Do public works programmes foster climate resilience? Conceptual framework and review of empirical evidence

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Abstract Public works programmes (PWPs) are pervasively used to tackle poverty and unemployment, and to build infrastructure and skills in low- and middle-income countries. While their impacts on poverty, food security and labour outcomes have been widely documented, there is little research focusing on the role of PWPs in supporting household climate resilience in the global context of a deepening climate crisis. To fill this gap, we propose a conceptual framework that links the different components of PWPs – wages, infrastructure, and skills development – to household capacity to cope with, and adapt to, climate-related shocks. We use this framework

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to guide our review of empirical experimental and quasi-experimental evidence on the multiple short-term and long-term effects of PWPs on resilience to weather shocks, such as floods, droughts and cyclones. Such evidence mostly draws from a few programmes in India, Ethiopia and Malawi. Overall, we find that, through the wage component, PWPs can be effective in enhancing household resilience through increasing savings and productive investments. However, these benefits usually only materialize in the case of regular, long-term programmes, as opposed to ad-hoc/temporal PWPs. PWPs' infrastructure component can play a crucial role in supporting households' long-term capacity to adapt to shocks, especially in the case of "climate-smart" infrastructure, with positive externalities beyond direct programme beneficiaries to communities. There is a key evidence gap investigating the effects of PWPs through the infrastructure component on both beneficiaries and other community members, as well as on the role of on-the-job training and its capacity to strengthen resilience in combination with the infrastructure component. Evidence from different socioeconomic contexts is also scarce. Another key gap relates to the identification of the main mechanisms through which these relationships operate. Filling these gaps will support policy makers taking decisions about when to implement PWPs (especially in comparison with other social protection interventions), and how to design them to tackle vulnerability to climate change.

Keywords social protection, resilience, labour intensive employment, climate change, economic and social development, international

Introduction

Climate change causes, among other things, an increase in the incidence and severity of extreme weather events, such as floods, droughts, wildfires or heatwaves (IPCC, 2018). Households in low- and middle-income countries (LMICs) are especially affected by these weather shocks due to their high reliance on the agricultural sector as a key source of income and to their limited access to

credit and insurance markets (Dercon and Christiaensen, 2011). Climate-related hazards resulted in an annual loss of 23 million working-life years between 2000 and 2015, especially among vulnerable groups, amplifying existing social and economic inequalities (ILO, 2018). Identifying strategies that promote households' resilience to weather shocks, both by enhancing their ability to *cope* with shocks once they materialize as well as their ability to *adapt* to future shocks, is, therefore, a key global challenge and policy priority.[1]

Public works programmes (PWPs) – also known as labour-intensive employment, workfare, or cash-/food/input-for-work programmes – are among the most common forms of social protection globally, with over 90 countries implementing them (World Bank, 2018). Given their pervasiveness, they can play a crucial role in mitigating the impacts of weather-related shocks (Bowen et al., 2020; Costella et al., 2023). PWPs are government-led or donor-led initiatives, which offer temporary employment opportunities to people usually living in poor or vulnerable areas (Subbarao et al., 2013). PWP beneficiaries usually engage in labour-intensive activities related to the construction or maintenance of community infrastructures or to the provision of other public services. In exchange for their work, beneficiaries receive compensation either in cash or in kind (often food).

In the shorter run, PWPs can support households in withstanding and recovering in the face of shocks by offering income support. They can also promote longer-term resilience, including after PWPs end, through asset and infrastructure creation, as well as skills development. Increasingly, PWPs are used to create climate-smart community assets or provide climate-smart services (e.g. afforestation, land rehabilitation, river walls, etc.). This way, they can support climate resilience more directly compared with other social protection schemes, such as unconditional cash or food transfers (Beierl, 2021; Godfrey-Wood and Flower, 2018; Beazley et al., 2016). It is noteworthy that the world's two largest PWPs – India's Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) and Ethiopia's Productive Safety Net Program (PSNP) – were initiated as a public response to two large drought shocks (Bagga et al., 2023).

Despite this potential, PWPs have not yet been fully exploited as a major policy leverage to mitigate and adapt to climate change (Costella et al., 2023). This is partly due to lack of evidence synthesis. Studies reviewing the impacts of PWPs (Gehrke and Hartwig, 2018; Sakketa and von Braun, 2019; Beierl, 2021; Bagga et al., 2023) did not have a specific focus on climate resilience.

Our goal is to contribute to this literature by, first, proposing a diagrammatic conceptual framework, which links the different components of PWPs to households' different (resilience) *capacities* to deal with current and future

1. We present a comprehensive definition of resilience in the next section.

climatic shocks; and by, second, synthesizing existing empirical evidence of the multiple (short-run and long-run) effects of PWPs on climate resilience. Finally, we highlight gaps for further research.

We identify three main evidence gaps. First, there is very limited causal evidence about the effectiveness of the infrastructure component of these programmes. Understanding the impact of this component is crucial for policy makers when deciding between PWPs and less costly social assistance programmes, such as cash transfers. Second, despite being widely used globally, existing experimental and quasi-experimental studies are limited to a few rural settings (India, Ethiopia and, to a lesser extent, Malawi). We do not have much information on their average and distributional effectiveness in the face of climate shocks for Central and Latin America, the Middle East, and East Asia, or other settings in sub-Saharan Africa or South Asia. Also, evidence from urban or peri-urban areas, and humanitarian settings is very limited. Finally, our understanding of the mechanisms and programme design features through which PWPs can support resilience-building in different contexts remains relatively limited.

Conceptual framework: Public works programmes and climate resilience

We define climate resilience as the capacity of a social system to cope effectively with a hazardous event, responding in a way that preserves its basic function, identity and structure, while maintaining the capacity to adapt. Several scholars define resilience as a two-pronged concept encompassing the capacity to cope with, and adapt to shocks (Bowen et al., 2020; Beazley et al., 2016; Bahadur et al., 2015). This concept includes at least two key aspects: a) the *capacity to cope*, which refers to the ability to withstand and recover from a climate-related shock; b) the *capacity to adapt*, which refers to the ability to adjust to potential damage, take advantage of opportunities and cope with consequences, and entails reducing long-term exposure to risks as well as learning to adjust after a shock to reduce vulnerability to the same shock in the future.[2]

In line with the existing literature (e.g. Beierl, 2021), we suggest that PWPs may contribute to fostering climate resilience through three key components: wages; infrastructure development/service provision; and skills development. Of course, the relationship between PWPs and climate resilience is complex and highly contextual, varying according to the setting in which the programme is implemented and programme design features. Nevertheless, it is possible to develop a general (although non-exhaustive) conceptual framework, which

2. Others add a third component – a transformative capacity (Béné et al., 2015; Sengupta and Costella, 2023).

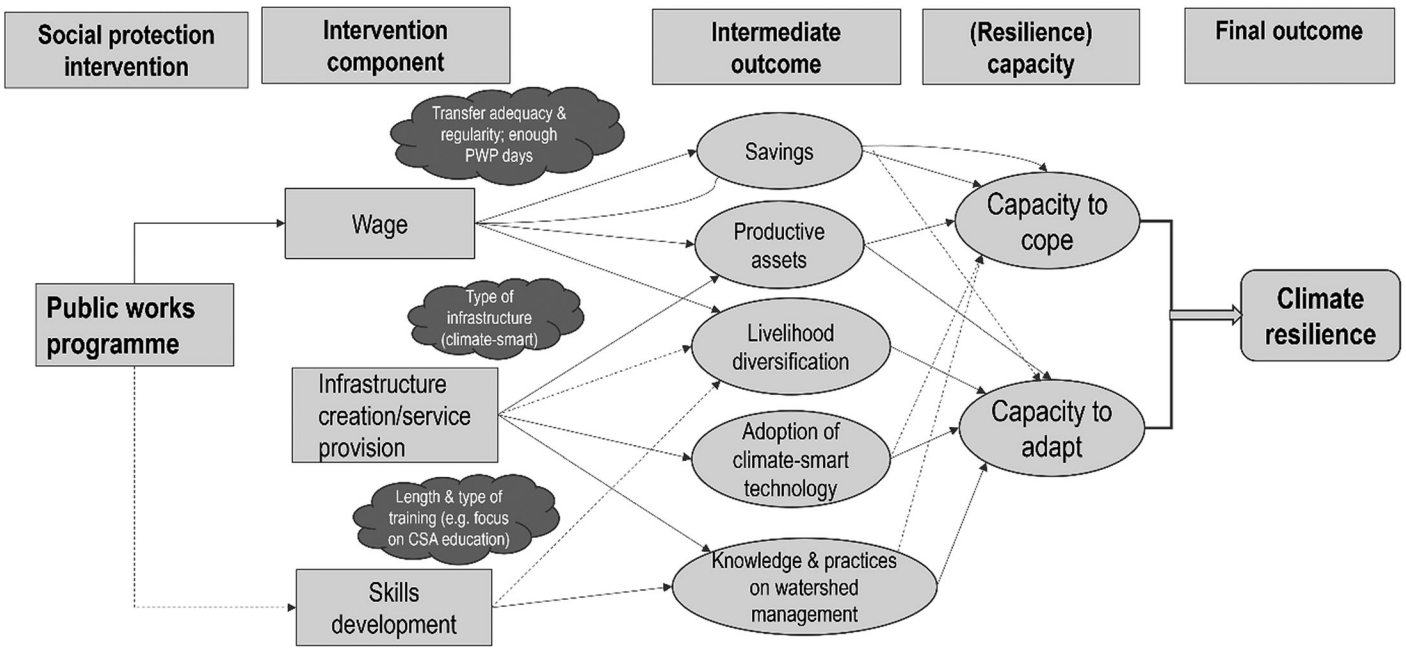
illustrates the main pathways/intermediate outcomes through which PWPs can contribute to building resilience at different scales (individual, household, and community). Such intermediate outcomes are proxies for the two resilience capacities, and how they relate to the ultimate outcome, i.e. climate resilience. While it is not always easy to associate a specific indicator to one or the other resilience "capacity" and while, in the literature, there is no full consensus, we do identify some proxy measures. In turn, this can guide identifying the key indicators to be used to measure programme effectiveness (see Figure 1).

We argue that PWPs may contribute to fostering climate resilience through three key components: wages; infrastructure development/service provision; and skills development. This framework also presents the intermediate outcomes that these three intervention components may produce, which are proxies for the two resilience capacities, and how they relate to climate resilience. While it is not always easy to associate a specific indicator to one or the other resilience "capacity" and while, in the literature, there is no full consensus, we do identify some proxy measures. An increase in savings is considered primarily a proxy for coping (or absorptive) capacity (Bowen et al., 2020; Béné, Frankenberger and Nelson, 2015; Beazley et al., 2016); the same applies to a reduction in the use of extreme coping strategies – including selling productive assets (Bowen et al., 2020; Béné, Frankenberger and Nelson, 2015; Beazley et al., 2016; Sengupta and Costella, 2023). Indicators of adaptive capacity, instead, are livelihood diversification (Sengupta and Costella, 2023; Bowen et al., 2020; Beazley et al., 2016; Béné, Frankenberger and Nelson, 2015); adoption of climate-smart technology (Sengupta and Costella, 2023; Bowen et al., 2020; Béné, Frankenberger and Nelson, 2015); and long-term investments in productive assets (Bowen et al., 2020; Beazley et al., 2016; Béné, Frankenberger and Nelson, 2015).

The first intervention component of PWPs involves the provision of a wage,[3] which enhances the coping capacity by improving access to food and/or avoiding detrimental consumption smoothing strategies (Hadley et al., 2023), enabling savings, preventing distress selling, and/or investing in productive assets (Dercon and Christiaensen, 2011; Hidrobo et al., 2018). Regarding the enhancement of adaptive capacity, wage payments may allow investments in productive assets and technology (e.g. drought-resistant crops), which helps to diversify livelihoods and increase the ability to adjust to climate change (Barrett et al., 2021). In addition, wages may enhance adaptive capacity by influencing saving habits, although this effect may be limited, as PWPs typically provide low remuneration (hence, this channel is indicated in Figure 1 by a dashed line).

3. The term "wage" here also includes in-kind (especially in-food) remuneration for public works engagement.

Figure 1. *Conceptual framework linking PWPs to climate resilience*



Notes: a) Clouds indicate the key design and implementation features of the specific PWP components. They influence the relationship between the specific intervention component and intermediate outcomes; b) Filled arrows indicate assumed strong relationships, while dashed lines indicate weaker relationships.
Source: Authors' conceptualization.

The extent to which wages affect these intermediate outcomes depends on several factors: the size of the transfer (whether it is sufficient to induce change or meet consumption needs); the regularity and reliability of payments, the frequency of disbursement; and whether the number of working days is sufficient to generate a significant impact (McCord, 2022). Additionally, the timing of employment should align with seasonal variations in food security and labour market demand. For example, if access to PWPs is consistently reliable, participants may reduce precautionary savings and invest in more productive assets, thereby strengthening their adaptive capacity. In addition to these prerequisites, improving adaptive capacity also requires wage levels that are high enough to encourage investment in productive inputs, capital, and/or livelihood diversification.[4] This highlights that – like any other social protection tool – effective programme design and implementation are critical.

The second intervention component involves infrastructure creation and/or service provision. The provision of public goods is a key feature of PWPs, distinguishing them from cash transfers. Through this provision, PWPs can strengthen household resilience to climate shocks. Subbarao et al. (2012) categorize goods and services created by PWPs into two types: infrastructure (e.g. road reconstruction after weather shocks or afforestation) and land management (e.g. soil conservation projects). While both types of PWPs may mitigate the effects of shocks and increase resilience, it is likely that PWPs focusing specifically on climate-smart infrastructure, such as afforestation and land rehabilitation, may yield larger impacts on climate resilience than other types of infrastructure and service provision (Bagga et al., 2023). Over the last years, an increasing number of countries, such as Ethiopia, Haiti, India, Indonesia, Madagascar, Malawi, Pakistan and Rwanda, have focused on the provision of these services through PWPs with the specific objective of reducing vulnerability to different weather shocks, as well as some consequences of unsustainable land use, such as soil erosion and degradation (Subbarao et al., 2012; Adam, 2015; Godfrey-Wood and Flower, 2018).

One intermediate outcome of the infrastructure creation and service provision component of PWPs is the adoption of climate-smart technologies. Climate-smart agriculture (CSA) practices, such as conservation agriculture, agricultural diversification, and improved seed use, have been widely promoted in many African countries. However, their success has often been limited due to high costs (Amadu, McNamara and Miller, 2020). Hence, PWPs may actively increase the adoption of CSA practices by easing household budget constraints. This, in turn, may enhance agricultural productivity and climate resilience (Scognamillo and

4. At the same time, wages should usually be below market wages, and in general not too high: otherwise, people in the middle class may also be incentivized to participate, although PWPs are meant to reach the poor.

Sitko, 2021). For example, the adoption of drought-resistant crop varieties can make farming more resilient to water scarcity, allowing farmers to maintain, or even increase, crop yields during drought periods. Additionally, adopting climate-smart approaches can improve sustainable resource use and productivity. For example, drought-resistant crops often require less water and fewer inputs such as pesticides and fertilizers, promoting more sustainable agricultural practices and reducing environmental degradation, ultimately improving their long-term resilience.

Just like wages, the impact of interventions is highly dependent on the relevance, quality and functionality of the infrastructure and services created. It is crucial that these infrastructures are tailored to local needs and that they are provided with adequate technical inputs during design, implementation and maintenance. Governance and community ownership of these infrastructures is also key (Burchi and Sakketa, 2025).

The third component of PWPs is skills development. Indeed, PWPs interventions are often combined with on-the-job training or broader training initiatives. Training activities on CSA practices, disaster preparedness, livelihoods diversification, and extension services are often promoted to equip household with specific skills that enhance their adaptive capacity. Such human capital-building interventions can have long-term effects on labour market outcomes, including wages, employability, labour participation, and productivity. Compared to cash transfers, PWPs offer the distinct advantage of fostering on-the-job skill development, which can contribute to sustained economic resilience. However, given that many of the activities undertaken in PWPs are generally low-skill and short-term, it is hard to evaluate the degree to which the quality of skill acquisition and transferability occurs in practice (Gehrke and Hartwig, 2018). Several factors determine whether skills development interventions for PWPs would enhance capacities to cope or adapt. These include: 1) the alignment of the training with the local context and resilience; 2) the availability of resources to enable beneficiaries to apply the acquired skills; 3) the demand for these skills; and 4) labour market conditions, among others (McCord et al., 2016; Bertrand et al., 2017; Solórzano and Cárdenes, 2019; Beierl, 2021).

Effects on the community

The three intervention components can affect not only the resilience of the beneficiaries but also that of entire communities. For instance, the injection of considerable amounts of cash (or food) through PWPs into targeted communities may lead to several general equilibrium effects on local wages, prices and overall economic activities such as trade, production and income diversification (Loewe and Zintl, 2023). This is often referred to in the literature

as spillover effects (Gazeaud, Mvukiyehe and Sterck, 2019). For instance, the competition induced by a PWP with private-sector jobs may push local wages up, as has been documented in the case of the MGNREGA in India (Imbert and Papp, 2015; Muralidharan, Niehaus and Sukhtankar, 2018; Zimmermann, 2020) and Ethiopia's Urban PNSP (Franklin et al., 2024). Such increases in equilibrium private-sector wages can lead to substantial decreases in poverty, as well as to large aggregate welfare gains in relation to the gains received solely by programme participants. However, such an increase in wages may also affect local prices, with potential detrimental effects on food and non-food consumption. Based on the evidence from cash transfers in Mexico, local effects on prices may also depend on the type of transfer (e.g. food versus cash) and the degree of market-connectedness of the communities involved (Cunha, De Giorgi and Jayachandran, 2018). Theoretically, increases in wages may also reduce the local demand for labour among non-participants in the private sector (Bagga et al., 2023).

Moreover, by providing access to public infrastructures, such as roads, water systems and dams, PWPs make users less vulnerable to climate shocks: these infrastructures are, by design, planned to benefit the entire community (and therefore cannot be defined as *spillover* effects). These effects of PWPs on non-beneficiaries are even more evident in the case of the creation of climate-smart infrastructures, as the entire community can make use of them. Finally, programme participants can share their skills and knowledge as well as resources with other community members (non-beneficiaries), further contributing to community resilience (Angelucci and De Giorgi, 2009).

Methodology

First, we looked for empirical studies that examined the direct impact of PWPs on resilience, without specifying whether this materialized through enhancing the coping or the adaptive capacity. This meant selecting those studies that examined whether PWPs had buffered the negative effects of climate shocks (such as floods, droughts or earthquakes) on key outcomes such as poverty, consumption, productivity and food security. Then, we looked at empirical studies of the impacts of PWPs on *proxy indicators of capacity to cope* under *normal* conditions (i.e. not in relation to shocks). As discussed, these included savings, the use of extreme coping strategies, and the ownership of productive assets. Finally, in a similar way, we reviewed the studies that focused on PWPs' effects on *proxy indicators of adaptive capacity*, such as the adoption of modern technologies, knowledge and practices related to climate-smart agriculture, diversification of income-generating activities, and diversification of livelihoods in general, as well as investment and long-run or medium-run effects on savings. At the same time, though it was not always easy to do so, we distinguished the above impacts

according to the specific component – wage, infrastructure or skills – that had most likely triggered them. Thus, in the next section we review the evidence. In the first instance this was done according to effects driven/associated with each programme component, and then according to outcome type. To assess effects through the infrastructure component, we focused only on climate-smart infrastructure and roads. This does not mean that other types of infrastructure, such as health facilities, cannot have an impact on climate resilience. However, the causal chain is longer, and the potential effects may materialize only in the long term.

We searched for the relevant literature in major bibliographical databases, including Google Scholar and the International Initiative for Impact Evaluation (3ie). Our primary focus was on the effects of PWPs, and therefore, we included "public works programs", "cash for work", "food for work", and "workfare programs" as key search terms. As we focused on the linkages between PWPs

Table 1. *Summary of the PWPs reviewed for this study*

Country	Programme	Period
Comoros	Social Safety Net Project (SSNP)	2016–2018
Côte d'Ivoire	Emergency Youth Employment and Skills Development Project (PEJEDEC-THIMO)	2013–2014
Djibouti	Urban Workfare Programme	2014–2015
Democratic Republic of Congo	Eastern Recovery project (STEP) programme	2016–2018
Egypt	The Emergency Labor Intensive Investment Project (ELIIP)	2015–2017
Ethiopia	Productive Safety Net Programme (PSNP)	2005–present
India	Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA)	2007–present
Laos	Road Maintenance Groups Program (RMG)	2018–2020
Malawi	Malawi Social Action Fund (MASAF)	1990–present
Mozambique	Productive Social Action Programme (PASP)	2012–present
Nepal	Karnali Employment Programme (KEP)	2006–present
Rwanda	Vision 2020 Umurenge Programme (VUP)	2008–present
Sierra Leone	Youth Employment Social Support Project/Cash for Work (YESP/CfW)	2012–2015
Somalia	Cash for Work (CfW)	2011–ended
Tunisia	Community Works and Local Participation (CWLP) pilot	2015
Uganda	Northern Uganda Social Action Fund (NUSAF-3)	2015–2020
Yemen	Labor Intensive Works Program (LIWP)	2005–present

Source: Authors' elaboration.

and weather shocks, we integrated two types of evidence into our analysis. Wherever possible, we used studies employing experimental and quasi-experimental methods as they allowed us to better estimate the causal effects of PWPs. In a few cases, especially to integrate the rather limited experimental and quasi-experimental evidence of programme effects through the infrastructure and the skills development components, we also considered studies that used more descriptive quantitative methods or even qualitative methods. Finally, we focused only on low-income and lower-middle-income countries, as defined by the World Bank's 2023 income classification.[5]

Table 1 provides a description of the programmes considered. Only a few were long-term, regular programmes (such as the India's MGNREGA and Ethiopia's PSNP), while the majority were ad-hoc or temporary.

Empirical evidence

The wage component of PWPs

Effects on core outcomes (food insecurity, poverty, labour productivity) under shocks. Several studies have investigated the capacity of PWPs to buffer the negative effects of weather shocks on household poverty, food insecurity and other outcomes such as productivity and labour supply. In detail, we started our review using long-term PWPs that provided predictable employment, such as the ones in India and Ethiopia, because we hypothesize that the resilience role of wage support is more prominent in stable, predictable programmes. Both Ethiopia's PSNP and India's MGNREGA provide a substantial number of workdays per year (72 and 100, respectively) and employment opportunity for several years. One important difference between the two programmes is that while MGNREGA guarantees employment to anyone who makes a demand (self-targeting), PSNP reaches only households that are formally targeted, and therefore benefits always the same household until re-targeting takes place.

Knippenberg and Hoddinott (2019), Dasgupta and Robinson (2021), and Scognamillo, Mastrorillo and Ignaciuk (2024) have examined the influence of Ethiopia's PSNP on food security and vulnerability to drought. All three studies found that PSNP participation reduced the adverse impacts of negative weather shocks on food security. Scognamillo, Mastrorillo and Ignaciuk (2024) used multiple waves of a nationally representative household survey and applied an instrumental variable approach to address selection endogeneity. The study showed that PSNP beneficiaries were *less likely* to experience food insecurity and

5. See World Bank data for 2023.

harvest losses following droughts. No significant impacts were identified when households reported stresses unrelated to droughts.

Prior work conducted by Knippenberg and Hoddinott (2019) employing a similar identification as Scognamillo, Mastrorillo and Ignaciuk (2024) found that droughts led to a reduction in the number of months during which a household perceived itself as food secure. Importantly, these impacts lasted for up to four years following the drought. Additionally, PSNP payments mitigated the initial impact of drought shocks by 57 per cent and eliminated their adverse effects on food security within two years. Dasgupta and Robinson (2021) found qualitatively similar results but did not account for endogeneity in programme participation. In contrast, an earlier study by Béné, Devereux and Sabates-Wheeler (2012) that used propensity score matching to account for non-random selection into the programme, found no statistically significant difference in the impact of drought and other weather events on food security between PSNP participants and non-participants.

Moving to MGNREGA, a large-scale PWP that guarantees rural employment for 100 days per year, Ajefu and Abiona (2019) applied a difference-in-differences (DiD) approach to study the effect of positive "wet" shocks and negative "dry" shocks on labour market outcomes. They show that MGNREGA decreased the adverse effects of dry rainfall shocks on labour supply. In villages not exposed to MGNREGA, one-standard deviation negative rainfall shock decreased the village employment rate by an average of 4.2 percentage points (p.p.), while in the villages exposed to MGNREGA, the effect of negative rainfall shock on the employment rate was not statistically significant. This mitigation effect was similar for men and women. These findings underscore the role of MGNREGA in creating additional employment opportunities during weather shocks. However, it also showed that MGNREGA could increase child labour especially during periods of "wet" shocks.

Some studies also examined whether participation in PWPs mitigated the impact of weather shocks through its effects on agricultural productivity (Daidone and Fontes, 2023; Gazeaud and Stephane, 2023; Rosenzweig and Udry, 2014; Taraz, 2023). Taraz (2023) addressed this question in India by showing that MGNREGA *exacerbated* the adverse effects of low rainfall on yields. By increasing labour demand, the programme created higher agricultural wages that were less elastic with respect to weather shocks, which in turn reinforced the negative effect of weather shocks on agricultural production. Similarly, Rosenzweig and Udry (2014) found that the implementation of MGNREGA was associated with increases in harvest-stage wages, particularly in years with bad rainfall shocks. Taraz (2023) showed that the benefits from MGNREGA payments still exceeded the MGNREGA-induced yield losses, especially for households with marginal landholdings. Tiwari (2022) used quasi-exogenous variations in yearly weather

and compared those effects of weather shocks before and after the introduction of the MGNREGA. The results indicated increased crop yield volatility after the implementation of the MGNREGA, coupled with additional yield losses of 8 per cent during a year of insufficient rainfall, attributed to increased labour costs.

In the Ethiopian context, Daidone and Fontes (2023) reported a negative association between the PSNP and agricultural productivity, especially when hit by adverse shocks. In contrast, Gazeaud and Stephane (2023) did not find any discernible differential effect of the PSNP on agricultural productivity during periods of negative rainfall shocks.

Several studies analysed the impact of the PSNP on livestock holdings (Andersson, Mekonnen and Stage, 2011; Devereux and Guenther, 2007). Andersson, Mekonnen and Stage (2011) found that PSNP participation did not seem to assist households in coping with significant weather shocks, as they tended to sell livestock due to a lack of alternative income sources. Similarly, Devereux and Guenther (2007) suggested that, during shocks or the hungry season, the PSNP did not prevent many households from selling productive assets.

Effects on intermediate outcomes. Next, we reviewed the studies that focused on proxy measures of coping capacity, such as savings, selling and ownership of productive assets under non-shock situations.[6] Gehrke and Hartwig (2018) reviewed the evidence of programme effects on savings and productive investments for eight PWPs: THIMO (Cote d'Ivoire), PSNP (Ethiopia), MGNREGA (India), MASAF (Malawi), KEP (Nepal), VUP (Rwanda), YESP (Sierra Leone), and CfW (Somalia). Note that some (PSNP, MGNREGA, MASAF KEP, VUP) had medium-term poverty reduction objectives or were providing employment guarantees, while others had short-term relief objectives.

In various PWPs, participants increased savings, especially when they had long-term access to PWPs. Studies on the YESP in Sierra Leone (Rosas and Sabarwal, 2016) and the KEP in Nepal (Nepal National Planning Commission, 2012) indicated a higher participation in informal saving groups and asset ownership.[7] Importantly, KEP's evaluation shows that household were investing in livestock, household articles and mobile phones, which can have long-run effects and enhance both their coping and adaptive capacities. However, programmes with limited duration, such as the Somali CfW, increased productive investments initially, but the effect faded away in the longer term (FAO, 2013). Similarly, the Rwandan VUP generated positive effects on savings and livestock holdings in the short term, but these effects faded away shortly after participation if households took part only

6. Note that in Figure 1, we also relate some of these outcomes – in particular investment in productive assets – with adaptive capacity.
7. The Rosas and Sabarwal (2016) study is a short-term evaluation.

for one period (Hartwig, 2014). The Ethiopian PSNP showed increased asset accumulation, particularly of livestock, after four years of participation (Andersson, Mekonnen and Stage, 2011; Berhane et al., 2014). Gilligan, Hoddinott and Taffesse (2009) also document the PSNP participants did not experience faster asset growth than the comparison group. Unlike many PWPs with no long-run effects on these outcomes, the ad-hoc PWP THIMO in Cote d'Ivoire increased savings and productive investments within just four months of participation and the effect persisted in the medium term (Bertrand et al., 2017).

Another review of eleven experimental evaluations of PWPs (Comoros, Côte d'Ivoire, Laos, Djibouti, Sierra Leone, Egypt, Tunisia, Democratic Republic of Congo (DRC), urban Ethiopia) by Bagga et al. (2023) found mixed evidence on savings.[8] Specifically, in five out of eleven PWPs (Cote d'Ivoire, Djibouti, Egypt, Tunisia, rural DRC), programme effects on savings were positive, while in another six programmes they were not statistically different from zero. They also distinguished between short-run and medium-run effects and in four out of eight medium-run effect studies, the effect was positive, while in the remaining four studies, it was not statistically significant. The effects on households' assets were analysed for only seven programmes: three of which showed an increase in household assets index (two in Tunisia and one in rural DRC).

To summarize, most of the empirical studies indicated that participation in PWPs increased households' coping capacity through higher savings in the short run and the holding of productive assets. However, the evidence of the long-term and medium-term effects on savings is less clear, which may suggest that PWPs have limited ability to affect the adaptive capacity by influencing saving habits.

As pointed out previously, PWPs are likely to increase the adaptive capacity of households through the adoption of modern technologies, knowledge and practices related to climate-smart agriculture, diversification of income-generating activities, and diversification of livelihoods in general. Therefore, we next review PWPs' effects on these outcomes.

Gehrke (2013) showed that participation in MGNREGA increased the use of riskier but more profitable crops, fertilizer and irrigation levels. Zimmermann (2020) employed a regression-discontinuity design to examine the effects of MGNREGA on livelihood diversification and found that participation in MGNREGA increased the opening of small enterprises. Similarly, the evidence from ad-hoc PWPs in Sierra Leone, rural DRC, and Côte d'Ivoire indicated that participants were significantly more likely to set up new enterprises after the programme than non-participants (Rosas and Sabarwal, 2016; Bagga et al. 2023).

In contrast, Weldegebriel and Prowse (2013) did not find a beneficial effect of the Ethiopian PSNP on livelihood diversification and risk management. Specifically,

8. For both Egypt and DRC, the authors considered two different experimental evaluations.

they looked at farm versus non-farm income increase, as a measure of households' diversification of activities and applied a propensity score matching methodology. They showed that there was no significant effect of the PSNP on livelihood diversification (neither for farm nor non-farm income), while it notably increased natural-resource extraction, suggesting that the PSNP encouraged a negative adaptation strategy. Additionally, Kozicka et al. (2024) showed that PSNP had a negative effect on crop diversity, which may decrease farmers' resilience to climate shocks. For their analysis, they applied the DiD approach combined with propensity score matching. Hoddinott et al. (2012) studied the effects of the PSNP on the use of fertilizer and investment in water retention, using matching techniques. Participation in the PSNP alone did not increase the use of fertilizer or agricultural investment. However, when combined with other food-security programmes designed to increase agricultural productivity the effect of the PSNP turned positive, hinting at the potential role of complementary investments. Using propensity score matching, Gilligan, Hoddinott and Taffesse (2009) found a significant increase in fertilizer use among PSNP beneficiaries, along with a higher share of own enterprises compared to the control group.

Beegle, Galasso and Goldberg (2017) evaluated the effect of Malawi's MASAF on various outcomes including the use of fertilizer, relying on across- and within-village randomization. Overall, the PWP did not increase fertilizer use, maybe due to limited employment duration in the MASAF in comparison to, for example, the Indian MGNREGA. In contrast, a non-experimental study by Scognamillo and Sitko (2021) based on multivariate regressions, showed that Malawi's MASAF was associated with the adoption of CSA practices, such as building soil water conservation structures and applying the use of fertilizer.[9]

In summary, PWPs have great potential to enhance households' adaptive capacity by promoting livelihood diversification through business activities, as indicated in most studies. However, the evidence regarding the impact of PWP wages on the adoption of CSA practices and agricultural technology is mixed. Some studies even report negative effects, suggesting that the wage component of PWPs may not be sufficient to induce farmers' adaptation to climate shocks. Table 2 provides a synthesis of the main results of the empirical studies examined.

The infrastructure component of PWPs

Tiwari et al. (2011) and Esteves et al. (2013) showed that the activities undertaken under MGNREGA were linked to decreased variability in crop yields, enhanced soil fertility, improved crop productivity, reduced soil erosion and, consequently, an overall increase in crop yields along with a decline in the agricultural

9. Please note the dashed line linking the wage component to technology in Figure 1.

Table 2. *Summary of the results*

Proxy outcome	Number of studies	Adverse effect	No effect	Beneficial effect
Food security and vulnerability to climate shocks	4	0	1	3
Employment vulnerability to climate shocks	1	0	0	1
Productivity vulnerability to climate shocks	4	3	1	0
Selling livestock during shocks	2	0	2	0
Savings	14	0	6	8
Ownership of productive assets	15	0	5	10
Savings (long or medium-run)	9	0	5	4
Livelihood diversification (includes self-employment)	7	1	1	6
Use of technology/CSA practices (e.g. fertilizer)	6	1	2	3
Flood control infrastructure, water infrastructure, soil quality, cultivated land, transportation costs.	6	0	1	5
Effect on non/participants	3	0	1	2
Business training (transition to self-employment)	1	0	0	1
CSA training (usage of CSA practices)	2	0	0	2
Forestry skills	1	0	0	1

Source: Authors' elaboration.

vulnerability index. Similarly, Fisher (2020) analysed 798 MGNREGA projects and concluded that these projects helped vulnerable households to confront climate shocks. This evidence directly indicates that the infrastructure component of the MGNREGA positively affects capacities to cope and to adapt to climate shocks; however, this evidence is rather descriptive.

A quasi-experimental study of Gehrke (2015) applied the DiD approach to study the effects of India's MGNREGA infrastructure on agricultural productivity and the employment of non-participants. Specifically, the study compared farmers who had had any form of MGNREGA activity undertaken close to their lands with farmers who had not. The results indicated that there was a positive effect of MGNREGA activity on agricultural production but no effect on the demand for labour. The study also indicated significant heterogeneity, with different types of infrastructure favouring specific groups. Landowners, for instance, benefited from land development-related infrastructure, while flood control infrastructure benefited the rural landless population, increasing their employment opportunities. This indicated that the infrastructural component of the MGNREGA may help households to adopt to future shocks.

Christian et al. (2015) analysed the effect of infrastructure created by Yemen's Labor Intensive Work Program (LIWP), a PWP that provides short-term employment to poor rural households in the construction of local infrastructure within a conflict setting. The LIWP construction projects included reclamation of agricultural lands from harmful plants, protection of irrigation canals and water sources, improvement of rural roads, paving of rural markets, rainwater harvesting, construction of shallow wells, and terrace repair. The evaluation was based on the random assignment of 60 of 120 communities into participation in the LIWP in the first year (2010), while the remaining 60 control communities entered the programme in the second year (2011). Thus, the evaluation highlighted the short-term effects of LIWP infrastructure on water accessibility and transportation costs. The results suggested that the LIWP-created infrastructure reduced the average length of water-fetching trips during the rainy season, leading to an increase in water availability. Moreover, increased access to water resulted in one to two fewer months of water shortage per year. Furthermore, most households (about 80 per cent) reported that they benefited directly from the projects. This again indicates that PWP infrastructure is climate-smart and increases the capacity to cope and adapt to climate shocks.

Levine et al. (2024) investigated the long-term (3–5 years) impacts of PWP assets on livelihoods and resilience in North Wollo, Ethiopia and in Makueni County, Kenya. In the first case assets such as check-dams, tree planting and infiltration trenches were meant to ensure soil and water conservation, while in the second earth dams were created to improve water access. To assess programme impacts they employed a mixed-method approach and relied on retrospective information. For neither of the two programmes were positive benefits of the assets found, despite previous claims which led these programmes to be considered successful. In Wollo, the assets were generally still of good quality and functioning; the main problems lied in the wrong planning of activities (e.g. planting at the wrong time of the year; too many assets on a piece of land). In contrast, in Kenya, a technical appraisal detected major problems in the construction or maintenance of several dams, which precluded its functionality.

Finally, some studies did not disentangle the effect of the wage component of PWPs from that of the infrastructure component but focused on the effects of PWPs on non-participants, arguing that they were probably driven by the public infrastructure. Within the Ethiopian PSNP framework, the quasi-experimental study by Scognamillo, Mastrorillo and Ignaciuk (2024) found that the positive impacts of the programme on food security during weather shocks extended partially to the broader community beyond direct participants. This was likely attributed to the nature of the public works executed through the programme, particularly the integrated community-based watershed development initiatives. The World Bank (2018) conducted a randomized control trial (RCT) within

Egypt's PWP – The Emergency Labor Intensive Investment Project (ELIIP) – which aims to build and protect community assets in poor communities. ELIIP's infrastructure component includes several sectors including some climate-smart activities, such as protection of the Nile riverbanks, the cleaning and upgrading of canals, and roads upgrading. The village-based randomization allowed to study effects on both participants and non-participants in treated villages. The study found no statistically significant infrastructure effects for the likelihood of being affected by shocks, such as loss of harvest and loss of property.

Overall, there is some initial evidence that the infrastructure created by PWPs – when adequately designed and realized – contributes to climate resilience, but the empirical literature is still limited, especially that which relies on sound quantitative methods to derive firm conclusions. Moreover, most evidence is based on India's MGNREGA and therefore might not be generalizable to short duration or ad-hoc emergency programmes.

The skill development component of PWPs

The third component of PWPs is skill development. If PWPs include training on CSA practices or other forms of on-the-job training, they may enhance adaptation to climate-related shocks via the acquired skills.

Gehrke and Hartwig (2018) summarized the results from several PWP programmes that contain a skill development component, such as THIMO (Cote d'Ivoire), PSNP (Ethiopia), CfWTEP/YEP (Liberia), and LIWP (Yemen). Specifically, the THIMO incorporated compulsory courses on entrepreneurship; the YEP included technical skills training, internships, and employment search support; and the PSNP and the LIWP included on-the-job training. Kenya's Kazi KwaVijana Programme (KKV) also incorporated training and labour market activation, since its main goal was to improve youth employment outcomes. Another example of a programme which may affect climate resilience through skill development is the MASAF (Malawi), since it increases the use of CSA practices promoted in the country. However, the evidence concerning the skill component of PWPs is scarce and mainly draws on non-experimental studies and observational data, with few exceptions. Below we detail the results of these studies.

In general, the evidence indicates that participation in on-the-job training combined with wage and infrastructure can enhance participants' knowledge levels in CSA practices and increase income and employment. One example is the Ethiopian PSNP where participants received training in soil and water conservation and afforestation. Andersson, Mekonnen and Stage (2011) suggested that participants acquiring forestry skills through the PSNP could explain its positive impact on tree holdings. However, the study did not

disentangle this skill component from the rest of the programme components. More qualitatively, one survey suggested that almost half of those involved in the PSNP gained soil and water conservation skills that they subsequently applied on their personal land (Lieuw-Kie-Song, 2011).

Bertrand et al. (2017) evaluated the effect of the training component of the THIMO in Cote d'Ivoire, exploiting the fact that a random subset of beneficiaries was offered basic business training to facilitate transition into self-employment or training in job-search skills to facilitate access to the job market. While the study found no impacts on employment, it found a positive effect on earnings, driven by non-agricultural and self-employment activities in the group assigned to complementary business training.

Beierl (2021) applied a DiD approach to study the skill and other components of Malawi's MASAF, using the number of CSA practices (soil and water conservation) and days worked on these CSA practices as indicators of a skills vector. The study showed an increase in CSA practices in MASAF catchments compared to the control catchments, with the effect being driven by non-participants. Scognamillo and Sitko (2021) demonstrated that involvement in the MASAF was correlated with an increased adoption of CSA methods, fostering sustained utilization over multiple agricultural seasons. Further, it showed that the combined impact of participating in the MASAF and maintaining the use of soil and water conservation structures significantly enhanced households' productivity and welfare. According to Scognamillo and Sitko (2021), this effect is probably due to the application of skills acquired during MASAF public works to the farmers' own fields.

In summary, although patchy, the limited evidence available suggests that the skills development component of PWPs in combination with the infrastructure component can improve climate resilience.

Discussion and conclusions

With the ongoing pace of climate change, it is necessary to identify policies that support households' resilience to climate-related shocks. This article has focused on the role of PWPs from both a theoretical and an empirical perspective. We developed a diagrammatic conceptual framework to understand how, and to what extent, PWPs foster climate resilience, and conducted a comprehensive review of the empirical evidence on the effects of PWPs on climate resilience, linking it to our conceptual framework. While a number of previous studies have reviewed the evidence of the effects of PWPs (Gehrke and Hartwig, 2018; Beierl, 2021; Bagga et al., 2023), these studies do not focus directly on climate resilience. Similarly, previous studies have created conceptual frameworks that explain the link between social protection programmes and climate resilience,

but this literature either had a more general focus on all social protection programmes (Costella et al., 2023) or was not directly connected with the recent empirical literature (Beazley et al., 2016). Hence, we attempt to fill this gap.

We suggest that PWPs may affect households' capacity to cope with weather shocks through the wage component by creating additional economic resources during the period of negative shocks; and by promoting savings and investments in productive assets to bolster future adaptive resilience. Additionally, the wage component of PWPs may affect the capacity to adapt to climate change by inducing households to use different technology (especially, climate-smart technology) and, in general, to diversify livelihoods. Second, the infrastructure component of PWPs has the potential to promote climate resilience by enhancing households' long-term adaptive capacity. This is especially the case when PWPs are used to create "climate-smart" assets, such as water conservation or swales, or provide services such as afforestation, which may benefit the entire community. Third, as PWPs are often combined with training, households' capacity to adapt to weather shocks can increase, for example, by inducing them to use CSA practices and to diversify livelihoods.

Our review of the evidence suggests that the wage component of PWPs interacts significantly with weather shocks. Participants in PWPs are less likely to reduce their labour supply or experience food insecurity during negative weather events than non-participants. However, PWPs may also exacerbate the adverse effects of climate-related shocks on agricultural productivity. This could be due to spillover effects, where PWPs decrease labour supply in agriculture and agricultural wages become less responsive to negative weather shocks. Moreover, most empirical studies from different countries indicate that participation in PWPs enhances households' coping capacity through the accumulation of productive assets, with evidence on the effect on savings being mixed. However, these benefits typically materialize when people participate in the programme for several years and are thus predominantly observed in long-term PWPs, such as the Indian MGNREGA. Furthermore, the results of the review indicate that long-term employment guarantee programmes such as the MGNREGA have the potential to enhance households' adaptive capacity by encouraging higher-risk investments and the adoption of CSA practices. In contrast, less generous or short-term emergency programmes appear to have limited bearing on the adaptive capacity.

We noticed very few quasi-experimental studies focusing on the infrastructure component: these suggest better protection from weather shocks for the whole community where the PWP was implemented, which is likely driven by community assets created through the programme. There are, instead, numerous descriptive studies indicating that community assets – such as rural roads, water management and watershed development initiatives – of PWPs positively affect climate resilience. Projects focusing on rural connectivity, water management

and watershed development initiatives help households to deal with climate-related hazards. A few quasi-experimental studies suggest positive effects for the whole community in treatment villages, such as a reduction in the negative effects of weather shocks on food security, which is likely driven by community assets created by the PWPs.

Finally, the overall evidence on the skill-development component of PWPs suggests that combining on-the-job training with wage support and infrastructure development can enhance participants' knowledge of CSA practices, while also increasing their income and employment opportunities, potentially promoting livelihood diversification. However, evidence on the skill component of PWPs is very limited and primarily based on non-experimental studies.

In general, the effects of the different components of PWPs on climate resilience may largely depend on how the programme is designed and implemented, as well as on the objectives (e.g. long-term development versus ad-hoc measures). Some studies highlight the relevance of factors such as regularity in payment, adequate management of funds, and quality of assets created through the PWPs in explaining their effectiveness. While it is key that transfers are delivered on time to support households coping with shocks, several sources have documented delays in the disbursement of wages (Mugabo, 2018 in Rwanda; Steinbach et al., 2020 in India; and Hoddinott et al., 2011 in Ethiopia). Furthermore, without quality and well-maintained infrastructure, PWPs are unlikely to increase resilience: some studies provide evidence of the positive effects of active community participation in the different phases of the project cycle in achieving this objective (Shigute, 2022; Burchi and Sakketa, 2025). The International Labour Organization (ILO) through its employment-intensive investment programmes (EIIP) has provided extensive guidance on how to optimize labour inputs in PWPs to highlight the fundamental function of PWP assets and to promote an efficient production of quality and durable assets (McCord et al., 2024). Yet, most of these design features are quite underexplored in the literature, highlighting a key evidence gap for policy makers aiming to use PWPs to enhance climate resilience.

Another major gap relates to the contexts from which our studies were drawn. We mostly drew upon evaluations conducted in Ethiopia and India, and to some extent Malawi. Further, existing studies focus on rural areas, while PWPs are also used in urban and peri-urban settings and in humanitarian contexts. Variation in employment opportunities between urban and rural areas or across humanitarian settings may influence the degree to which on-the-job training can lead to long-term employability and, subsequently, resilience to future shocks.

In brief, our review highlights that PWPs can be used as an important policy tool to strengthen the resilience of beneficiaries and reduce poverty in the face of climate shocks, particularly if investments in high-quality and relevant infrastructures are made. However, more research is needed to provide evidence on which

intervention components of PWPs and which design features matter the most for effective resilience building. In particular, there is a lack of scientifically sound evidence on the impact of PWPs through their infrastructure/service component. In addition, future studies should explore the effectiveness of combining infrastructure projects with skills development and on-the-job training to enhance the resilience capacity of beneficiaries, and beyond. Finally, PWPs – more than other social protection schemes – can have relevant (positive) effects on the entire communities in which they are implemented, especially through the infrastructure component. This is especially the case given the increasing emphasis on climate-smart infrastructures, which specifically have the objective of fostering resilience. Since there are only very few rigorous studies that investigate PWPs' impacts beyond those on their immediate beneficiaries, more research should be oriented towards a more comprehensive documentation of these spillover effects. Only with adequate information on the overall effects on different members of society, and on the channels through which these effects materialize, can policy makers take decisions about when to implement PWPs (especially in comparison with other social protection interventions), and how to design them.

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