strengthening the climate resilience of the poorest and most vulnerable (IPCC 2018, UNEP 2019). This is especially the case in India, where more than 145 million live below the poverty line (ADB 2020), and even more so in rural India, where poverty is combined with a high dependence on agricultural livelihoods.

Social protection is increasingly recognised as an important part of the 'toolbox' for building the climate resilience of the poor and most vulnerable. There are substantial overlaps between social protection and climate adaptation goals. They both aim to address poverty and inequality; they are both targeted approaches that support marginalised groups; and they both aim to reduce risks and support individuals, households or communities from shocks (World Bank 2013, Agrawal et al. 2019, Tenzing 2019).

The global evidence base for social protection suggests that, while it can build individuals' absorptive capacity to climate shocks, it has limited impact in building adaptive or transformative resilience capacity (Bahadur et al. 2015, Agrawal et al. 2019, Tenzing 2019). However, the evidence also shows two notable gaps in current understanding of social protection and climate resilience. The first is a lack of robust outcome-level or impact data to show the extent to which specific social protection programmes have helped vulnerable people respond to a specific and recent climate shock. Most studies are based on theories of change, showing potential contributions to resilience rather than empirical resilience outcome evidence. The second gap is actionable guidance on how social protection programmes can improve decision making to support climate risk management, particularly by integrating climate information services (CIS) into decision making.

This paper, supported under and contributing to DFID India's Infrastructure for Climate Resilience Growth programme, aims to help fill these research gaps by analysing India's largest social protection programme – the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS). A rights-based, rural public works scheme, MGNREGS provides a minimum of 100 days of paid wage labour to any rural household that demands it, using this labour to build public and private infrastructure (GoI 2005). It reaches 272 million rural workers across 33 of India's 36 states and union territories (MGNREGA 2020). The Government of India has begun to promote MGNREGS as a climate resilience building mechanism, with the Ministry of Environment Forest and Climate Change (MoEF&CC) recognising it as one of the 24 key government initiatives for tackling climate change while improving poor peoples' livelihoods (MoRD 2019).

Previous IIED research lays out the theoretical case for how MGNREGS can build rural households' and rural economy's climate resilience, presenting initial findings on MGNREGS' contribution to climate resilience in six Indian states (Kaur et al. 2019). This working paper aims to deepen our understanding of MGNREGS' contribution to rural households' climate resilience

and address the two gaps in the global evidence base highlighted above. This paper presents:

- **Improved evidence of MGNREGS' contribution to climate resilience outcomes after a climate shock.** We present evidence from four districts in Rajasthan and Uttar Pradesh that were impacted by a drought in the main *kharif* planting season in 2018.[1] This evidence is representative of the entire MGNREGS' workforce of more than 1.5 million workers across the four study districts. The statistical methods we use mean that, for the first time, our findings are representative of MGNREGS' resilience contribution across an entire study area. To our knowledge, this is the first-ever published representative dataset on the extent to which a social protection programme has delivered resilience outcomes in the immediate aftermath of a climate shock.
- **Evidence on the extent to which MGNREGS workers are using CIS to inform their participation in the programme.** Also for the first time, we provide baseline data on the types of climate information that rural households access and use to inform their MGNREGS planning and engagement. These findings provide useful data to recommend how to improve CIS integration into MGNREGS decision making to make it climate-smart – ensuring development investments and their decisions proactively consider and are responsive to a changing climate.
- **Guidance on how MGNREGS can further integrate CIS into planning and decision making to strengthen climate resilience outcomes.** Building on the evidence of MGNREGS' contribution to climate resilience and the current levels of CIS use in MGNREGS decision making, we develop more context-specific recommendations for how central, state and district governments can strengthen the integration of CIS into planning and decision making. These recommendations are aimed at strengthening the climate-smart delivery of MGNREGS' wage and asset instruments, to ensure they support better climate resilience outcomes for rural households as climate shocks continue to escalate.

The analysis we present in this working paper is timely. The implications of the COVID-19 pandemic are likely to push 14–49 million people into extreme poverty in 2020 (World Bank 2020), amplifying the need for strong social protection programmes. This crisis provides a timely impetus to evolve MGNREGS so it can more proactively address socioeconomic and climate shocks. It is our hope that the guidance presented in this report offers tangible ways forward to ensure MNGREGS is better equipped to help vulnerable people become resilient to shocks in an increasingly uncertain future.

BOX 1. GOVERNANCE OF RISK AND MONEY WHERE IT MATTERS

This IIED working paper comes under two IIED work programmes:

Governance of risk seeks to strengthen the agility, resilience and mobility of the world's poorest against climate change.

Money Where it Matters seeks to get more climate finance into the hands of the poorest and most excluded people, for adaptation investments that meet their needs.

[1] *Kharif* is the main cropping season, usually during the southwest monsoon from July to October; rabi is the second cropping season, usually from October to March.

2

Research context

This section provides an overview of social protection, CIS and MGNREGS and outlines the gaps we aim to tackle in this report: the lack of first-hand evidence on social protection programmes' contribution to vulnerable peoples' resilience and tangible guidance for integrating CIS into these programmes to strengthen development and resilience.

2.1 Social protection and climate resilience

Social protection plays an important role in global efforts to reduce poverty. In 2017, social protection expenditure in low and middle-income countries reached almost US$500 billion and provided benefits to nearly 2.7 billion people (World Bank 2018, Agrawal et al. 2019). Social protection can take many different forms (see Box 2). In low and middle-income countries, it tends to be delivered through social assistance or public works programmes that provide income or in-kind support to improve consumption and reduce the impact of livelihood shocks.

BOX 2. WHAT DO WE MEAN BY SOCIAL PROTECTION?

Social protection refers to "all public and private initiatives that provide income or consumption transfers to the poor, protect the vulnerable against livelihood risks, and enhance the social status and rights of the marginalised; with the overall objective of reducing the economic and social vulnerability of poor, vulnerable and marginalised groups" (Devereux and Sabates-Wheeler 2004).

There are three main types of social protection instrument:

1. **Social assistance** includes non-contributory, means tested or targeted programmes for vulnerable groups such as cash or in-kind transfers, input and food subsidies, conditional cash transfers, fee waivers and social pensions.
2. **Social insurance** includes contributary programmes like maternity benefits, unemployment insurance, health insurance and weather-based crop insurance.
3. **Labour market** interventions include employment guarantee schemes and cash-for-work and skills transfer programmes.

Sources: Ulrichs (2016), Agrawal et al. (2019), Tenzing (2019)

Social protection can be a key instrument to help reduce poverty and vulnerability and deal with climate shocks and disasters. In recent years, a growing body of literature has outlined the potential for social protection to move beyond poverty reduction to also help poor people manage climate change risks, support adaptation and build climate resilience. The justification is that both types of intervention aim to address poverty and inequality. They are both targeted approaches that support marginalised groups, aim to reduce risks and support individuals, households or communities from shocks (Kuriakose et al. 2012, World Bank 2018, Agrawal et al. 2019, Tenzing 2019).

Studies have proposed several ways to combine social protection and climate adaptation approaches to tackle poverty, vulnerability and climate risk more effectively – from forecast-based financing to shock-responsive social protection, climate-responsive social protection and adaptive social protection (Kuriakose et al. 2013, World Bank 2013, Ulrichs 2016, Costella et al. 2017, Maher et al. 2017, ADB 2018, Asfaw and Davis 2018, Béné et al. 2018, RCCC 2018, O'Brien et al. 2018, Wilkinson et al. 2018, Kaur et al. 2019, Ulrichs et al. 2019).

The global social protection evidence base suggests that, when social protection and climate resilience approaches are aligned, they can build household and individual absorptive resilience capacity to climate change. But they have limited impact on building adaptive or transformative resilience capacity (Agrawal et al. 2019, Tenzing 2019).

To strengthen the climate resilience contribution made by social protection, many studies propose integrating CIS into planning and decision making to support more climate-smart decisions and subsequently deliver better climate resilience outcomes. However, there are two significant gaps in the empirical evidence base on how social protection can build resilience and reduce vulnerability. These are a lack of:

1. **Outcome-level data on how social protection delivers climate resilience to vulnerable people and households:** Most social protection and climate resilience case studies do not have data to demonstrate whether the interventions improved the overall wellbeing of individuals or households. Importantly, few have measured the impact of social protection interventions in relation to a specific climate shock to understand the extent to which the social protection programme supported them to manage the shock.
2. **Practical guidance on how policymakers can improve climate-smart planning and decision making:** Integrating climate information into planning and decision making is particularly important for public works programmes that build infrastructure, to ensure new assets contribute to climate resilience.

This working paper helps fill these two gaps by investigating India's MGNREGS, which we introduce in detail below, before turning to the research approach we use to answer these two critical questions.

BOX 3. WHAT ARE CLIMATE INFORMATION SERVICES (CIS)?

Understanding the weather (the state of the atmosphere at any point in time) and the climate (the long-term statistics of weather) is crucial for many livelihood decisions, particularly those that rely directly on the weather, such as agriculture. People have always dealt with weather variability, often using historical records or their own traditional knowledge. However, with projected climate change, historical and traditional knowledge is no longer solely suitable, as it changes natural weather variability and shifts the frequency and severity of extreme weather events.

Weather and climate information is crucial for effective climate risk management, providing data to make more informed and robust decisions on hazard types, their probability of occurrence and their scale. Effective use can raise adaptive capacity, supporting people's ability to adjust to potential damage, take advantage of new opportunities and respond to consequences. Both short-term (weather) and long-term (climate) information can be useful, helping people to address their existing adaptation deficit to short-term variability or longer-term climate change.

CIS seeks to make this weather and climate information useable and helpful. Although some refer to CIS as weather or climate information, in this report it encompasses the useful dissemination of short-term (less than one day) weather information, all the way to long-term climate projections in the second half of the century. CIS components include tools, products, websites and bulletins in formats that can be interpreted by different decision makers.

An effective CIS may also build people's and institutions' capacity to use this information effectively.

Sources: Hansen et al.(2019), Barrett et al. (2020)

2.2 MGNREGS overview

With a 2020 budget of US$13 billion MGNREGS is India's largest social protection programme. In 2018–2019, it provided employment to 122 million rural people across the country. Created by the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) in 2005 (GoI 2005), MGNREGS has operated in all rural districts since 2008. Its main objectives are to reduce poverty and enhance livelihood security (MoRD 2019), through:

- **Guaranteed wages:** Every rural Indian household is entitled to at least 100 days of paid, unskilled labour each year within five kilometres of their household. Based on MGNREGS' bottom-up and participatory planning process, all states have a labour budget – an annual plan that outlines the proposed works and the expected number of individual worker days required to complete them – which projects the yearly amount of labour to be demanded. The annual plan for each administrative level and 50 additional wage labour days are also available on the formal declaration of a natural calamity such as a drought or flood. In theory, this makes MGNREGS implicitly shock responsive.
- **Rural infrastructure:** MGNREGS workers build community or private infrastructure – also known as assets or works – that are prioritised within an annual plan and a priority list for assets to be constructed, or 'shelf of works'. Assets are discussed and selected through village-level public assemblies known as *gram sabhas*, which are convened by government officials in a *gram panchayat*, the most decentralised level of Indian government. The central government mandates that at least 60% of works undertaken should be productive assets directly linked to agriculture and allied activities through the development of land, water and tree resources, which have potential to reduce climate change vulnerability, protect farmers from risks and conserve natural resources.
- **Other instruments:** Although wages and rural infrastructure are MGNREGS' main instruments, the scheme also supports rural workers to open a bank account so they can receive electronic payments directly to their account. Over the years, the national government has increased the emphasis on skills development for MGNREGS workers.

MGNREGS is embedded within the national and state government civil service and has a strong institutional delivery structure from central (national) down to community level. Table 1 outlines this delivery structure at centre, state, district, block and *gram panchayat* administrative levels.

Table 1. Institutional delivery structure of MGNREGS

	ASSET DESIGN AND PRIORITISATION	WAGE LABOUR BUDGETING AND RESOURCING
CENTRE	**Ministry of Rural Development (MoRD)** • Sets percentage of works to be undertaken in annual master circular • Sets standard design of assets (works)	**Empowerment Committee** • Reviews and approves state labour budgets **MoRD** • Approves additional 50 days of wage labour in case of natural calamity
STATE	**State rural development (and *Panchayati Raj*) department** • Makes changes to permissible assets (works) allowed within the state • Selects 'backward' (vulnerable) blocks for special attention	**State rural development (and *Panchayati Raj*) department** • Sets state wage rate • Approves district labour budget and consolidates into state labour budget • Provides guidelines for participatory labour budget (annual) planning • Ensures adequate 'shelf of works'
DISTRICT	**Chief executive officer or district collector** • Integrates natural resource management assets (works) into district irrigation plan • Oversees district-level convergence • Assures achievement of nationally and state-led asset (work) prioritisation: 50% *at gram panchayat* level, 65% expenditure on natural resource management, 60% for productive agricultural assets **Executive engineer** • Issues technical sanctions (estimates cost of labour and material) for all MGNREGS assets	**Chief executive officer or district collector** • Consolidates block labour budget into district labour budget
BLOCK (GROUP OF VILLAGES)	**Block development or project officer** • Ensures *gram panchayat* annual plans contain permissible works and consolidates *gram panchayat* plans into block plans **Technical assistants or junior engineers** • Provide first technical evaluation of assets (works)	**Block development or project officer** • Ensures an adequate 'shelf of works' for each block
GRAM PANCHAYAT (VILLAGE)	**Technical assistants or *gram rozgar sahayaks*** • Help identify works, prepare work estimates and ensure the quality of works, support maintenance of work **Workers (job cardholders)** • Propose works at the *gram sabha* • Implement works	**Workers (job cardholders)** • Demand wage labour

Sources: MoRD 2013, MoRD 2019 and MGNREGS functionary interviews conducted for this research in Rajasthan and Uttar Pradesh
Note: Labour budgets are annual plans for each administrative level that include the proposed works (assets to be built) and the expected number of person days required to complete them.

3

Research approach

This section introduces the strategic rationale for our research in response to the two gaps in the global evidence base outlined in Section 2. We then outline the analytical framework that guides our research – introducing how we frame climate resilience – before introducing the four study locations in Rajasthan and Uttar Pradesh.

3.1 Rationale for deepening our understanding of MGNREGS' contribution to resilience

Over the past four years, IIED has conducted research on MGNREGS across several Indian states to understand how the programme can support climate resilience. These case studies in Andhra Pradesh, Jharkhand, Karnataka, Odisha, Rajasthan and Sikkim found that MGNREGS can build climate resilience. In particular, MGNREGS can support absorptive resilience capacity – the ability to cope with low-magnitude climate shocks. To a lesser extent, it can also support adaptive resilience capacity – the ability to make planned and deliberate actions to cope with current and future climate shocks (Bahadur et al. 2015 Kaur et al. 2019).

This report aims to deepen our understanding on MGNREGS' contribution to resilience. In particular, it aims to respond to the two critical evidence gaps identified in Section 2: the lack of outcome-based data on the extent to which social protection programmes have delivered resilience, especially after a recent climate shock has occurred; and the lack of clear guidance on how CIS can be incorporated into social protection decision making to better support climate risk management.

To address the first global evidence gap, we reflected on our early MGNREGS research, which was based on small case studies with limited sample sizes. We identified the need for:

- More representative data that enables us to extrapolate findings to the broader population in our selected research sites
- More robust outcome-level data from households that had recently experienced a climate shock to understand the programme's true contribution to building climate resilience, and
- A better understanding of the extent to which households participate in MGNREGS decision making and the types of climate information they use (or do not use) to inform their engagement.

This working paper therefore deepens our understanding of MGNREGS' contribution to climate resilience in two ways.

Representative household survey: The results presented in this report are representative of more than 1.5 million MGNREGS workers across four study districts in Rajasthan and Uttar Pradesh – the entire

MGNREGS workforce in the selected districts. The statistical methods we used for data collection mean we can confidently say our findings are representative of MGNREGS' performance in supporting climate resilience in these four study districts. To our knowledge, this is the first-ever published representative dataset on the extent to which a social protection programme has delivered climate resilience outcomes in the immediate aftermath of a climate shock.

Improved evidence of MGNREGS' contribution to climate resilience outcomes after a climate shock: This report provides evidence on the extent to which MGNREGS helped build the climate resilience of rural households in relation to a recently experienced drought. Following our analytical framework (outlined in Section 3.2), MGNREGS workers in four drought-prone north Indian districts reported their perceptions on how income from wages and public or private infrastructure built under the programme helped them prepare, cope or recover from a drought that occurred in the main 2018 *kharif* (monsoon) planting season.

To address the lack of clear guidance on how CIS can be incorporated into social protection decision making to better support climate risk management, we reflect again on our own MGNREGS research. We have previously made nine recommendations for strengthening MGNREGS to deliver more comprehensive climate resilience outcomes for rural households through climate-smart wages, climate-smart infrastructure and stronger climate risk management skills in MGNREGS institutions (Kaur et al. 2019). CIS is an important instrument for delivering most of these climate-smart recommendations, which include delivering anticipatory wage employment, climate-responsive wage rates, stronger labour and asset decision making, and climate-smart infrastructure. More recently, MoRD has requested that historical and projected climate change information and vulnerability assessments are included in MGNREGS asset planning and design (MoRD 2019, see Box 4).

This working paper deepens our understanding of MGNREGS' contribution to climate resilience by providing:

- **Evidence on the extent to which MGNREGS workers are using CIS to inform their participation in the programme.** We present findings on the extent to which MGNREGS workers participate in decision making on MGNREGS wage timing and asset selection. Crucially, for the first time, we analyse the extent to which CIS helps inform MGNREGS decision making, providing useful baseline data for our recommendations on how to improve CIS access and climate-informed decision making.
- **Guidance on how MGNREGS can further integrate CIS into planning and decision making to strengthen climate resilience outcomes**. We also present more practical guidance for how MoRD and other subnational governments begin integrating CIS into MGNREGS decision making, to deliver wages and infrastructure that are more responsive to climate change. This guidance builds on the evidence of MGNREGS' contribution to climate resilience and current levels of CIS use in MGNREGS decision making.

BOX 4. MGNREGS GUIDANCE ON USING CIS

In its most recent guidance on MGNREGS implementation, MoRD outlined that historical and projected climate change information and vulnerability assessments should be used across all sub-State administrative levels in MGNREGS asset planning and design:

> *"Planning and design of works under MGNREGS should take into account impacts of climate change in order to ensure resilience of vulnerable rural communities and make the benefits sustainable in the long run. Specifically, the following things should be ensured: historical and projected climate change data, especially incidence of droughts and floods, along with vulnerability assessment at the district, block or gram panchayat level should be used in the planning and design of MGNREGS works"* (MoRD 2019).

There is, therefore, a need to better understand the current levels of CIS usage among MGNREGS workers and officials, how it is used to inform MGNREGS decision making, and the opportunities to strengthen the use of CIS for MGNREGS' functionaries and workers in the future.

3.2 Analytical framework

Our starting point for understanding climate resilience is "the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions" (IPCC 2012).

Our previous MGNREGS climate resilience research (Kaur et al. 2019) uses the conceptual and analytical climate resilience framing of Béné et al. (2012), breaking resilience into three interdependent capacities: absorptive, adaptive and transformative. Here, we also draw on Bahadur et al. (2015), adding anticipatory capacity, recognising that preparation and planning before shocks occur are an important climate risk management strategy.

A key challenge in climate change research is translating abstract concepts such as 'resilience' into non-technical terminology that can be understood by participants in research studies. This is made more challenging when translating concepts into Hindi and Marwari, and ensuring that all researchers and participants have a shared understanding of terminology and concepts. Therefore, in this study, we used a temporal framework to inquire how MGNREGS' instruments supported rural households to manage the 2018 drought, asking whether MGNREGS' wages and assets supported households to:

- **Prepare** before the 2018 drought occurred
- **Cope** during the drought period, and
- **Recover** after the drought had occurred

Linking prepare, cope and recover to resilience outcomes: We present our findings as asked to households – whether MGNREGS wages and assets helped them to prepare, cope or recover – and do not link them to specific resilience capacities. We believe this enables us to present relevant findings on how MGNREGS supports resilience outcomes from the households' perspectives.

Conceptually, we can link the temporal framing of 'prepare, cope and recover' to the resilience frameworks of Béné et al. (2012) and Bahadur et al. (2015). A simple interpretation is that:

- An ability to prepare for a climate shock means they have anticipatory resilience capacity
- An ability to cope during a shock means they have absorptive resilience capacity, and
- An ability to recover means they have adaptive or transformative resilience capacity, depending on the nature and timeframe of the recovery.

The situation is, however, more nuanced. With a slow-onset climate shock such as drought and a survey administered 12 months after the shock occurred, it is empirically difficult to determine whether households' 'prepare or cope' responses mean they were able to anticipate or absorb the shock. We would have to know whether the households:

- Knew the drought was going to occur beforehand and prepared accordingly, or
- Realised mid-way through the drought and used MGNREGS to seek additional days of employment and use income to help the household cope.

A more cautious approach is to link both 'prepare' and 'cope' with absorptive resilience capacity, since both point to managing the impact of the shock in the short term.

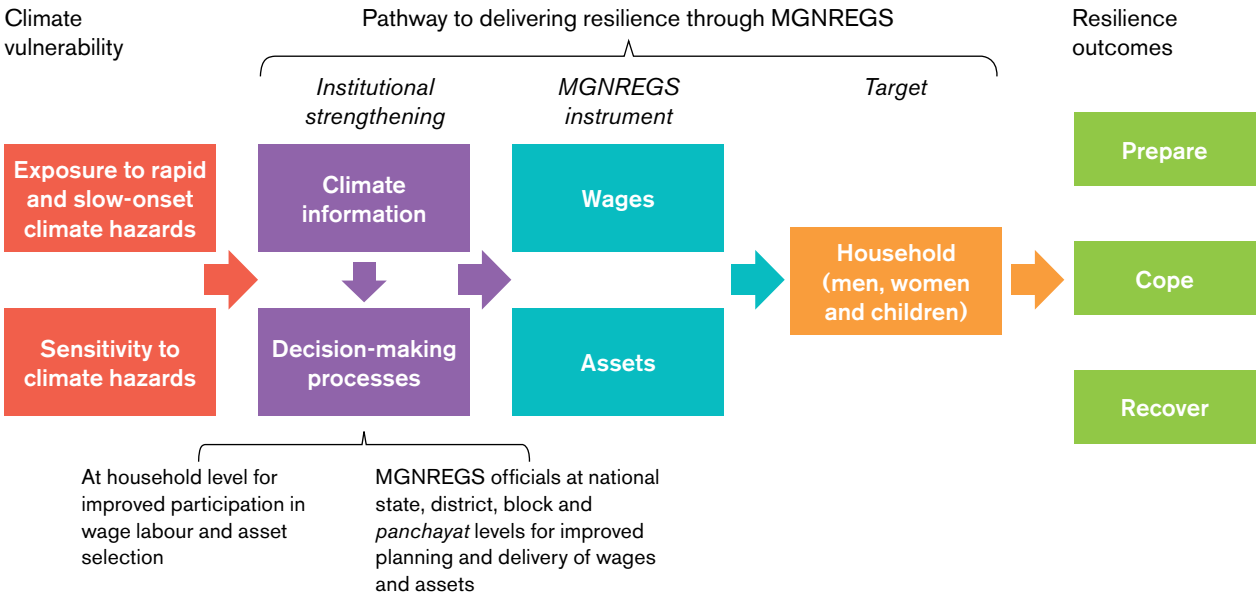
We need to exercise a similar degree of caution when equating 'recovery' with adaptive or transformative capacity. Both types of resilience capacities take longer timeframes to develop than the single calendar year between the 2018 drought and our survey in 2019. Our findings on households' ability to recover from the 2018 drought because of MGNREGS can therefore only show early signals of adaptive resilience capacity. Given that transformative resilience capacity implies deep or systemic changes, we do not equate our findings on short-term household recovery to changes in transformative capacity.

Theory of change

With these considerations in mind, Figure 1 outlines the theory of change that guided our research. This was built on the premise that MGNREGS uses two main instruments – wages and assets – to help households improve their resilience to climate change. Underpinning the delivery of these programme instruments are strong institutions that plan and deliver the programme. Our theory of change proposes that integrating CIS and supporting climate-informed decision making within MGNREGS planning and budgeting can lead to delivering better-designed wages and assets that help households build resilience and manage climate risks. Actions to strengthen climate-informed decision making can happen at all levels – from the centre down to the household level – and depend on the availability of information, as well as the skills and knowledge to use this information to make informed decisions.

Unlike previous IIED MGNREGS research, we do not investigate the role of skills building in this report, as the primary focus of MGNREGS is to deliver wages for unskilled manual labour.

Figure 1. Theory of change for using social protection to build climate resilience



Source: Adapted from Kaur et al. (2019)

3.3 Research locations

We conducted field research in four districts in Rajasthan and Uttar Pradesh, two northwest Indian states. In consultation with MoRD and state governments, we selected Jodhpur and Barmer in Rajasthan and Banda and Mahoba in Uttar Pradesh. The main criterion for district selection was that they were affected by drought in 2018/19, so we could study the contribution of MGNREGS in helping respond to a climate shock in recent memory. As Table 2 shows, all four study districts have been significantly exposed to drought over the past two decades, including, most recently, the 2018 drought during the main summer planting season.

Jodhpur and Barmer, Rajasthan: Both districts are situated in the highly arid and semi-arid zones of western Rajasthan, where low levels of rainfall and high temperatures lead to frequent and recurring droughts. Barmer and Jodhpur respectively receive an average of 310 mm and 378 mm rainfall each year. They were both affected by drought in 13 of the 18 years between 2000 and 2017 (IMD 2020). Rural households here also face shifting monsoon patterns, extreme temperatures and sandy soils that do not efficiently retain water (The Weather Channel 2019, Times of India 2019). Most rural households in Barmer and Jodhpur rely on rainfed agriculture, so are highly vulnerable to current and future climate shocks (Rao et al. 2013).

Banda and Mahoba, Uttar Pradesh: Banda and Mahoba are in the dry Bundelkhand region of southwestern Uttar Pradesh. These districts have been historically exposed to several climatic and biophysical risks, including recurring droughts, floods, storms, rainfall variability and extreme temperatures leading to heat and water stress, groundwater depletion and salinisation, soil degradation and forest fragmentation. Droughts and heat waves are the main environmental hazards. A high percentage of both districts' rural populations depend on agriculture, increasing the sensitivity of rural households to these hazards. Rainfall in Banda and Mahoba is significantly higher than in Rajasthan. However, in Banda the soil is extremely sandy and has low water-holding capacity. High temperatures further exacerbate the situation, leading to high evapotranspiration and low recharge of ground water. Likewise, in Mahoba, groundwater availability is low and salinity levels high, which put agricultural livelihoods at risk. Flooding affects some communities in Banda that are located on low ground near large rivers, but this climate hazard is less frequent than drought and rainfall variability (Rao et al. 2013).

Table 2. Drought incidence in the four study districts, 2000–2017

STATE	DISTRICT	DROUGHT YEARS (NUMBER)	DROUGHT YEARS (%)	DROUGHT YEARS
Rajasthan	Barmer	13	72	2000, 2001, 2002, 2004, 2005, 2006, 2008, 2009, 2012, 2013, 2015, 2016, 2017
	Jodhpur	13	72	2000, 2001, 2002, 2004, 2005, 2006, 2008, 2009, 2012, 2013, 2015, 2016, 2017
Uttar Pradesh	Banda	6	33	2002, 2004, 2007, 2009, 2014, 2015
	Mahoba	6	33	2002, 2004, 2007, 2009, 2014, 2015

Source: Farmers' portal.[2]

The empirical evidence we present in this report is based on a household survey of 1,232 households that participate in MGNREGS across the four study districts. This sample size is representative of the 1.5 million-strong MGNREGS workforce across the four districts, out of a total population of more than 11 million (GoI 2011).

The sampling method we used is presented in detail in Appendix 1, including a specific outline of how we incorporated gender analysis into our methodology. To supplement the household survey, we also undertook a detailed series of consultations with MGNREGS officials from national, state, district, block and *gram panchayat* levels to understand how CIS is currently integrated into MGNREGS planning.

[2] https://farmer.gov.in > Risk management > Drought management

4

MGNREGS' contribution to resilience in Rajasthan and Uttar Pradesh

BOX 5. KEY CLIMATE RESILIENCE FINDINGS

MGNREGS contributed modestly to the ability of households in Rajasthan and Uttar Pradesh to manage the 2018 drought:

- **Wages support preparatory capacity:** Wages supported 37% of households to prepare for the drought, enabling them to buy essential goods for consumption and livestock. But wages were minimal in helping households cope during the drought (10%) and recover afterwards (5%). Most of the households that reported improved resilience were in Barmer. In the other districts, wage contribution to climate resilience outcomes was minimal.
- **Emergency relief labour is delayed:** There is a lack of alignment between the timing of a climate shock and receiving additional MGNREGS emergency relief in the form of additional wage labour. Only 4% of households received the additional 50 days of wage labour, and due to delays in drought response verification procedures, they received this income approximately six months after the drought occurred.
- **Assets support 30% of households to manage drought:** Assets helped 30% of households to prepare, 28% to cope and 21% to recover from the 2018 drought, primarily by increasing the availability of water in drought-prone areas. But this was not true across all districts: almost all households with improved climate resilience through assets were in Barmer.
- **MGNREGS supports strong improvements in water conservation:** Assets improved water conservation for 35–66% of households, varying by district, but improvements in agricultural productivity were more modest (4%–22%, depending on the district). Higher water conservation was particularly evident in Rajasthan, while higher agricultural outcomes were reported in Uttar Pradesh.
- **Participation in MGNREGS decision making is low:** MGNREGS workers reported low rates of participation in MGNREGS decision making on asset selection and location. Only 15% of households felt their preference on MGNREGS assets was taken up by the *gram sabha* during the MGNREGS planning cycle.

This section presents the empirical findings and discussion from a representative household survey of 1.5 million MGNREGS workers across four districts in Rajasthan and Uttar Pradesh. Households here had been exposed to a drought in the 2018 main kharif planting season, enabling us to study MGNREGS' contribution to household responses to the drought.

4.1 Overall findings

We begin by outlining the overall findings on the extent to which MGNREGS wages and assets supported households to prepare, cope and recover from the 2018 drought.

To a modest extent, MGNREGS wages and assets supported vulnerable households to manage the impacts of the 2018 *kharif* drought. Our findings reflect survey households' perception of how MGNREGS supported them to prepare, cope and recover from the drought, where:

- Prepare refers to how MGNREGS wages and assets helped them before the drought
- Cope refers to how MGNREGS wages and assets provided support during the drought, and
- Recover refers to the support that MGNREGS wages and assets provided after the drought.

MGNREGS wages supported 37% of households to prepare before the 2018 drought, enabling them to buy essential goods for household consumption and fodder for livestock. But their contribution to helping households cope during or recover after the drought was minimal.

MGNREGS assets supported 30% of households to prepare before the 2018 drought, 28% to cope with the drought and 21% to recover from the drought, primarily by increasing water availability in drought-prone areas.

Figure 2 shows that nearly all the households reporting improved climate resilience from both MGNREGS wages and assets were in Barmer. Our results suggest that MGNREGS has not significantly contributed to households' capacity to prepare, cope or recover from drought in the other districts.

There are also important gendered differences in the reported climate resilience outcomes (Figure 4). Generally, female-headed households benefit more from MGNREGS' wages and assets in terms of preparing for and coping with climate shocks than male-headed households, but wages help male-headed households recover from shocks more than female-headed ones. Further analysis to unpack intra-household dynamics for how MGNREGS may differentially support women and men to manage climate-related shocks and risks

Figure 2. Households that MGNREGS wages and assets help to prepare, cope and recover from drought shock, across the four study districts

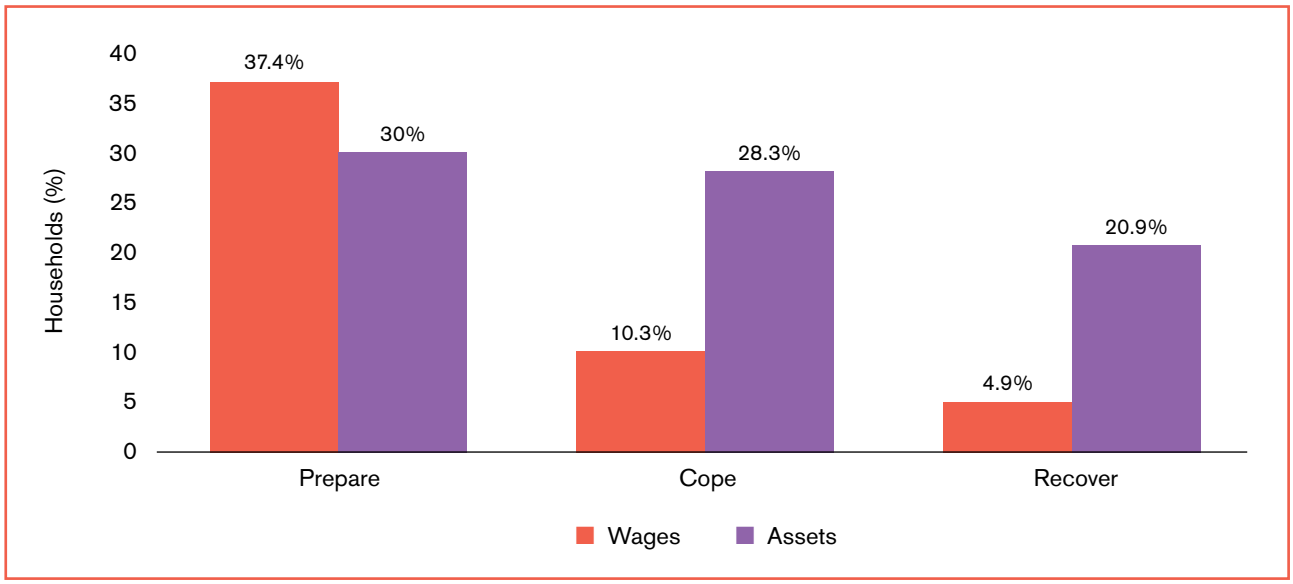


Figure 3. Households that MGNREGS wages and assets help to prepare, cope and recover from drought shock, by district

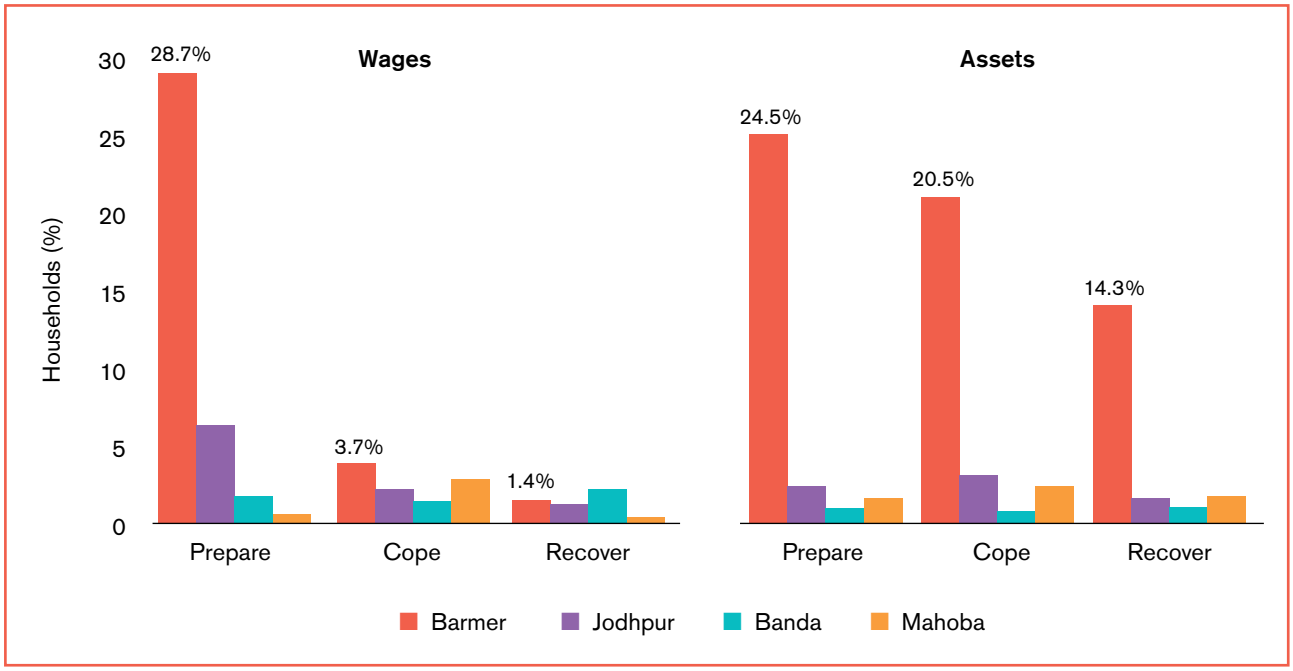
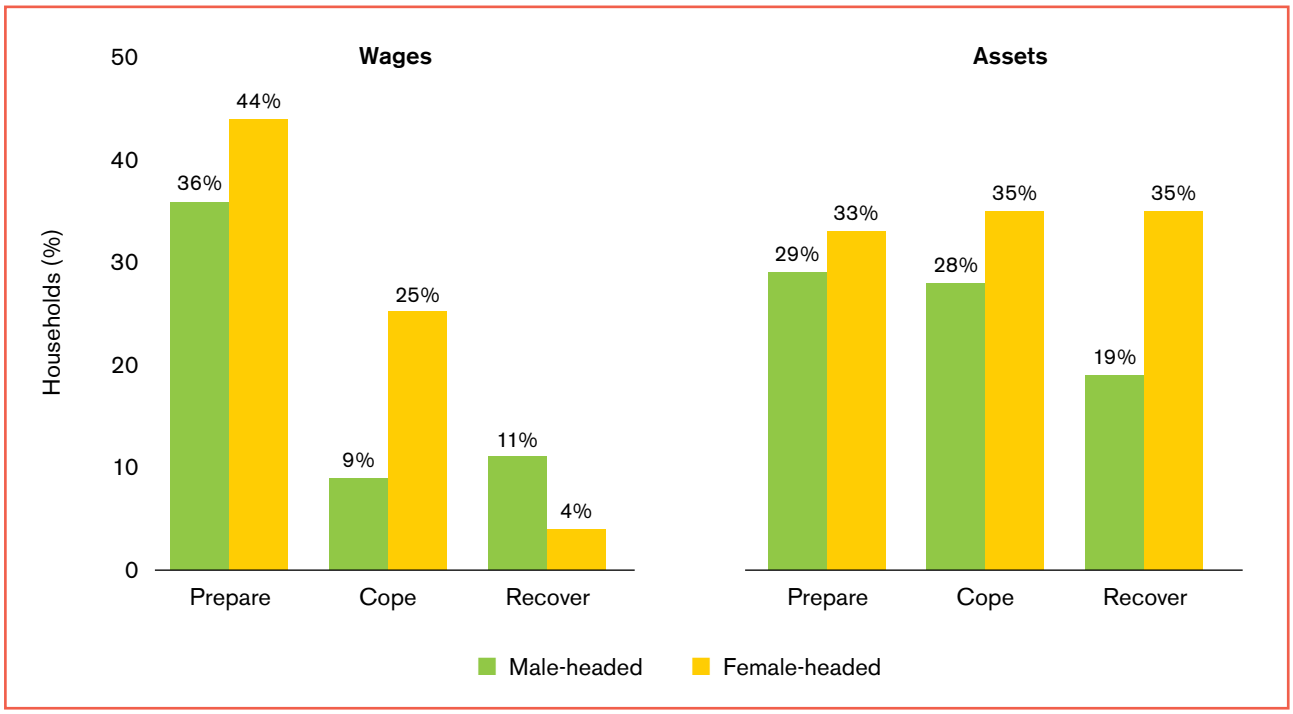


Figure 4. Households that MGNREGS wages and assets helps to prepare, cope and recover from climate shocks across the four study districts, by gender



was beyond the scope of this report, but is an important topic for future research.

The top-level findings presented above suggest MGNREGS has played a limited role in supporting households to manage climate risks in our four study districts. This is particularly so outside of Barmer, which accounts for nearly all the households reporting improved resilience outcomes. In Sections 4.2 and 4.3, we dig deeper into the household survey results to understand the contribution and limitations of MGNREGS wages and assets in delivering resilience outcomes. Section 4.4 is a more detailed discussion of our findings, including the implications of our findings for future efforts to strengthen MGNREGS' contribution to resilience.

4.2 Key findings: wages

4.2.1 Shock-responsive wage delivery

MGNREGS provides an additional 50 wage labour days on top of the minimum 100 if the government formally declares a natural calamity, like a drought or flood (Box 7). Previous IIED research has suggested this is a shock-responsive function to support climate resilience (Kaur et al. 2019).

Our household survey shows that this shock-responsive wage mechanism supported a small number of households after the 2018 drought. Only 4% of surveyed households received additional MGNREGS employment as a result of the drought, with Barmer

BOX 6. DEFINITIONS OF DROUGHT IN INDIA

In India, there are four definitions of drought:

1. Meteorological drought: IMD refers to meteorological drought as a rainfall deficit, measured by the degree of dryness and duration of dry period due to lower rainfall than normal. The five classifications are:

- Normal within 10% of the long period average
- Below normal 10% below the long period average
- Above normal 10% above the long period average
- Deficit year more than 10% rainfall deficit over 20-40% of India's land area, and
- Large deficit year rainfall deficit over 40% of India's land area.

2. Hydrological drought: Where streamflow and groundwater supply to a given water management system is inadequate. Indicators include:

- Reservoir Storage Index: percentage of reservoir storage deficit v. long-term average
- Groundwater Drought Index: based on monthly groundwater records; and
- Streamflow Drought Index: based on monthly deficits or surplus levels of streamflow.

3. Agricultural drought: Where soil moisture is insufficient to meet agricultural crop needs. A drought is when the sown area is less than 33% of the normal total sown area; a severe drought is when sown area is less than 50% of normal. Vegetation remote sensing and soil moisture indexes are also available, including:

- Normalised Difference Vegetation Index (NDVI): estimates the vegetation cover at a point in time
- Normalised Difference Wetness Index: surface wetness of soil (used at the beginning of the cropping season)
- Vegetation Condition Index: deviation of NDVI from normal years, providing an indication of poor, fair and good vegetation and therefore drought conditions
- Soil Moisture Index: percentage of available soil moisture, weekly soil moisture data during vegetation growth
- Moisture Adequacy Index: ratio of weekly evapotranspiration rates.

4. Socioeconomic drought: Where available food and associated income are reduced due to crop failure from drought. Indicators include scarcity of drinking water, employment levels, availability of fodder, agricultural and non-agricultural wages.

Sources: Department of Agriculture and Farmers' Welfare (2016)

BOX 7. DECLARING A DROUGHT

National and state drought declaration process

Declaring a drought in India should follow the drought manual set by the Department of Agriculture and Farmers Welfare, although, the process is not universally followed across the country. Meteorological drought is first determined using mandatory rainfall deviation and dry spell indicators. States can then select another three out of four indicators from vegetation remote sensing, soil moisture, agricultural drought and hydrological drought (Box 6).

State governments then prepare a notification for central government, outlining their drought severity by 30 October for *kharif* and 31 March for *rabi* cropping seasons. If there is significant rainfall deficit in June–July, this can take place in August. In the case of a severe drought, the state government submits a memorandum of assistance to the National Disaster Response Fund the week after the severe drought is declared. This is then ground-truthed by an interministerial central team, after which the Central Government decides on relief funds within one month. States must distribute relief funds within one month of receiving them.

MGNREGS drought declaration process

Despite the wide variety of indicators available to states to declare drought, we understand from interviews that MGNREGS always uses the 'crop-cutting experiment' to approve the additional 50 wage labour days that can be used for drought relief. The district collector will only recommend a drought declaration following the crop estimates, where areas with less than 50% cultivation than normal are considered to be affected. Crop-cutting, undertaken by the Revenue Department, only takes place after an agricultural drought has taken place – in other words, after the drought impacts have begun to be felt.

Sources: Department of Agriculture and Farmers' Welfare (2016); and MGNREGS functionary interviews conducted for this research in Rajasthan and Uttar Pradesh with MGNREGS officials

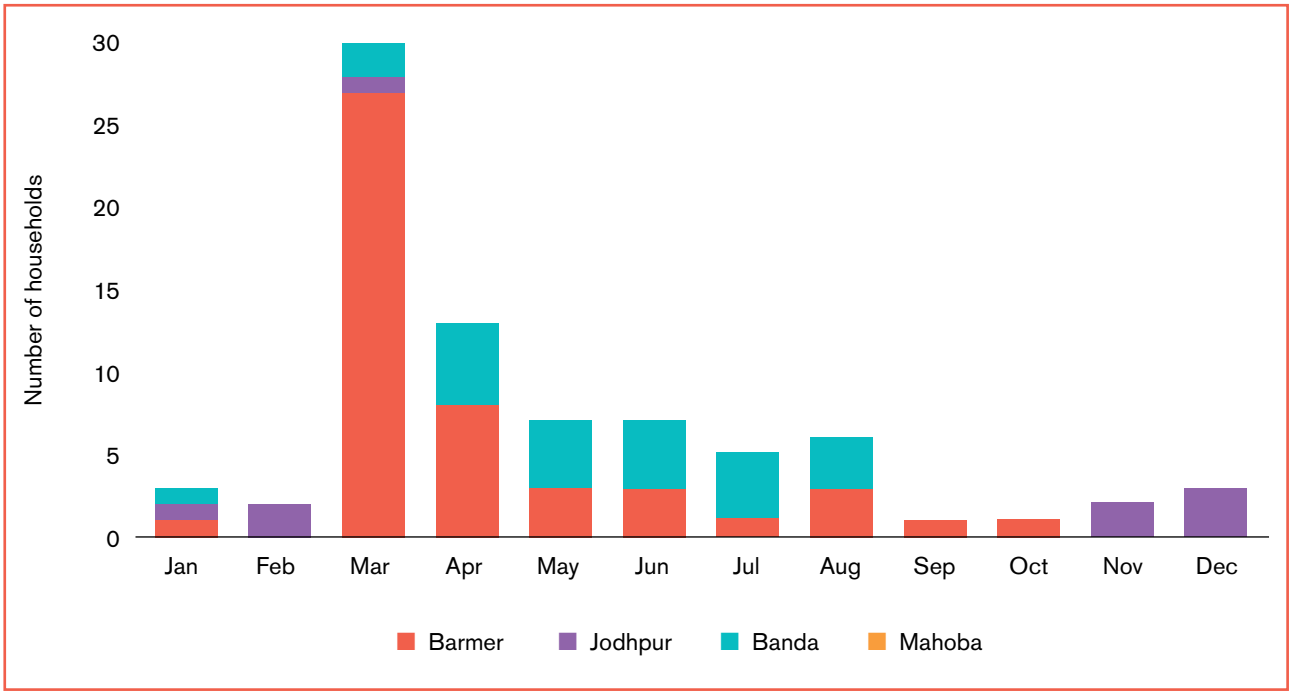
reporting the highest use of additional labour days, at 7.7%. Given the high exposure to drought in all four study districts, these figures appear to be quite low, calling into question whether this supposed shock-responsive measure is helping households manage climate risk.

Households also reported that these additional days became available a long time after their drought exposure. Most extra labour days were accessed in March and April 2019 (Figure 5). Given that monsoon rains normally arrive between June and August, this is approximately six months after the onset of the drought. This suggests a major misalignment between the onset of a climate hazard and delivery of additional wage labour support to affected households.

The findings are made more significant by the preferred timing for emergency support by MGNREGS workers. The poorest segment of wage labourers wished to receive additional wage labour days in May to August – in other words, before or during a shock – to smooth their consumption gap. Relatively wealthier households reported a desire to receive additional wage labour in August to November. These findings indicate that MGNREGS households see swift delivery of additional wage labour as an important support mechanism.

The main explanation for the low number of additional MGNREGS days delivered after the 2018 drought is the lengthy drought declaration process that delays central government relief to drought-affected areas (Box 7). Interviews with MGNREGS functionaries confirmed the slow and often political official drought declaration process means that, by the time additional MGNREGS days are sanctioned, the financial year is almost finished. This only allows households to work a few additional days.

Figure 5. Households working extra MGNREGS days after a drought shock in 2018, by month and district



4.3 Key findings: assets

Our high-level findings on MGNREGS assets' contribution to climate resilience (Box 5) show that MGNREGS assets can play a role in supporting households to manage climate shocks. To understand how assets contribute to climate resilience outcomes in more detail, we asked households about the extent to which MGNREGS assets deliver important livelihood benefits and the extent to which they participated in deciding which assets are constructed under MGNREGS.

4.3.1 Asset contribution to improved livelihoods

One of the ways MGNREGS can help households build their climate resilience is by investing in public and private infrastructure that supports local livelihoods. Previous research shows that the livelihood benefits of new assets are particularly important for supporting more adaptive resilience outcomes (Kaur et al. 2019).

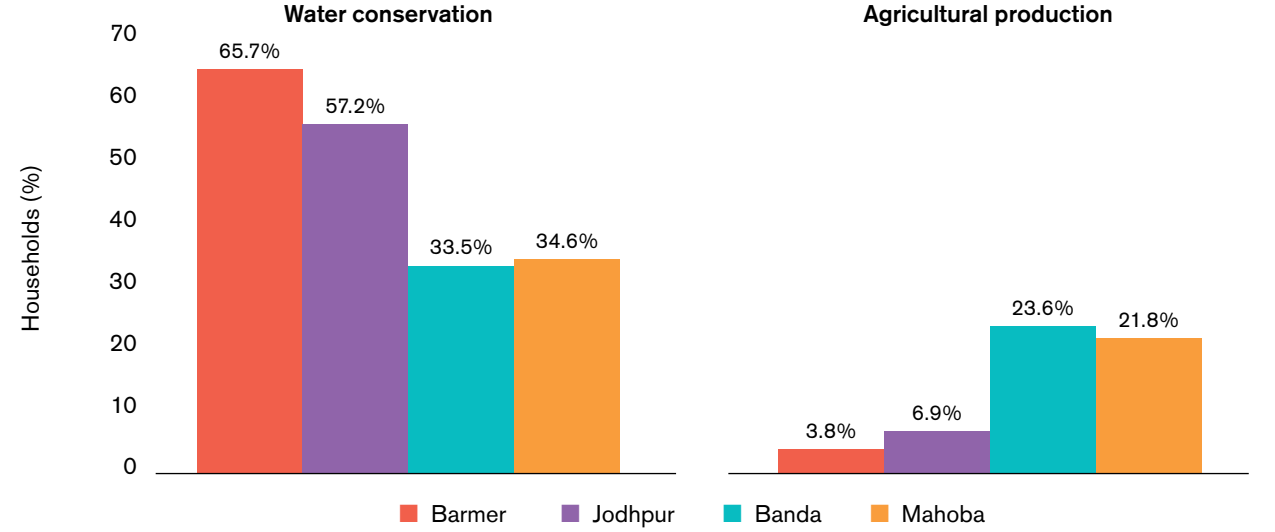
Evidence from our household survey shows that MGNREGS' performance in contributing to livelihood benefits that support resilience is mixed. We analysed whether households believed MGNREGS had improved water conservation – for consumption, livestock, irrigation and agricultural production – to improve food security and boost household incomes.

More than half of households (52%) reported that MGNREGS improved water conservation in their community. Barmer and Jodhpur Districts showed particularly high improvements in water conservation. These communities have specifically targeted the construction of water conservation assets such as farm ponds, wells and community water tanks, providing households with drinking water, water for livestock and irrigation for agriculture. Water conservation improvements are significantly lower in Banda and Mahoba.

Only 11% of households reported that MGNREGS improved agricultural production in their community. Improvements in agricultural production are much lower in Rajasthan than Uttar Pradesh.

For water conservation and agricultural production, there was little difference between households' income and education levels or whether they were male- or female-headed. Reported improvements in water conservation were 5–10% lower in the lowest-income households, but there was less variation across the remaining 80% of respondents.

Figure 6. Households reporting improved water conservation and agricultural production from MGNREGS assets across the four study districts



4.3.2 Participation in asset selection and location

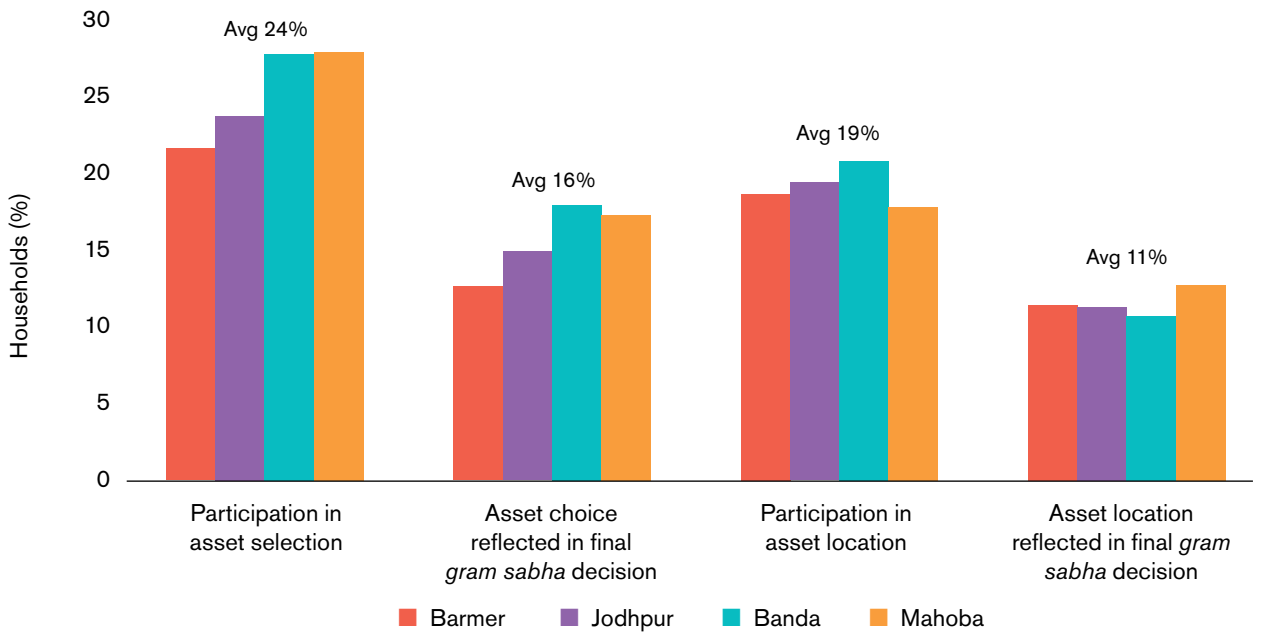
India's local governance system is based on decentralised planning through *Panchayati Raj* institutions (Faguet and Poschl 2014). Through these institutions, MGNREGS aims to deliver local-level, bottom-up participatory decision making over its assets. Households and MGNREGS workers can participate in a series of annual village (or ward) meetings, known as the *gram sabha,* where they can discuss key topics and make key decisions related to MGNREGS planning for the coming year. These discussions and decisions are reflected in a *gram panchayat* annual plan, which is cascaded upwards until the centre approves each state's consolidated annual plan and labour budget (MoRD 2019).

Our previous MGNREGS research proposes that household and worker participation in the *gram sabha* can strengthen climate resilience because it allows them to voice their concerns and prioritise productive assets that will support and improve their livelihoods and wellbeing (Kaur et al. 2019). This is based on the premise that local agency – power to decide over their own adaptation investments – is a crucial part of adaptive capacity. To test this theory, we asked whether MGNREGS workers participated in asset selection and location through the *gram sabha*, and whether their choices were reflected in final decisions.

The survey results show that households in all four study districts play a limited role in MGNREGS decision making in the *gram sabha* (Figure 7). Only 24% of households reported participating in **asset selection**, and only 16% felt their choice of asset was reflected in the final *gram sabha* decision. Only 19% reported participating in **asset location**, with 11% feeling their choice of location was taken into account in the final decision. This means that overall, only 15.5% of households surveyed felt their choice of asset and/or location was taken up.

There are notable gender and educational inequities to the results. Female-headed households participate significantly less in asset selection and location, which suggests significant barriers to women's participation in MGNREGS decision making. Only 8% of female-headed households participated in the selection of MGNREGS assets and had the *gram sabha* include their preference in the final decision, compared to 16% for male-headed households. This figure is even lower for asset location, where only 5% of female-headed households participated and had their voice heard, compared to 12% for male-headed households. Households with lower levels of education are also slightly less likely to participate in asset selection and location.

Figure 7. Household participation and influence in decision making around MGNREGS asset selection and location, by district



4.4 Discussion of findings

Our findings indicate that, to a limited extent, MGNREGS supported households to manage the 2018 drought. In this section, we discuss our findings, present some of the limitations of the data and outline how we intend to use these findings to inform processes for strengthening MGNREGS decision making so that it better supports climate resilience outcomes for MGNREGS workers.

4.4.1 Wages and resilience outcomes

Our first finding is that MGNREGS wages supported some households to prepare and cope during the 2018 drought, particularly in Barmer. This is consistent with the broader social protection literature, which shows that cash and in-kind transfers can help households manage short-term shocks by ensuring they have enough money to provide for basic household needs. In climate resilience terminology, wages have helped these households to build absorptive capacity (Béné et al. 2012, Agrawal et al. 2019, Kaur et al. 2019). MGNREGS wages have not supported longer-term climate risk management in our four study districts, which is also broadly consistent with findings from other social protection programmes (Agrawal et al. 2019).

Our analysis also shows that the main shock-responsive wage mechanism under MGNREGS does not appear to be delivering widespread benefits to households. Only 4% of households in our study districts received additional MGNREGS days triggered by the 2018 drought. However, we must treat this finding with caution. One interpretation of these results is that MGNREGS is not delivering shock-responsive wages to enough households that were exposed to drought in 2018. An opposite interpretation could be that only 4% of households needed this additional income and MGNREGS is therefore reaching all those in need through shock-responsive wage delivery. Our survey does not provide the data to estimate the percentage of households that needed additional MGNREGS days because of drought versus those households that received additional days.

It is also possible that MGNREGS' true shock-responsive value addition could have been providing more days to households in 2018 than they would otherwise use in non-shock years. Our ability to untangle this relationship between number of days worked by a household on MGNREGS and their experience of a climate shock is limited by methodological challenges. We would need accurate district or sub-district-level rainfall data, which was not available in our four study

districts. We would also need suitable non-drought reference years to compare against 2018, which are not available in Jodhpur or Barmer, since they have experienced drought in eight of the past ten years (see Table 2). Similar efforts to analyse this through a household survey would be limited by participant recall in comparing their engagement in MGNREGS years of drought compared to non-drought years.

As a result, the main finding that we can report on the shock-responsive nature of MGNREGS wages is that the current drought declaration system hinders timely access to shock-responsive wage access. Households that did receive additional MGNREGS days in 2018 were only able to access these days approximately six months after the drought occurred due to the lengthy official drought declaration process. This points to a need for the system to be streamlined so it is more agile in delivering emergency benefits to MGNREGS workers in the future.

4.4.2 Assets and resilience outcomes

MGNREGS assets supported some households to prepare, cope and recover from the 2018 drought. Generally, these findings are consistent with previous social protection and resilience literature, suggesting that assets created under public works programmes can help households build both absorptive and adaptive capacity (Agrawal et al. 2019).

Most households with improved resilience through MGNREGS assets were in Barmer. Households here were most likely to report that MGNREGS contributed to improved water conservation, but least likely to report that it improved agricultural production. They also reported the lowest level of participation in asset selection through the *gram sabha* out of any of our four study districts.

These findings suggest that tailoring MGNREGS delivery to the unique landscape, climate risks and livelihood context of specific areas is important for supporting resilience. Barmer has very high levels of drought exposure, low levels of access to water, and livelihoods that mix agriculture, pastoralism and other income sources to manage risks. Our interviews with MGNREGS officials indicate that in Barmer, a narrow sub-set of five or six water conservation assets have been prioritised to support households in this extremely arid district. Although our survey shows that this was not a participatory decision, prioritising water conservation assets has led to resilience outcomes that are significantly higher than the other three study districts. We do not take this finding to suggest that MGNREGS should focus on top-down planning directives, as it is possible that higher participation in asset selection could have led to even greater resilience outcomes. Rather, we believe it highlights the importance of having locally tailored MGNREGS solutions informed by both an understanding of climate exposure and the ways in which MGNREGS assets can minimise household sensitivity to this exposure.

For these locally tailored solutions to also build resilience to drought conditions that continue to move away from recent historical experience, better access to climate information and risk management tools could help. We focus on these in Sections 5 and 6.

4.4.3 Building on our understanding of resilience outcomes

Overall, the results from our household survey show that MGNREGS can support climate resilience. Though the results are modest, and limited to Barmer, they show that MGNREGS is supporting some households to prepare, cope and recover from drought. This is an important starting point because it shows that MGNREGS can be strengthened to deliver more significant and widespread resilience benefits to rural households.

To get to a position where we can recommend changes for strengthening MGNREGS decision making, we must first better understand the current state of play on how climate awareness informs MGNREGS decision making. Section 5 presents baseline data on the extent to which households and MGNREGS functionaries have access to CIS, and how this information is integrated into MGNREGS decision making. With this data in mind, Section 6 makes recommendations to strengthen this decision making, with a focus on how access to CIS can help MGNREGS develop climate-responsive planning and budgeting processes.

5

MGNREGS' use of and access to climate information

This section introduces the types of CIS available in India to provide context on how it could be integrated into MGNREGS. We then present findings from our household survey and interviews with MGNREGS officials to understand current levels of access, use and future demand for CIS in our four study districts.

BOX 8. KEY FINDINGS ON OFFICIAL MGNREGS CIS USE

- **More than half of all households have access to CIS:** 58% of households have access to climate information. The most common type of CIS accessed by households are short-range (25%), medium-range (22%) and very short-range daily forecasts (16%).
- **Household use of CIS to inform MGNREGS activity is low:** The use of CIS to inform MGNREGS wage labour engagement and asset selection is low. Of the households that access CIS, 84% of them use them to inform their livelihood decisions. Only 25% use these services to decide when to participate in MGNREGS wage labour. Only 26% use them to select public assets and 18% to choose private assets in the *gram sabha* MGNREGS planning meeting.
- **Households express a strong demand for CIS access up to one month ahead:** MGNREGS households report a desire for improved access to medium-range (87%) and extended-range (32%) forecasts. Respondents in Uttar Pradesh reported a stronger demand for CIS information with less than one month's lead time, while respondents in Barmer reported a slightly stronger demand for access to extended-range forecasts than the other three districts.
- **Use of CIS by officials in MGNREGS is low:** There is virtually no integration of CIS into planning and decision-making procedures used by MGNREGS functionaries to deliver MGNREGS.
- **There are new opportunities to integrate CIS into MGNREGS planning:** The new geospatial information system (GIS) planning tool offers the first opportunity to integrate CIS into MGNREGS planning. At the time of our field work, this tool was in the early stages of its launch, and officials did not yet have adequate skills or understanding to use it in practice.

The social protection literature, MGNREGS literature and MGNREGS' own annual guidelines all call for greater use of CIS to support climate informed decision making (Tenzing 2019, Kaur et al. 2019, MoRD 2019). It is our hypothesis that integrating CIS into MGNREGS decision making can lead to stronger resilience outcomes for MGNREGS workers. Before making recommendations on how best to use CIS for climate-resilient planning under MGNREGS, we need a baseline understanding of the extent to which MGNREGS workers and officials currently access and use CIS in their decision making and planning.

5.1 CIS availability in India

Climate information is overseen by the Indian Meteorological Department (IMD), under the Ministry of Earth Sciences. The Indian Institute of Tropical Meteorology (IITM) within IMD carries out all back-end research on weather forecasts and climate information. A state has a meteorological office or department to communicate centrally generated climate information downwards. IMD provides a wide variety of climate information products, including:

- **Nowcasting:** Provides extreme weather warnings a few hours in advance (Thomson and Mason 2018). IMD provides district-level nowcasting for extreme rainfall, thunderstorms and cyclones. There are four categories: no-warning, watch, alert and warning. Watches indicate that hazardous events are possible, while warnings indicate that they are expected and action should be taken. Warnings are disseminated to the local level via internet, TV, radio and newspapers, and to registered farmers via Agrometeorological (Agromet) Advisory Services (AAS).
- **Very short to medium range weather forecasts:** IMD's very short, short and medium-range weather forecasts predict weather for the next 12 hours, 12–72 hours and 72 hours to 10 days, respectively. These include rainfall, temperature and wind gustiness information down to a spatial resolution of 12km^2.[3] These forecasts are supposedly accurate to 90%.
- **Agromet Advisory Services:** AAS disseminates very short to medium-range weather forecasts specifically for farmers, combined with crop and livestock information. These agromet services are provided under the Gramin Krishi Mausam Seaw programme, in collaboration with the Indian Council of Agricultural Research (ICAR) Central Arid Zone Research Institute. They cover rainfall, maximum and minimum temperature and wind speed and direction, cloud cover, and specific crop and livestock advice for these associated weather conditions. They are prepared and issued at district and state level every Tuesday and Friday by 130 agromet field units located within the state agricultural universities or ICAR institutes via TV, radio and newspapers. They are also disseminated by Krishi Vigyan Kendra, agricultural extension or farm science centres that provide SMS bulletins to registered farmers.
- **Extended range forecasts:** These normally include weekly (seven-day) weather variable averages a few weeks into the future, generally from 11–30 days. Extended range forecasts mark a departure from shorter weather forecasts, as they are no longer predictable to specific weather events. Instead, they inform on average weather over a certain time period. IMD provides extended range forecasts for up to four weeks in advance at a much lower spatial resolution of 100km^2. These include forecasts for seven-day rainfall averages, monsoon breaks (four days of no rain), minimum and maximum temperatures, and low-level winds. Extended range forecasts are particularly relevant for heat wave predictions; the temperature forecasts are much more accurate than rainfall. However, sub-seasonal forecast skill is limited and must be used with caution (Thomson and Mason 2018).
- **Long-range monsoon forecasts:** Also known as seasonal forecasts, these are averaged weather conditions over a period of anything from a month to two years, but generally between one to six months. IMD presents seasonal forecasting for the full monsoon season (June to September), the second half of the season (August to September) and three separate monsoon months (July, August and September). It generates these for the whole of India and for four homogenous regions: Rajasthan and Uttar Pradesh fall under the Northwest Region. The second-stage long-range forecast provided in May or early June is much more accurate than the first-stage forecast in April (Bajaj et al. 2019). The second-stage forecast includes rainfall for July and August. Monsoon forecasts are presented in terms of probability of rainfall, which falls into five categories: deficient, below normal, normal, above normal and excess rainfall compared to the long-term period average.

[3] Forecasting models are made up of 'grids' that average the climate over a given area. Spatial resolution describes the distance between two model grid cells, and therefore how many grid cells make up a model. The higher the spatial resolution, the higher the model's precision, as there are smaller distances between grid cells that can capture more localised effects such as topography. When a weather forecast refers to a spatial resolution, it means the forecast is precise to this spatial area.

- **Long-range forecast for heat stress:** The IMD also provides seasonal outlooks for minimum and maximum temperatures for March to May in early March, and for April to June in early April on a spatial resolution of 38km^2 (subdivision level). We were unable to identify the uncertainty associated with seasonal temperature forecasts, but they are likely much more accurate than monsoon rainfall forecasts and may be relevant for heat stress climate services (Thomson and Mason 2018).
- **Decadal and multi-decadal predictions** are available on varying timescales. Decadal climate projections normally run from two to nine years, multi-decadal climate projections up to the next 30 years and long-term climate projections up to 2100 and beyond (Thomson and Mason 2018). Previously, Indian policymakers have used multi-decadal projections from the UK Met Office's downscaled PRECIS climate model within the Indian agricultural vulnerability atlas, also covering our four study districts. New regional climate models now widely used in India include the Coordinated Regional Downscaling Experiment (CORDEX). But serious care must be taken when using regional climate model projections without fully understanding their weaknesses. They can provide misleading impressions of high confidence in local climate change impacts. The links between regional and local climate are still poorly understood, and although these models may strengthen model climatology, they do not ensure improved forecasting skill. In India, both global and regional climate models are routinely poor at reproducing the southwest monsoon, consistently leading to model bias, which underpredicts monsoon rainfall over land and overpredicts monsoon rainfall over sea (IPCC 2013, Choudhary et al. 2018).

5.2 Use of CIS in MGNREGS planning

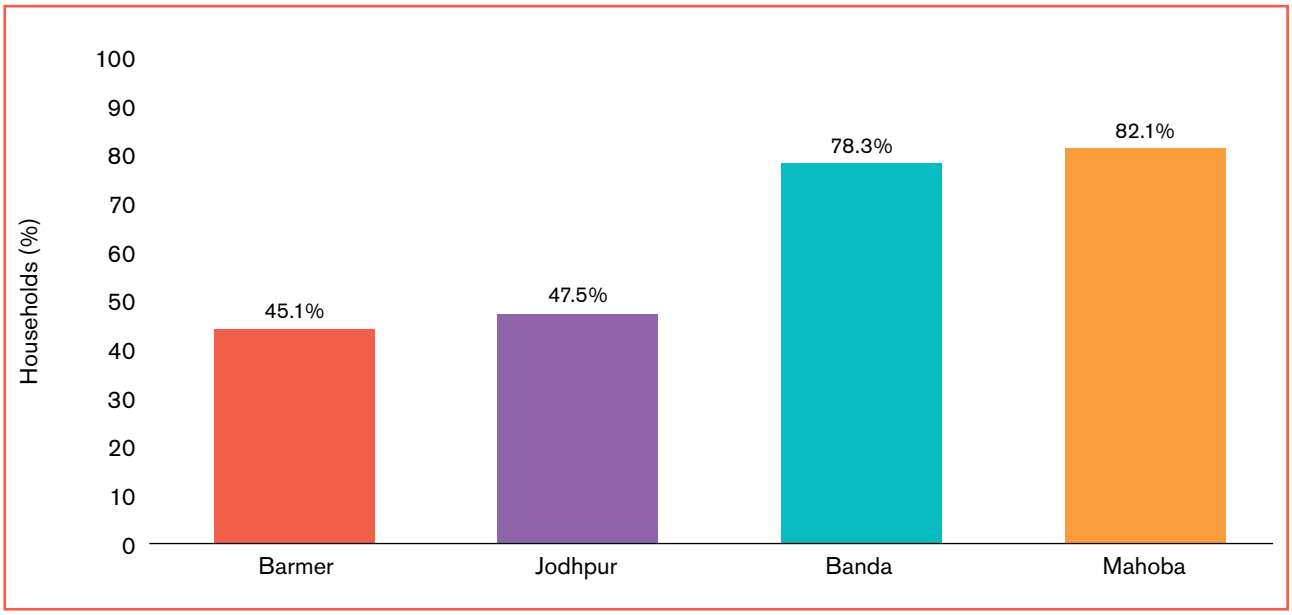
We have shown that there are various types of climate information decision makers can use for different timescales. In this section, we outline the extent to which MGNREGS workers and officials have access to these types of CIS, how households use it in their engagement with MGNREGS, how officials use it to inform MGNREGS planning and the types of CIS that households and officials would like to access in the future.

5.2.1 Access to climate information services

Overall, 58% of households access some form of climate information. There is noticeable regional variation, with households in Banda and Mahoba accessing CIS at much higher rates than households in Barmer and Jodhpur (Figure 8).

The most common type of CIS product accessed by households (Figure 9) are short-range (25%), medium-range (22%) and very short-range (daily) forecasts (16%). There is some regional variation,

Figure 8. Households with access to CIS, by district



with households in Barmer accessing extended range forecasts most, and higher access to AAS in Jodhpur and Banda. Few of the surveyed households use long-range (monsoon) forecasts. Very few receive AAS, with only 17% of Rajasthani farmers and 36.2% of Uttar Pradesh farmers registered to receive them (IMD 2020). The most common mode of accessing climate information is through the *gram sabha* (75%), followed by radio (52%) and mobile phone (43%) (Figures 10 and 11).

Figure 9. Households using CIS in livelihood decision making, by district

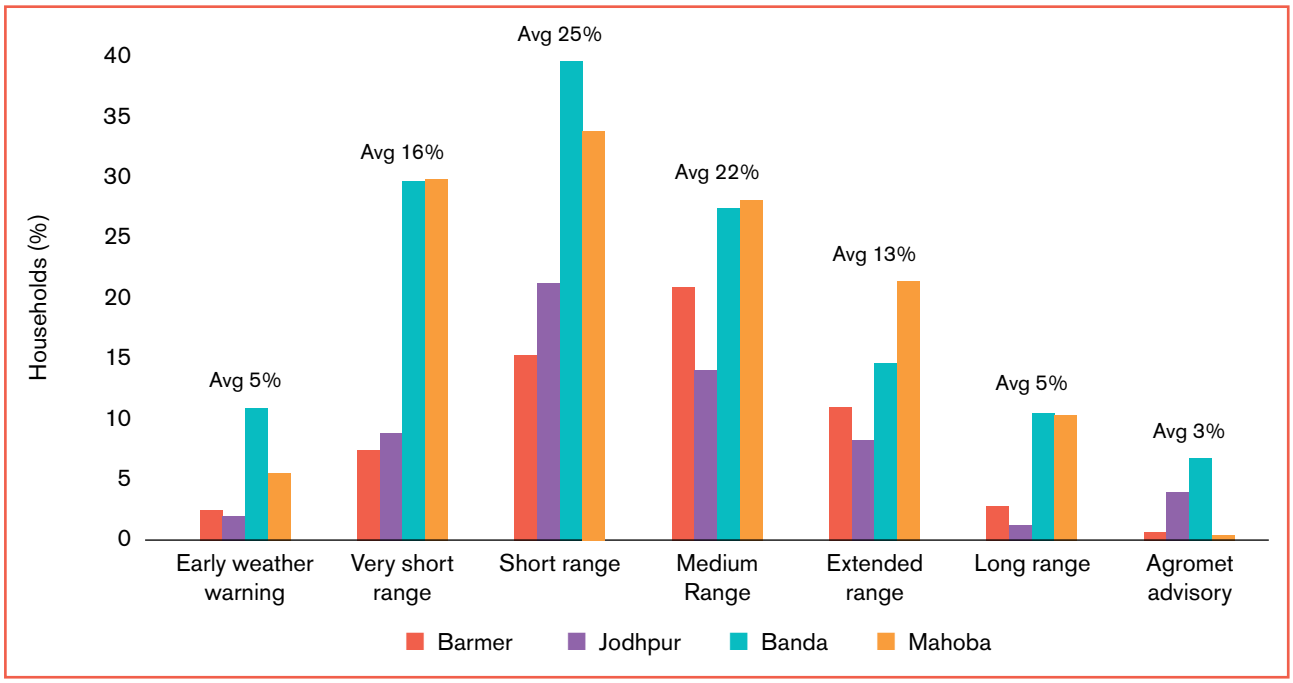


Figure 10. Mode of accessing CIS across the four study districts

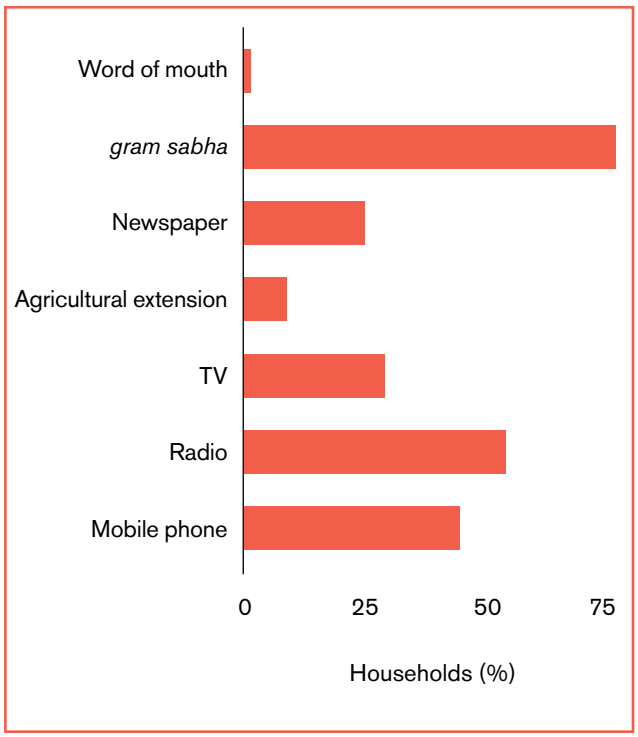
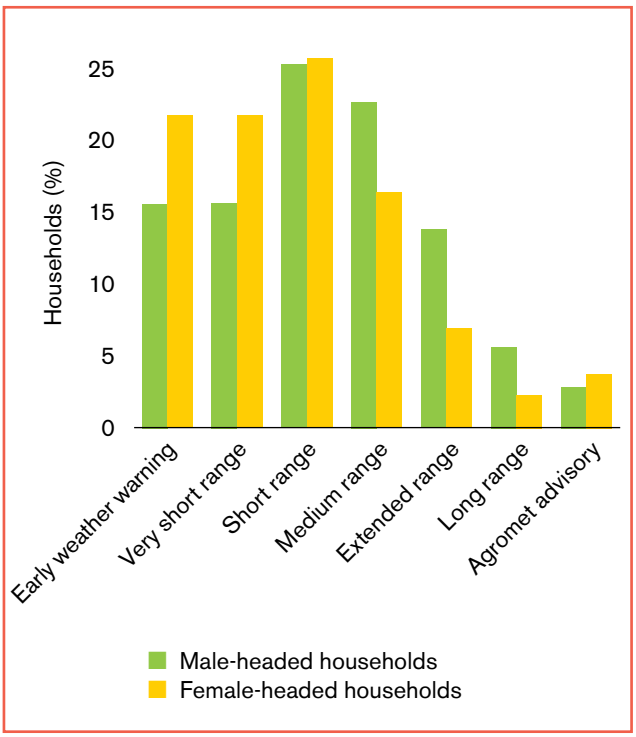


Figure 11. Access to CIS across the four study districts, by gender



Households with a higher level of education have more access to longer-term CIS and through more technological applications – including mobile phone, radio and TV. Female-headed households reported higher access to short-range CIS (1–5 days), but lower access to medium and longer-term CIS (15–90 days). They also reported lower levels of understanding, trust and acting on climate information. This could mean that female-headed households have less knowledge and information to help them manage climate hazards than male-headed households.

5.2.2 Household use of CIS in livelihoods and MGNREGS decision making

Household use of climate information to inform their engagement with MGNREGS is low (Figure 12). Of the households that access CIS, 84% use this information to inform their livelihood decisions. Integrating CIS into MGNREGS planning is significantly lower. Only 25% of households with access to CIS use it to help decide when to participate in MGNREGS as wage labourers, 26% use it when selecting public assets in the MGNREGS *gram sabha* planning process and only 18% use it when choosing private assets.

There are clear regional, timeframe, educational and gendered differences in households' use of climate information in MGNREGS decision making:

- **Regional:** Households in Uttar Pradesh are significantly more likely to use CIS for both livelihoods and MGNREGS decision making than those in Rajasthan.
- **Timeframe:** Of those that use climate information for MGNREGS decisions, the numbers using it fall as the forecast timeframe increases. Households tend to use short-range forecasts for wage labour timing and when selecting public assets. For decisions around private assets, the use of daily through to long-range forecasts is relatively equal.
- **Education:** Households with medium levels of education are more likely to use CIS to inform MGNREGS decision making than those with high or low levels of education.
- **Gender:** Female-headed households use CIS more to inform MGNREGS decision making than male-headed households.

In general, there is declining trust and willingness to act on climate information as the duration of the forecast lengthens beyond 20 days. More than 79% of households with access to very short, short and medium-range forecasts use them to inform their livelihood decisions. But, of the 13% of households that access monthly forecasts, only 68% act on them. Likewise, of the 5% of households that access monsoon forecasts, only 64% act on them.

Figure 12. Households using CIS in MGNREGS decision making across the four study districts

Figure 13. Households using CIS in livelihood and MGNREGS decision making, by district

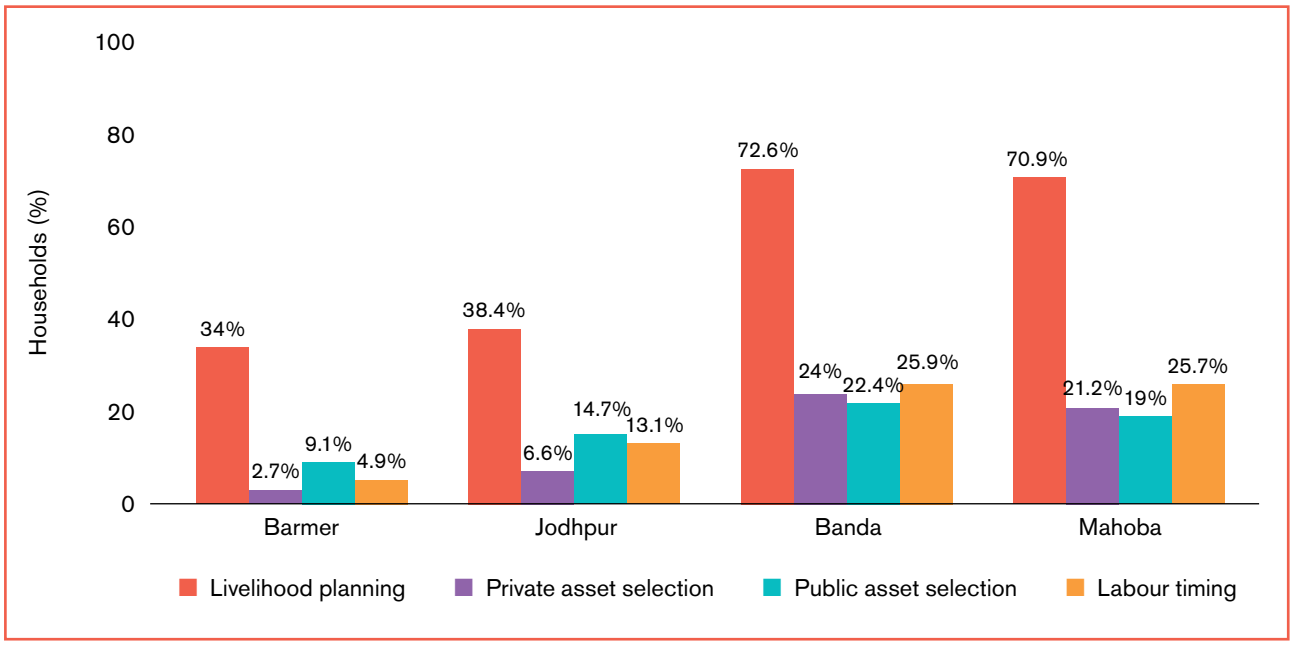
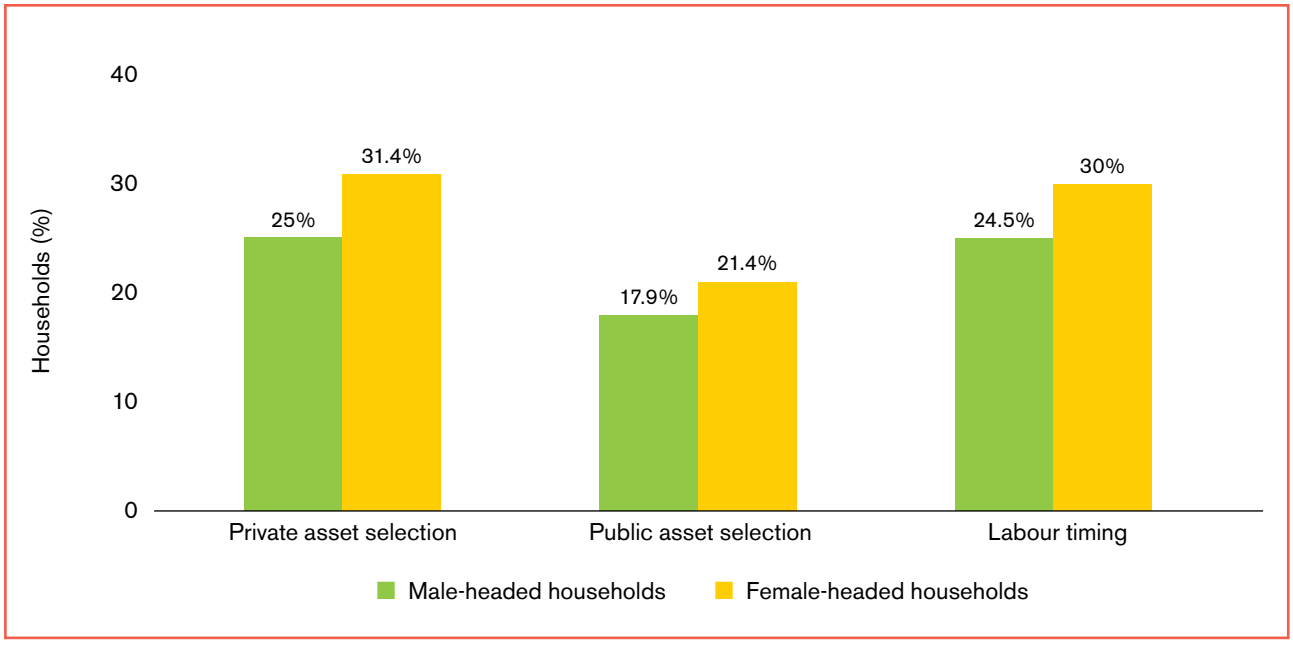


Figure 14. Households using CIS in MGNREGS decision making, by gender



5.2.3 Official use of CIS in MGNREGS decision making

We found that there is minimal integration of CIS into official MGNREGS planning and budgeting. Our interviews with MGNREGS functionaries in Rajasthan and Uttar Pradesh revealed that state-level MGNREGS policymakers only use one form of formal CIS, with flood and cyclone warnings provided to state rural development departments. Importantly, no forms of climate information are used in MGNREGS drought declaration process, which relies on crop-cutting experiments for the (often lengthy) drought declaration procedure (Box 7). However, interviews demonstrated that MGNREGS functionaries use other, more informal, forms of climate information.

Other findings include:

Centre labour budget approval: Although the central Empowerment Committee reports using historical rainfall information when reviewing state labour budgets, we found no evidence of this historical rainfall information playing a notable role in approving, rejecting or modifying states' annual MGNREGS plans.

District and state labour budget planning: Officials reported that they add a 10% buffer to annual MGNREGS plans to help cope with possible increased wage labour demand resulting from drought. So, there is unlikely to be an administrative blockage through shortage of available wage labour within the minimum 100 days available.

***Gram panchayat* asset sequencing:** Although assets should be sequenced at the *gram panchayat* level based on the seasons through local climatology understanding – for example, prioritising farm bunds before monsoon rains arrive – officials reported that they do not use CIS to sequence assets.

New planning tool: The interviews also revealed that MGNREGS is gradually introducing more GIS-based planning via a platform called Bhuvan. This new planning tool, which may integrate CIS for the first time into MGNREGS planning, has used ten-year rainfall averages to pilot water budgeting exercises. However, few officials have the skills they need to use the Bhuvan platform adequately and GIS offices are only available in three districts within both states, one for each agroclimatic zone.

5.2.4 Demand for CIS products

CIS lead time: MGNREGS households reported a desire for improved access to medium-range (87%) and extended-range (32%) forecasts. A smaller number of households said they would like to access very short-range forecasts (17%) (Figure 15). Demand for long-range (monsoon) and decadal to multi-decadal climate forecasting was low, with the majority preferring access to CIS products with lead times less than one month. This likely indicates low knowledge of or trust levels in the usefulness of long-range monsoon forecasts or climate projections. There are slight regional variations in demand for CIS products. Respondents in Uttar Pradesh reported a stronger preference for very short- and short-range forecasting than those in Rajasthan. Households in Barmer reported a stronger desire to access extended-range forecasting than those in the other three districts.

Means of communication: The preferred mode of accessing CIS is by mobile phone (30%), word of mouth (28%) and TV (25%), which together accounted for more than 80% of all responses. There is notably low demand for communicating CIS via the *gram sabha* (Figure 16). There were slight regional variations, with respondents in the two Rajasthan districts preferring mobile phone communication and those in Uttar Pradesh favouring word-of-mouth communication. Respondents in Jodhpur had a high preference for television compared to respondents in the other three districts.

Figure 15. Demand for different types of CIS product across the four study districts

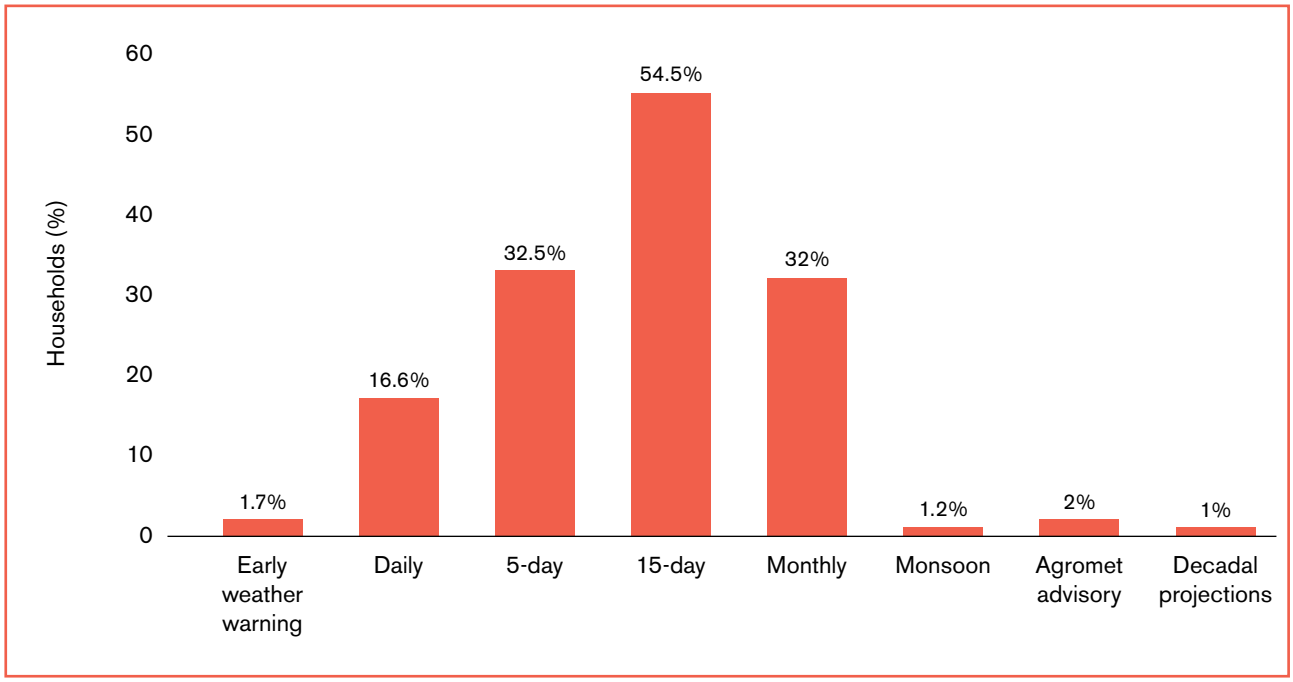
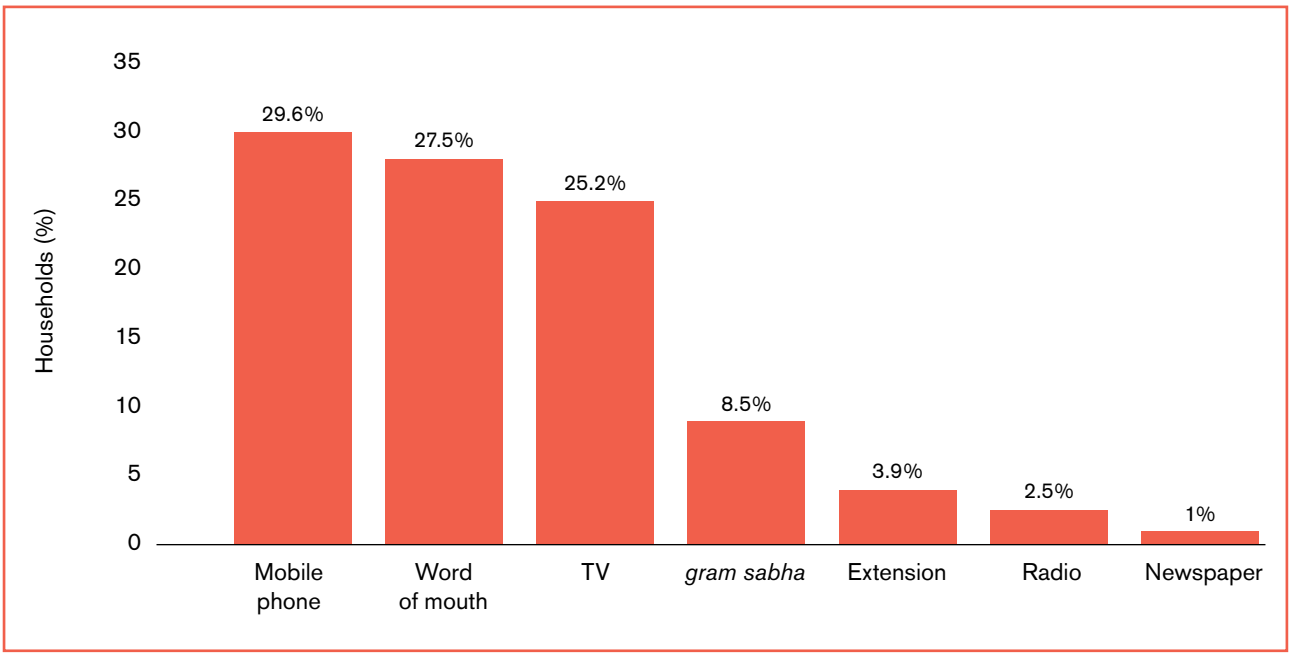


Figure 16. Preferred means of accessing CIS across the four study districts



Income, education and gender: These factors did not influence household preference for CIS products or modes of accessing CIS. This means that all households – regardless of inter-household differences – would prefer short range and extended range CIS products to be communicated via phone, word of mouth and television.

5.3 Discussion of findings

5.3.1 Using CIS in MGNREGS decision making

Our findings show that there are strong levels of CIS access in the four study districts, particularly in Uttar Pradesh. Those who have access use CIS to plan their household livelihood decisions, but the use of CIS to inform planning around when to participate in MGNREGS wage labour and what assets to recommend in the *gram sabha* is limited.

It is not clear why households use climate information in MGNREGS decision making less than they do for livelihood decisions. It could be that most households are not clear about how to use climate information to inform their asset and labour planning decisions to achieve better outcomes, whereas using CIS for agriculture is much more widely understood. For example, CIS dissemination formats may not be adequately tailored to MGNREGS workers in a way that provides guidance that is applicable to their participation in the programme, or the timeframe of CIS products that are available to households may not be adequate for the types of decision they need to make under MGNREGS. It may also be that low participation in MGNREGS decision making during the *gram sabha* means that households are unlikely to use CIS when selecting assets.

Our findings also show that CIS use by MGNREGS functionaries in the budgeting and planning process is virtually non-existent. MGNREGS wage and asset planning do not formally include an understanding of short or medium-term climate risks, which could help them plan for a more climate-resilient future.

These low levels of CIS use by both workers and officials highlight a need to better integrate CIS into MGNREGS decision making, so that the programme can better support households to prepare, cope and recover in relation to future climate shocks.

5.3.2 Tailoring CIS products to the needs of different users

Household demand for different CIS products differs depending on the local context. This includes climate exposure, livelihood activities that are unique to specific contexts, education levels, income and access to technology. So, CIS products need to be tailored to specific users' demands.

For instance, the higher demand for short-term weather forecasts in Uttar Pradesh could reflect the nature of agricultural livelihoods in the Bundelkhand region, which requires understanding how short term weather variability impacts on agricultural production. In contrast, Barmer households' higher preference for extended-range weather forecasts could reflect the extremely low levels of rainfall and acute vulnerability to drought in the district, which require more long-term planning. The future delivery of CIS products to support MGNREGS decision making will have to be mindful of these different needs and ensure that users have the types of CIS that they need for their unique decision-making context.

Understanding the context of decision making is particularly important for vulnerable groups, who must not be left behind. Their unique needs must be incorporated into CIS product design and the way they are communicated. Our findings illustrate the importance of this point firsthand. Female-headed households reported higher levels of access to short-range (1–5 day) CIS, but lower access to extended and longer-range (15–90 day) CIS. This suggests that, in general, they are not equipped with the information they need to support longer-term risk management strategies. Yet on the other hand, the few female-headed households that did access CIS were more likely to use it to inform their MGNREGS decision making, despite having lower overall levels of participation in MGNREGS decision making than men. This highlights the fact that those with the highest vulnerability will embrace opportunities to improve their livelihoods if the means of support are made available to them.

In the next section, we investigate the ways in which CIS can be integrated into specific MGNREGS decisions. However, given the unique contexts, there is a need to build households' capacity or awareness of both the types of CIS product available to them and the ways they can use this information to help their MGNREGS and livelihood decisions.

6

How MGNREGS can use CIS to strengthen resilience outcomes

This section explores the different options for MGNREGS to integrate CIS into wage and asset decision making, to strengthen their delivery and help households better prepare, cope and recover from drought and other climate shocks. We consider the types of decisions being made, their timescale and who is making them. It also outlines key considerations for successful and equitable uptake of CIS by MGNREGS planners and workers.

6.1 Integrating CIS into wage labour planning

MGNREGS functionaries rarely use CIS in the budgeting and planning process. Based on our interviews and household survey findings and building on IIED's previous recommendations for climate-smart wages (Kaur et al, 2019), we consider three ways in which CIS can strengthen wage contribution to resilience outcomes:

- **Wage labour planning:** Over both the short term – to respond to forecasted changes in rainfall to maximise available labour days and build financial capital, and the long term – to proactively understand changing drought risk on wage labour demand
- **Dynamic wage rates for drought and heat stress:** Based on drought risk and/or heat stress to enable wage seekers to continue delivering and receiving sufficient wages in times of drought or extreme heat
- **Shock-responsive wage labour days:** Either anticipatory – before a drought is declared to allow households to build financial capital ahead of the shock – or by streamlining the delivery of 50 additional wage labour days so that households receive timely wage labour relief in times of shocks.

BOX 9. KEY FINDINGS ON POSSIBLE CIS USE IN MGNREGS DECISION MAKING

We identified several ways CIS could benefit MGNREGS wage and asset decisions, by integrating it into:

- **Labour budget planning** for short-term labour and asset revisions and long-term annual wage labour budgeting
- **Shock-responsive wage payments** to deliver dynamic wage rates, anticipatory wage payments and a CIS-informed drought declaration process for 50-additional wage labour days, and
- **Asset planning** for short and long-term asset planning.

Our recommendations also include:

- **Useability of sub-annual forecasts:** Seasonal (long-range) and medium to short-range (up to 10 days) CIS are most relevant for MGNREGS wage and asset decision making. Extended range forecasts (30 days) should not currently be used as they are too uncertain.
- **Useability of climate projections:** Long-term (2050 and 2100) climate projections are not relevant as no MGNREGS decisions take place over that time horizon. Decadal (2–10) and multidecadal (10–30 years) projections could be used, but only as a guide to develop plausible future scenarios within a robust decision-making framework.
- **Further investigation is needed before CIS is decided upon:** MoRD and state governments will need to further collaborate with IMD and remote sensing agencies to discuss the different options we present here – especially long-range monsoon forecasts and alternative drought remote sensing data. This will ensure information is available, useable and provided in formats that suit the needs of MGNREGS decision makers and workers.
- **Co-producing CIS with end-users is crucial:** CIS must be co-produced with end users, including district, block and *gram panchayat*-level MGNREGS officials and households. This will require building household and official capacity and knowledge on using CIS in MGNREGS decision making to better understand their own CIS needs. There must be special consideration for vulnerable groups to ensure CIS access is both equitable and meaningful. Households' overall participation in MGNREGS decision making also needs to be considered, as it is currently low.

6.1.1 Wage labour planning

For more strategic budget planning, MGNREGS officials could use CIS on different timescales to better understand weather and climatic variability, and its possible effects on wage labour demand for upcoming seasons and years. This would improve MGNREGS budget planning, making it more resilient to fluctuations due to weather and climatic variability, including rapid increases in expenditure as a result of climate shocks. CIS can inform MGNREGS budgeting in the short and longer term.

Short-term wage labour revisions

Shorter-term changes to the wage labour budget can be made at the district, block or even *gram panchayat* level where accurate forecasts are available. This would allow short-term revisions to the 'shelf of works' to prioritise or deprioritise labour-intensive works based on upcoming rainfall. For example, if monsoon rains are likely to be delayed or below-normal, possibly leading to drought, MGNREGS functionaries could promote labour-intensive asset creation to allow households to use up their 100 wage labour days more quickly. This could

give households more income in the immediate term and help unlock their ability to access the additional 50 days when drought is formally declared. Such revisions could improve households' preparedness and coping resilience capacity by increasing their wage income over the short term.

Because these short-term revisions to the labour budget and 'shelf of works' are insensitive to any timeframe beyond a season, we also consider how long-range monsoon forecasts down to short-range weather forecasts can also be used when planning short-term labour revisions:

- **Long-range monsoon forecasts:** Based on analysis of IMD's available climate information, officials could use the second stage long-range forecast for upcoming monsoon rainfall for northwest India for these decisions by calling a special *gram sabha* when the forecast is made available in May-June. A special *gram sabha* would be required as IMD's long-range monsoon forecasts do not overlap with the MGNREGS annual planning cycle (Table 3). However, seasonal rainfall forecasts must be used with caution, as their probabilities rarely differ from climatological probabilities and may not be a good indication of uncertainty: assigning too much probability to the 'normal' category is an ongoing problem (Thomson and Mason 2018). MoRD and state governments need to further discuss the useability of long-range monsoon forecasts with IMD and the best way to effectively communicate them.
- **Extended-range weather forecasts:** It is unclear whether extended range (11–30 day) forecasts are useable for short-term wage labour revisions. According to IMD, the accuracy of their extended range forecasts is 80% for days 8 to 14, and 70% for days 15 to 21. We were not able to identify the reported confidence level for the fourth week. But the global literature reports that rainfall predictions for the sub-seasonal timeframe are poor (Thomson and Mason 2018).
- **Medium to short-range weather forecasts:** Using short- to medium-range (1–10 days) forecasts, MGNREGS officials could amend the types of assets built under MGNREGS in response to an impending climate shock. Other forms of drought indices, such as NDVI (see Box 6) could also be used, but we do not discuss them here.

Longer-term labour budget planning

MGNREGS officials involved in reviewing and approving labour budgets could also use climate information in their longer-term annual labour budgeting process to proactively identify years where there is likely to be higher demand for MGNREGS linked with a climate shock – in this case, drought.

The Empowerment Committee is already meant to use historical climate information to quality-check state labour budgets, but we were not able to confirm whether this practice takes place. It could, however, also be useful for budgeting more contingency funds for drought and other climatic shocks.

We also identified that states budget an additional 10% contingency funds each year to deal with higher-than-anticipated wage labour demand. Considering this practice, we hypothesise that using CIS in annual labour budget planning may add limited resilience building value. Households may also benefit from understanding trends in drought that may alter when they intend to undertake wage labour throughout the year.

Considering labour budgets are planned annually, officials would ideally use long-range monsoon forecasts when making budget decisions. However, IMD's first and second long-range monsoon outlooks do not overlap with MGNREGS' current annual planning cycle (Table 3). Decadal climate projections may appear as another good option to enable officials to predict upcoming intense drought years, or years of likely good rainfall. However, they are not accurate enough to be used in decision making (Thomson and Mason 2018). Global and regional climate models are routinely poor at reproducing the southwest Indian monsoon, consistently leading to 'model bias', underpredicting monsoon rainfall over land and overpredicting rainfall over sea (IPCC 2013, Choudhary et al. 2018). Therefore, we consider historical climate information – as proposed for use by the Empowerment Committee – to be the only useable form of climate information for annual labour budget planning.

MGNREGS officials and participating households can use historical climate information to capture natural and anthropogenically forced variability on annual and decadal timescales. This helps capture the trends induced by committed climate change. To be most effective, historical records require lengthy observations – often around 80 years. Anecdotal evidence from communities can also be used, recognising the danger of under or over reporting climatic shocks (Hallegatte et al. 2012, Thomson and Mason 2018, Nissan et al. 2019).

Table 3. Timing of MGNREGS annual planning cycle v. IMD's long-range forecasts for the summer monsoon and heat stress seasonal outlooks

MONTH AND DATE		MGNREGS PLANNING	LONG-RANGE FORECASTS		HEAT STRESS SEASONAL OUTLOOKS	
			Second	First	Second	First
Oct	2	Launch of *gram panchayat* (GP) planning – *gram sabha* (GS) discussions				
	3	Special GSs begin for approving GP plan				
Nov	30	Special GSs period ends for approving GP plan				
Dec	5	Submission of GP plan to block *panchayat*				
	20	Block consolidated plan approved, submitted to district				
Jan	19	Block plans presented by project officer to district collector				
	20	District plan presented to district *panchayat*				
	31	District plan approved by district *panchayat*				
Feb	10	District labour budget (LB) submitted to MoRD				
	20	Empowerment Committee begins reviewing LB				
Mar	31	Approved LB communicated by MoRD downwards				
Apr						
May						
Jun						
Jul						
Aug						
Sep						
Oct	2	Launch of GP planning – GS discussions				
	3	Special GSs begin for approving GP plan				
Nov	30	Special GSs period ends for approving GP plan				
Dec	5	Submission of GP plan to block *panchayat*				
	20	Block consolidated plan approved, submitted to district				
Jan	19	Block plans presented by project officer to district collector				
	20	District plan presented to district *panchayat*				
	31	District plan approved by district *panchayat*				
Feb	10	District LB submitted to MoRD				
	20	Empowerment Committee begins reviewing LB				
Mar	31	Approved LB communicated by MoRD downwards				

Note: Orange shading depicts possible timeframe for delivering IMD's long-range forecast; red shading depicts period over which the forecast is being made.

6.1.2 Dynamic wage rates for drought and heat stress

The central government sets MGNREGS wage rates each financial year (MoRD 2017), with states able to increase the rate by paying the difference from state funds. The wage rate is based on the consumer price index for agricultural labourers, drawing on 1983 consumption patterns, so does not consider the impact of increasingly frequent and higher-magnitude climate shocks. In previous research, households indicated that the wage rate was insufficient to meet household consumption needs during a severe drought (Steinbach et al. 2017). Our household respondents across all four districts re-emphasised this view.

MGNREGS could better support households to cope during climate shocks by introducing climate-responsive wage rates, scaled up in response to climate shocks to help rural households cope with the impacts of climate change.

But long-range seasonal forecasts of the upcoming monsoon are not yet skilful or accurate enough to be used to set a dynamic wage rate. One good basis for reviewing wage rates is analysing the impact of climate change on current consumption patterns with different intensities of climate hazard (Kaur et al. 2019). While we do not consider this in detail here, state or central government officials could consider using historical climate and biophysical and socioeconomic vulnerability data – available from IMD and state remote sensing departments respectively – to apply a more climate-sensitive wage rate.

The MGNREGS functionaries we interviewed widely proposed the use of extreme heat warnings. This is a more realistic use of extended and long-range forecasts, as temperature is significantly more predictable than rainfall (Thomson and Mason 2018). MGNREGS officials also regularly reported that extreme heat impacted on workers' health and in some cases inhibited them from completing wage labour days when the heat created more compacted soil, which was harder to excavate by hand. MGNREGS functionaries reported that it was possible to use extreme heat forecasts, on varying timescales, to determine a dynamic wage rate or reduce the length of a wage labour day in times of extreme heat. Although this would be a short-term measure, it would make MGNREGS more responsive to heat extremes.

6.1.3 Shock-responsive wage labour days

An important result from our household surveys is the low and highly delayed uptake of the additional wage labour days available under MGNREGS on top of the minimum 100 days when a climate shock is formally declared. Only 4% of survey responders accessed these days, which were not available until on average six months after the onset of the drought. It is clear that in Rajasthan and Uttar Pradesh, this supposedly shock-responsive measure is not delivering on its objective. This may explain the low contribution households attribute to wages in helping households prepare, cope and recover from climate shocks, particularly in Jodhpur, Banda and Mahoba.

As outlined in Box 7, the slow procedural process is the main reason for the ineffectiveness of the 50 additional wage labour days. Alternative measures could be used, including CIS, to speed up drought declarations and therefore the allocation of additional drought relief through extra wage labour.

MGNREGS uses crop-cutting to approve the additional 50 wage labour days. As noted in Box 7, a district collector will only recommend a drought declaration if cultivation is 50% lower than normal. But crop-cutting only takes place after the impacts of drought have begun to be felt. But there are many other ways to declare a drought in India, which use alternative meteorological, vegetative and hydrological indicators that may be much quicker than the crop-cutting experiment. IMD's predictive CIS products could also be used to trigger additional wages ahead of an official drought declaration or to enable swifter delivery of additional wage labour days after drought has been declared. However, MoRD and state governments need to further discuss their feasibility with IMD, as they must take care when using highly uncertain extended and long-range forecasts (Thomson and Mason 2018).

MGNREGS could integrate CIS, or remote sensing data, into the design of one of two shock-responsive mechanisms to get MGNREGS payments to households faster, enabling them to respond to shocks more rapidly. These are:

- **Drought anticipatory wage labour:** Using CIS, MoRD could deliver additional wage labour before or in the early stages of a meteorological drought before its downstream impacts are felt. This is also known as forecast-based financing, which uses triggers to deliver financial assistance prior to a shock such as drought. These measures help to build anticipatory resilience capacity to manage a climate shock before it occurs. Forecast-based financing schemes are being trialled in more than 20 countries (Wilkinson et al. 2018), including Kenya, where the Hunger Safety Net Programme uses NDVI data to trigger an anticipatory wage. MoRD and state governments need to work with national and state remote sensing departments to further investigate the practicality of using such vegetation indices for MGNREGS, carefully considering different agroclimatic zones. Such an approach could use meteorological data from IMD's second stage long-range monsoon forecast in late May to early June, but this also requires further investigation. Practically, if such an anticipatory wage were possible, households could be warned of the likelihood of drought through a special *gram sabha* meeting, receiving a payment before conducting labour. This would allow households to build their financial capital before a drought, increasing investments in irrigation, alternative livelihoods or helping to manage migration.
- **Streamlined drought-responsive wage labour:** The other option is using improved drought indices to streamline the delivery of shock-responsive labour days. This would reduce the six month timelag between drought shock and relief wage delivery, strengthening its contribution to coping and recovery. Rather than rely on the slow crop-cutting experiment process, this approach could use IMD's second stage long-range monsoon forecast or other available remote sensing data to determine a meteorological drought. For such a streamlined measure, it is important to consider the needs of different MGNREGS households. During our surveys, poorer households indicated that they would prefer to receive additional wage labour days in May to August as they have less short-term coping capacity than richer households, who would prefer to receive the additional days in October and November.

6.2 Integrating CIS into asset planning

As we saw in Section 4.1, MGNREGS assets build less than 30% of households' capacity to prepare, cope and recover from drought shocks in the four study districts (Figure 2). Climate information could help strengthen these assets' contribution to both climate resilience and livelihood benefits by supporting more informed and strategic planning.

Based on our interview and household survey findings and building on IIED's previous recommendations for climate-smart assets and institutional strengthening (Kaur et al. 2019), we consider two possible ways in which CIS can strengthen asset planning:

1. **Shorter-term inter-annual alterations** to asset planning to maximise MGNREGS' asset contribution to resilience outcomes, and
2. **Long-term robust planning of assets** to consider decadal and multi-decadal climate change trends for more adaptive resilience benefits.

We do not consider the specific types of asset that should be constructed or changes to asset design as these are highly context specific.

6.2.1 Short-term climate-informed asset planning

As with wage labour planning, it is also possible to make short-term changes to the 'shelf of works' that outline the priority assets for a *gram panchayat* when accurate seasonal or weather forecasts are available. For example, if upcoming rainfall were predicted to be high but seasonal projections indicated a likely mid-season drought, then water conservation assets could be prioritised to help with drought management. Such revisions could help with short to medium-term preparedness, coping and recovery resilience capacity.

As with wage labour, short-term asset decisions may not be time-sensitive beyond one year as such decisions would be made in response to upcoming seasonal rainfall conditions. However, many assets are built to last and deliver benefits beyond one year, so more strategic planning is also required. For this, MGNREGS officials can use:

- **Short to medium-range weather forecasts:** Using short- to medium-range (1–10 days) forecasts, officials could amend the types of asset built under MGNREGS in response to an impending climate shock. According to our interviewees, *gram panchayat* and block-level MGNREGS officials – including *gram rozgar sahayaks* – have the authority to make changes to 15-day priority 'shelf of works'.

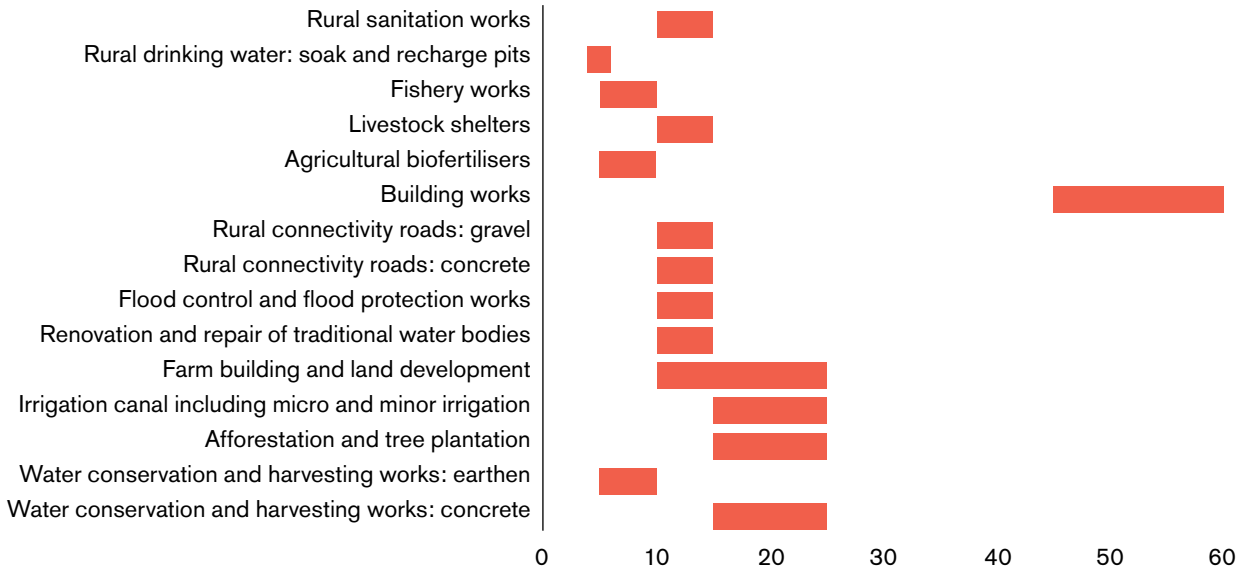
- **Long-range monsoon forecasts:** For more substantial planning, special or emergency *gram sabhas* can be called following an accurate long-range monsoon forecast to reprioritise proposed MGNREGS works. If the second stage long-range forecast indicates that monsoon rainfall is likely to be normal or above normal, officials could prioritise water conservation and associated works and stagger these throughout the year to improve beneficial asset outcomes. If, on the other hand, monsoon rains are likely to be delayed or below normal, possibly leading to drought, MGNREGS functionaries could promote labour-intensive asset creation to enable households to use their 100 wage labour days more quickly, unlocking the additional 50 days.

6.2.2 Strategic asset planning

MGNREGS works have varying expected timelines for durability (Figure 17), but most assets are supposed to last and deliver benefits for more than ten years. These include building works, land development, irrigation works and tree plantations (MoRD 2019). Given that most assets are expected to last 10–20 years, they are sensitive to decadal and multi-decadal climate change. Therefore, we also consider how MGNREGS could use climate information that informs of changes over these timescales to help households build their medium to long-term resilience to climate change.

- **Historical climate information:** When making decisions about things that will last for a decade or two, it is often useful to understand natural and decadal weather and climate variability, and the effect of committed climate change on these trends. These can be identified through historical climate information and expert climatologist judgment (Hallegatte et al. 2012, Nissan et al. 2019). Studying around 80 years of historical records would ensure sufficient and lengthy enough observations to make this an effective exercise (Thomson and Mason 2018, Nissan et al. 2019). MGNREGS' GIS platform may provide an opportunity to integrate this kind of historical information.
- **Climate projections:** Decadal (2–10 years), multi-decadal (10–30 years) and long-term (2050 to 2100) climate projections can be very enticing to use for infrastructure planning. We propose that long-term climate projections are not relevant for MGNREGS asset planning, as only one asset class (building works) is proposed to last more than 25 years. Multi-decadal and decadal projections may be relevant. However, officials must take serious care when using regional climate models that project future changes for India, as they can provide misleading impressions of high confidence in local climate change impacts. The links between regional and local climate are still poorly understood, and although regional climate models may strengthen model climatology, they do not ensure improved forecasting skill. Both global and regional climate models are routinely poor at reproducing the southwest Indian monsoon, consistently leading to model bias, underpredicting monsoon rainfall over land and overpredicting it over sea (IPCC 2013, Choudhary et al. 2018).

Figure 17. Proposed durability of MGNREGS assets



Source: MoRD (2019)

Given these limitations of future Indian climate projections, when and how can officials use them to inform resilience decision making? Where investments have long timescales or when they can create path dependencies long beyond their physical time horizon, future climate change information remains important. Over these decadal and multi-decadal timescales, historical information becomes less useful as we may experience weather and variability outside of past or recent experiences. Decision making under uncertainty and robust decision making provide a variety of tools that enable climate information – even if highly uncertain – to be useful in decision making, providing us with an insight into what kind of future change we can expect (Wilby and Dessai 2010, Hallegatte et al. 2012, Ranger 2013, Nissan et al. 2019). Examples include:

- **Scenario or sensitivity analysis:** Testing decisions under a range of plausible climate futures, identifying the risk of different decisions to different climate extremes. It is important to also look at the possible impacts outside the range of model predictions.
- **Low-regret measures:** Yielding benefits regardless of inaccurate forecasts.
- **Flexible measures:** Not necessarily making decisions or investments resilient to the worst-case climate scenarios now, but ensuring flexibility so they can be changed relatively easily if knowledge about the future climate becomes clearer or different.
- **Adequate safety margins:** Reducing vulnerability at negative or negligible costs. MGNREGS technical functionaries could use these to improve the designs of assets to perform better over climate extremes.

Importantly, decision making under uncertainty and robust decision making should always be bottom-up, beginning with a vulnerability assessment and using uncertain climate projections to test the sensitivity of these investments or decisions. It should not be a top-down exercise, beginning with the climate scenario. MoRD and state governments need to consider how they can integrate robust decision making into MGNREGS' proposed watershed management approaches, to strengthen watershed resilience in a more strategic manner that considers future climate risk.

6.3 Key considerations for successful CIS integration

The way CIS is currently communicated to rural households across the four study districts appears to be useful for livelihood decisions and can be replicated. However, for households to make greater use of this information in their MGNREGS wage and asset decision making, both the information itself and the ways it is communicated need to be adequately tailored to the needs of both households and MGNREGS officials, with special consideration of vulnerable groups – especially women – and adequate capacity building and awareness raising. Regional variations in the use and demand for different timeframes and modes of CIS communication must also be considered for successful application.

Below, we outline some of the processes and challenges national, state and MGNREGS officials should consider when designing and integrating CIS, whether it be for short or long-term wage or asset planning. Most importantly and in line with MGNREGS' bottom-up planning philosophy, co-production is vital for integrating CIS into MGNREGS' decision making at all levels. This includes building household and functionary capacity to understand the possibilities and limitations of different forms of CIS to enable adequate co-production.

Deepening understanding of the types of CIS that would be useful for both MGNREGS officials and workers to support decision making on wages and assets: Although the household surveys provide a baseline on the level and type of access and use in decision making, MoRD and state governments should undertake more consultation with MGNREGS beneficiaries and officials to understand what kind of CIS would be most useful to them and how exactly it can help them in their decision making and planning.

Working with IMD and the remote sensing departments to improve access to climate information and useability for different types of decision making: Using historical data to identify climate and natural variability trends often requires historical records from 30 to 80 years. Until recently, monthly and district-wide rainfall data were available on the IMD's website. However, this information is no longer open access. MoRD and state governments should proactively engage with IMD and state meteorological departments to get good-quality historical information and support from other data sources to fill any data gaps. They should also discuss the useability of long-range monsoon forecasts with IMD. State remote sensing departments house a wealth

of remote sensing data that MGNREGS could use for early drought preparedness and decision making.

Strengthening technical capacity to understand different types of climate information: Although we have initial baseline results for CIS use and demand, it is important to consider that, for key stakeholders to be able to co-produce and use CIS effectively, they need adequate CIS capacity and awareness of the benefits it can bring. As such, policymakers must consider:

- **GIS capacity at block level:** Although GIS planning is being rolled out, only three districts have GIS offices, one for each agro-climatic zone. During the interviews, officials reported that block-level technical capacity is low. As a key entry point for CIS, block level functionaries should have adequate capacity building on technology applications to enable integration of CIS.
- **Trust in forecasts beyond 20 days:** The household survey results show reduced trust levels in climate information that has a lead time of more than 20 days. MoRD and state government officials should therefore carefully consider the possible benefits of using this type of information and the way that they communicate it – as trust in CIS is key for success.
- **Choosing the right metrics for communication:** Average temperature or precipitation data is rarely suitable for making effective resilience decisions. Rather, it is important to understand when coping thresholds are exceeded, driven by extremes not averages. However, often future, long-range weather forecasts and climate change projections are presented and interpreted as meaningful representations of the future, despite being merely possible scenarios (Nissan et al. 2018).
- **Communicating a range of plausible outcomes:** Merely using the best guess given by climate models does not represent the true prediction of uncertainty and was never intended to. The possibility of outcomes outside the range of model projections can only be assessed subjectively with information about where the models fail to perform well, and why they fail in those situations (Nissan et al. 2018).

Choosing equitable modes of communication targeted to the needs of different users: Our household survey results show different levels of access to CIS depending on location, gender, education and income levels. To ensure CIS also reaches and benefits the most vulnerable groups, MGNREGS must consider different CIS needs and means of accessing CIS.

Strengthening households' ability to meaningfully participate in decision making: The *gram sabha* is an important space for integrating CIS into MGNREGS' decision making. Poor *gram sabha* participation across all four study districts is a possible reason for low CIS use in MGNREGS decision making. Strengthening households' ability to meaningfully participate in the *gram sabha* is an important structural barrier to address. Better ability to participate can increase households' agency over decisions that affect their livelihoods, with benefits in terms of how MGNREGS supports them to build climate resilience and wider local development benefits.

See Appendix 2 for an at-a-glance summary of our recommendations for using CIS in MGNREGS, with example actions, timeframes, MGNREGS entry points, key considerations and possible contributions to climate resilience.

7 Conclusion

The research we present in this report has broken new ground in understanding how social protection contributes to climate resilience and how CIS can be integrated into social protection programmes to help households better prepare, cope and recover from climate shocks – in this case, drought.

Our research shows that to a modest extent, MGNREGS wages and assets supported some households to build resilience to drought in 2018. However, these benefits were concentrated in just one of the four study districts: Barmer.

Our research also shows that CIS is available to 58% of households in Rajasthan and Uttar Pradesh. Yet, although they use CIS extensively when making decisions around livelihoods, only about a quarter of households use it to inform their engagement with MGNREGS. We also found that MGNREGS officials do not use climate information in their budgeting and planning decisions.

Based on these findings, we suggest three important ways that CIS can be integrated into MGNREGS, which will enable wages and assets to better support households to manage future climate risks. These are integrating CIS into:

1. Short and medium-term labour budget planning
2. Shock-responsive wage payments – including dynamic wage rates, anticipatory wage payments and streamlined shock-responsive drought declaration payments – so that households can better manage short-term shocks, and
3. Short and long-term asset planning.

Changes to MGNREGS processes are required at all levels, from central government down to *gram panchayats*, to integrate CIS into decision making.

To effectively integrate CIS into MGNREGS decision making, MoRD and the state governments of Rajasthan and Uttar Pradesh will need to make several important considerations. They will need to engage more deeply with households and MGNREGS officials to understand their needs for CIS and to build their capacity and knowledge on how to use CIS in MGNREGS decision making. They should also continue to collaborate with IMD to improve access to CIS, particularly in useable formats that suit the needs of MGNREGS decision makers and workers. This process must consider the needs of different users to ensure both equitable access to CIS and meaningful ways that these different groups can participate in more climate-informed MGNREGS decision making.

7.1 Future research

Through our research, we have identified several gaps in our knowledge that need to be strengthened going forward. These include:

- Developing a better understanding of MGNREGS wage contribution to overall household climate risk management. This could include modelling how much a climate-resilient daily wage rate needs to be for different types of shock; how many wage labour days households need to manage specific climate risks; and the extent to which MGNREGS wages contribute to the overall cash and in-kind goods households need to manage a climate shock.

- More evidence on the extent to which MGNREGS assets deliver longer-term adaptive capacity to make households more resilient to future shocks. This includes further research on integrating CIS and robust decision-making approaches with asset types – considering prevailing agro-climatic zones, livelihoods and asset locations – using new GIS-based tools and MGNREGS' watershed management approach.
- An improved understanding of how MGNREGS differentially enables women and men to manage climate risks. Our current understanding of the intra-household dynamics around MGNREGS impact is limited and could be strengthened to deliver better outcomes for women.

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Acronyms

AAS	Agrometeorological (Agromet) Advisory Services
CIS	climate information services
GIS	geospatial information system
ICAR	Indian Council of Agricultural Research
IITM	Indian Institute for Tropical Meteorology
IMD	Indian Meteorological Department
IPCC	Intergovernmental Panel on Climate Change
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme
MoEF&CC	Ministry of Environment, Forest and Climate Change
MoRD	Ministry of Rural Development
NDVI	Normalised Difference Vegetation Index

Appendices

Appendix 1. Sampling approach

Sampling methodology

The main aim of our sampling methodology was to develop an approach that would give results that were representative of the entire 1.5 million MGNREGS workers in the four study districts. To get a representative sample (with a 95% confidence level), we needed a sample of 1,066 active workers. To account for possible errors that could occur when administering the survey, we increased the number of interviewees by roughly 15% to get a total sample size of 1,232. In the first round, we collected data from 1,232 workers in our study districts in Rajasthan and Uttar Pradesh.

Given the huge difference in size and population between the four districts, we weighted the sample of MGNREGS workers by the total rural working population of that district to get a proportionate balance of interviewees across each district.

In total, we surveyed 470 households in Barmer, 320 in Jodhpur, 263 in Banda and 179 in Mahoba. To ensure that our results were a random sample that was representative of the whole district, we administered the survey in all blocks of each district. However, given the large number of blocks and the relatively small number of surveys across large geographic areas, we decided to select a limited number of *gram panchayats* per block. This approach balanced the need to not cluster findings around locations with particular sets of circumstances and not spread the sample too thin with the risk of capturing a series of outliers from a wide range of *gram panchayats*. We therefore set an average number of 10–15 surveys per *gram panchayat* and two to three *gram panchayats* per block. We used randomisation software to select the *gram panchayats* from each block.

Once we had finalised the list of *gram panchayats,* the survey team identified a list of MGNREGS job cardholders from each village that were eligible to participate in the study. To be eligible, a job cardholder had to have worked at least one day in the 2018/2019 MGNREGS financial year. We used this criterion firstly because it allowed us to identify households who had participated in the programme in the same year as the 2018 *kharif* drought. After drawing up the list of eligible households for each *gram panchayat*, we again used randomisation software to create a list of interviewees.

Gender analysis

We know from the literature that men and women experience the impacts of climate change in different ways and that women are more vulnerable to climate change than men. We also know that intra-household dynamics related to access and control of resources, decision making, poverty and exclusion, education, and so on are complex and difficult to empirically measure or observe. For these reasons, we were interested in understanding whether and how MGNREGS helps women and men differently, particularly whether and how it helps them differently to manage climate hazards and risks.

However, MGNREGS' unique programme delivery makes studying its differentiated impact on men and women a challenge. MGNREGS provides benefits to households, rather than individuals. Each household has one jobcard, which multiple people from the household can register under. The total number of days worked (up to the maximum 100 per year) are allocated at household, rather than individual, level.

This left us with an important decision regarding how we conducted our household survey: which member or members of the household should we interview? Each option came with an impact on the quality and objectivity we could get for gendered analysis of MGNREGS. Our options were:

1. Interviewing an equal number of male and female-headed households, which would mean the sample was no longer representative of the entire MGNREGS working population in the four districts.
2. Interviewing an equal number of men and women, regardless of their status within the household. However, if women are less likely to participate in household decision making, MGNREGS decision making or resource allocation, this could compromise the quality of the information we received for all aspects of the survey.

3. Interviewing men and women from one jobcard together, which would risk women being unable to speak and provide critical answers in front of their husbands in a highly patriarchal environment.
4. Interviewing male and female-headed households in proportion to the general population and conducting more limited analysis on intra-household dynamics due to more men responding to our survey.

There was no solution that would give us perfectly objective and high-quality data on the differential impacts of MGNREGS.

We decided to go with option 4 and interview a representative sample of male- and female-headed households so that our insights on MGNREGS are applicable to the wider population. But this meant we could not ask questions on intra-household dynamics of MGNREGS participation and benefits, since most (approximately two-thirds) of our respondents were male and the vast majority (89.4%) of our sample households were male-headed. This also means that in some cases, women were the main respondents for male-headed households, adding further potential error to our analysis. Although this approach gives us some ability to understand differential gender impacts, we recognise that this method comes with its own limitations. Where possible, we provide supplementary analysis based on the researchers' own experiences in India and from the wider literature. However, more robust analysis on gender, climate and MGNREGS is needed to understand the programme's differentiated impacts on women and men.

Appendix 2. Summary of recommendations for CIS use in MGNREGS

USE	EXAMPLE ACTIONS	TIMEFRAME	CIS TYPE	MGNREGS ENTRY POINTS	FEASIBILITY / CONSIDERATIONS	CLIMATE RESILIENCE CONTRIBUTION
1. Short-term labour revisions based on rainfall	Labour-intensive works prioritised to use up 100 days when drought predicted	Under a year / seasonal	Second long-range monsoon forecast Medium-short range weather forecasts Remote sensing NDVI	Special *gram sabha* *Gram rozgar sahayaks*	Useability of long-range forecasts needs investigating with IMD Useability of NDVI needs investigating with state remote sensing departments	Improved short-term preparedness capacity before a shock Improved short-term coping capacity due to increased wage income
2. Longer-term annual wage labour budgeting through proactive consideration of changing drought risk	Understanding the annual and decadal trends in drought to inform upcoming annual labour budget peaks and troughs	More than one year	Historical climate information on seasonal and decadal rainfall and drought trends	Central Empowerment Committee State, district, block and *gram panchayat* officials approving labour budgets Households in *gram sabha*	Acquiring up to 80 years of historical rainfall data at smallest geographical scale will require discussions with IMD and state meteorological departments	Improved medium-term preparedness capacity before a shock for expenditure resilience Improved medium-term coping capacity due to increased wage income
3. Dynamic wage rate based on (a) drought risk or (b) heat stress risk	Wage rate changes based on drought and heat risk to increase or maintain wages during time of drought and heat stress	Under a year From a few days	Remote sensing drought indicators Long-range and extended-range heat outlook and heat extreme weather forecast	Central or state MGNREGS officials	Useability of long-range forecasts needs investigating with IMD Useability of NDVI needs investigating with state remote sensing departments	Improved coping capacity during climate shocks or heat extremes due to higher wage rates
4. Anticipatory wage payments in times of drought (forecast-based financing)	Households warned of the likelihood of drought, receiving a payment before conducting labour	Under a year / seasonal	Long-range monsoon forecast Remote sensing drought indices	Central and state MGNREGS officials Households through special *gram sabha*	Useability of long-range forecasts needs investigating with IMD Useability of NDVI needs investigating with state remote sensing departments	Improved preparedness capacity before shock

USE	EXAMPLE ACTIONS	TIMEFRAME	CIS TYPE	MGNREGS ENTRY POINTS	FEASIBILITY / CONSIDERATIONS	CLIMATE RESILIENCE CONTRIBUTION
5. Streamlined shock-responsive wage labour	Shock-responsive days delivered more quickly than the current six month timelag from drought shock to relief wage delivery	Under a year / seasonal	Remote sensing drought indices	Central and state MGNREGS officials Households through special *gram sabha*	Useability of long-range forecasts needs investigating with IMD Useability of NDVI needs investigating with state remote sensing departments	Improved coping capacity during shock due to swifter wage delivery Improved short-term recovery capacity after a shock
6. Short-term climate-informed asset planning	Short-term changes to the 'shelf of works' If monsoon rainfall is likely to be normal or above normal, water conservation works could be prioritised	From under 15 days to under a year	Second long-range monsoon forecast Medium-short range weather forecasts	Households through special *gram sabha* Low-level functionaries with households *Gram rozgar sahayaks*	Useability of long-range forecasts needs investigating with IMD	Improved preparedness capacity before shock occurs Improved coping capacity during a shock Possible improved recovering capacity from shocks through productive assets
7. Long-term robust asset planning	Strategic asset choices, such as integrated watershed management planning Using robust decision making techniques to choose assets that are more robust to future climate scenarios	More than one year Up to 25 years	Decadal and multi-decadal climate scenarios for robust decision making Historical climate data	District, block and *gram panchayat* level planning Block GIS offices Participatory *gram sabha* planning	Assets and designs need sensitivity testing for different climate scenarios Participatory robust decision making needs to be designed Range of plausible future climate scenarios need to be developed that deal with uncertainty and model bias Acquiring up to 80 years of historical rainfall data at smallest geographical scale will require discussions with IMD and state meteorological departments	Long-term preparedness and coping capacity in advance of shocks Longer-term recovery capacity from shocks through productive and strategic assets
8. Cross-cutting					Participatory co-production of CIS product CIS capacity building for households and functionaries Strengthened trust and participation in *gram sabha*	

Related reading

Soanes, M, Kaur, N, Venkataramani, V, Shakya, C and Kaur, D (2019) Financing a climate-resilient MGNREGS. IIED working paper: London.

Kaur, N, Agrawal, A, Steinbach, D, Panjiyar, A, Sehgal, S, Manuel, C, Barnwal, A, Shakya, C, Norton, A, Kumar, N, Soanes, M and Venkataramani, V (2019) Building resilience to climate change through social protection: lessons from MGNREGS, India. IIED working paper: London.

Kaur, N, Steinbach, D, Manuel, C, Saigal, S, Agrawal, A, Panjiyar, A, Shakya, C and Norton, A (2017) Building resilience to climate change: MGNREGS and climate-induced droughts in Sikkim. IIED issue paper: London.

Steinbach, D, Kaur, N, Manuel, C, Saigal, S, Agrawal, A, Panjiyar, A and Barnwal, B (2017) Building resilience to climate change: MGNREGS, drought and flooding in Odisha. IIED issue paper: London.

Social protection is a key tool to support the poorest and most vulnerable to adapt to climate change. This working paper explores the extent to which India's largest social protection programme – the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) – helped households prepare, cope and recover from the 2018 summer drought across Rajasthan and Uttar Pradesh. As well as providing baseline information on the climate information services accessed by MGNREGS households and officials, it offers practical guidelines for how the scheme can use climate information in its decisions and planning.

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