Development Progress

Case Study Summary

Environment

GROWING MORE WITH LESS
China's progress in agricultural water management and reallocation

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Farmer in Gansu province, China. Photo: © Liang Qiang for the World Bank

- With just 10% of the world's farmland and 6% of the world's freshwater resources, China's agriculture is able to feed over 20% of the world's population – with crops mostly grown in the water-scarce north.
- Since the early 1990s, China has lifted nearly 600 million people out of poverty and increased agricultural productivity by over 130%. Levels of malnourishment have halved. However, progress has come at a high environmental cost.
- Institutional and investment reforms have helped to produce 'more crop per drop'. From 2004 to 2012, the Government increased its agricultural investment more than eightfold, from $15 billion to $124 billion.
- Since 1990, withdrawals of agricultural water per hectare of irrigated land have declined by over 20% – even in northern China, a region that has increased its total irrigated area by 35% and per capita grain yields by 30% since 1995 – freeing up water for industrial and urban users.

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Why focus on agricultural water management in China?

China is at the heart of debates around the perceived trade-off between economic growth and environmental protection. Since the early 1990s, the country has experienced remarkable economic growth, lifting nearly 600 million people out of poverty and averaging a per capita GDP growth rate of 8.9% (World Bank, 2014), as shown in Figure 1. Growth has been driven, in large part, by China's investments in agricultural production since 1978, but growth has also put a huge strain on the country's water resources through pollution and overuse.

Nonetheless, China has been able to get 'more crop per drop' by improving the efficiency of water use in agriculture, a sector that still accounts for 65% of total water withdrawals. This case study examines this progress, particularly in the water-scarce region of northern China, where agricultural water withdrawals per hectare of irrigated land have been reduced by around 20% since 1990. We also examine the synergies and trade-offs between agricultural output, poverty reduction and agricultural water management.

Despite the significant challenges that remain, China's story provides important lessons for other countries facing similar tensions when allocating water for food and water for growth.

What progress has been achieved?

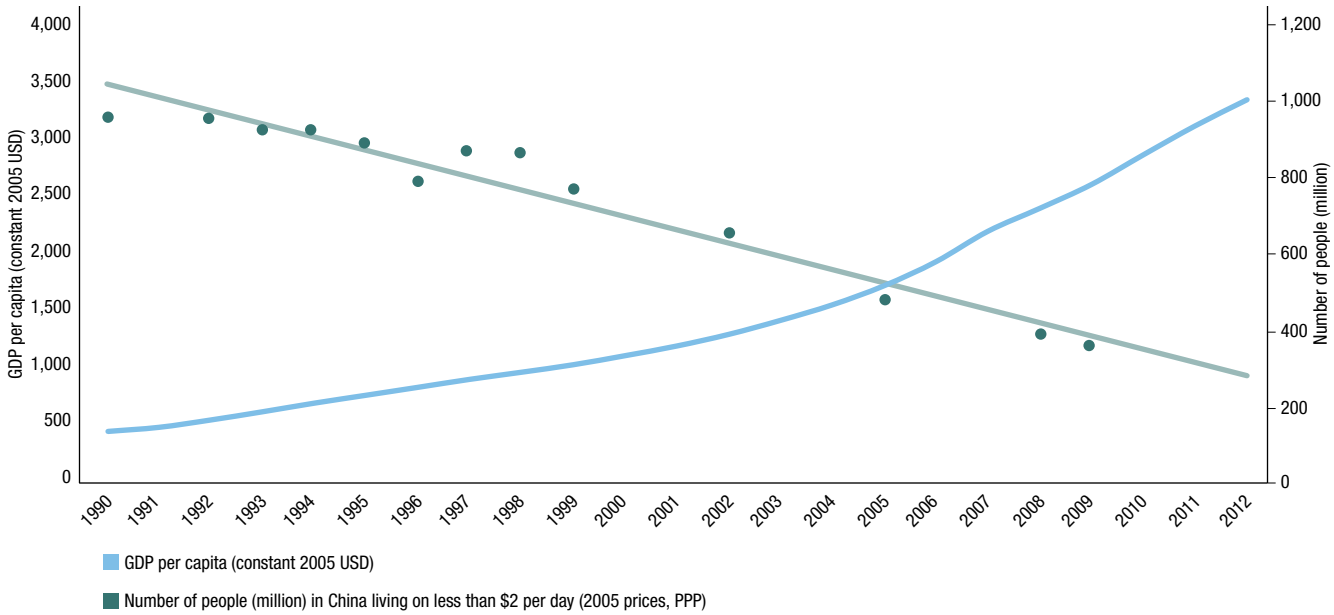
1. China's enabling policy environment

China's industrialised economic development began to accelerate in the 1990s, but so too did environmental degradation, including water pollution and overuse. By the middle of the decade, policy-makers started to take action with the beginnings of an environmental agenda. Strategies for sustainable development were included in official documents, along with rules for their implementation.

Since 2000, the Government's desire to build an 'ecological civilisation' has meant greater integration of economic development, environmental protection and poverty reduction in the country's most important national planning documents and policy agendas. This represents a new development ethos and an ideological framework for sustainable development and green growth. The current 12th Five-Year Plan (2011-2015) is by far the 'greenest' development plan to date, with nine environmental targets, including one to decrease water consumption per unit of industrial value added by 30%.

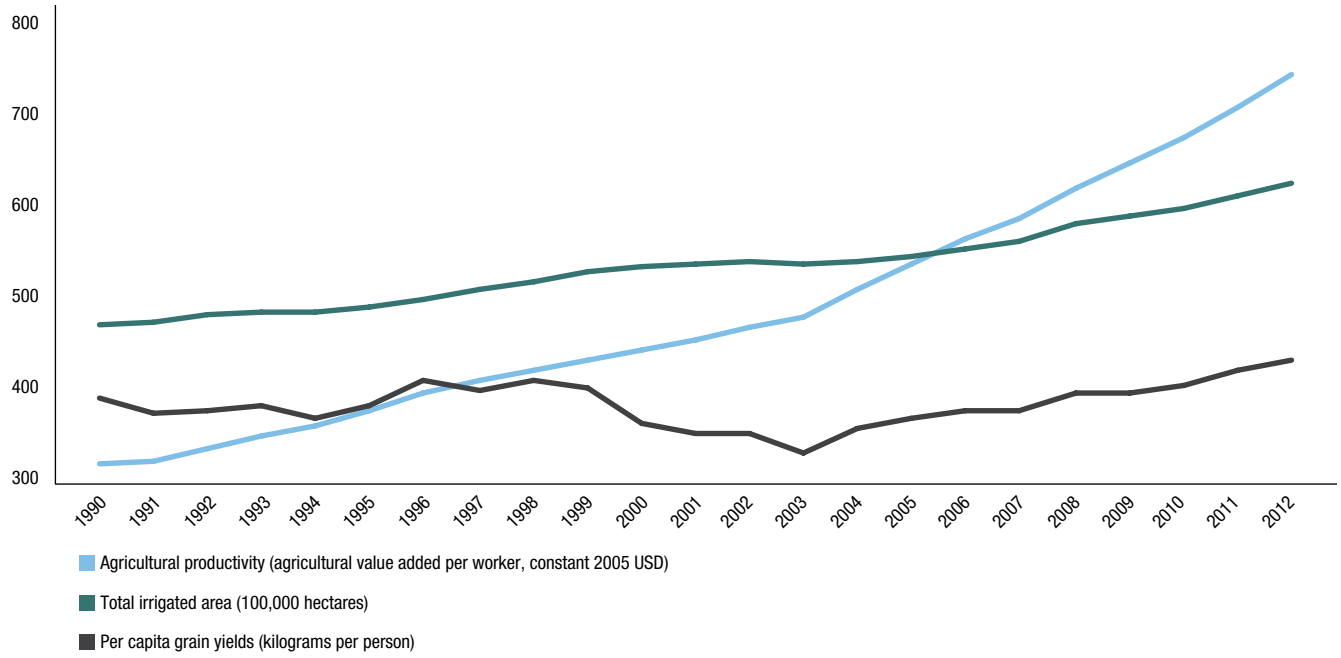
Increasingly ambitious laws and regulations have followed at national and local levels. A key moment for China's water policy was the revision of its Water Law in 2002 when, for the first time, the need to address inefficient water use and poor water management was prioritised. Further, the 'three red lines' policy developed by the State Council in 2010 established clear and binding limits ('red lines') on total water use, water use efficiency and ambient water quality for a number of benchmark years to 2030.

Figure 1: China's rising GDP per capita and falling levels of poverty



Source: World Bank, 2014

Figure 2: China's growth in agricultural production, 1990-2012



Source: World Bank, 2014; NBS, 2014

2. Achieving 'more crop per drop'

Agricultural production

China's expansion of agricultural production in the 1990s drove much of its economic growth and poverty reduction. Between 1990 and 2012, China's agricultural productivity (measured as its value added per worker) more than doubled, increasing by over 130%. Its total irrigated area increased by over 30% and its per capita grain yield increased by over 10% (World Bank, 2014; NBS, 2014), as shown in Figure 2. The 17 provinces and regions of water-scarce northern China yield similar results, expanding their total irrigated area by 35% and their per capita grain yields by 30% since 1995.

As a result, China's prevalence of undernourishment has halved and its food supply has increased by 22% since 1990 – the result of the intensification of crop production within existing production areas, rather than turning more land over to agriculture. The land area devoted to agriculture has remained fairly stable at around 55%, increasing by less than 3% since 1990.

Agricultural water withdrawals

China's agricultural water-use data confirm this success story. Even with far greater agricultural production since 1990, agricultural water-use intensity has declined significantly, with water use per hectare of irrigated land declining by 22% nationally, as shown in Figure 3 overleaf, and by 19% in northern China since 1995. Total agricultural water use has changed little, increasing by only 4% between 1990 and 2012, though increasing by 9% in northern China since 1995 (NBS, 2014).

Savings in agriculture have not been matched in other sectors, however. The country's total water withdrawals across all sectors of the economy increased by about 27% from 1990 to 2012 (NBS, 2014), driven mostly by China's urbanisation and growing industrial and service sectors.

What are the factors driving change?

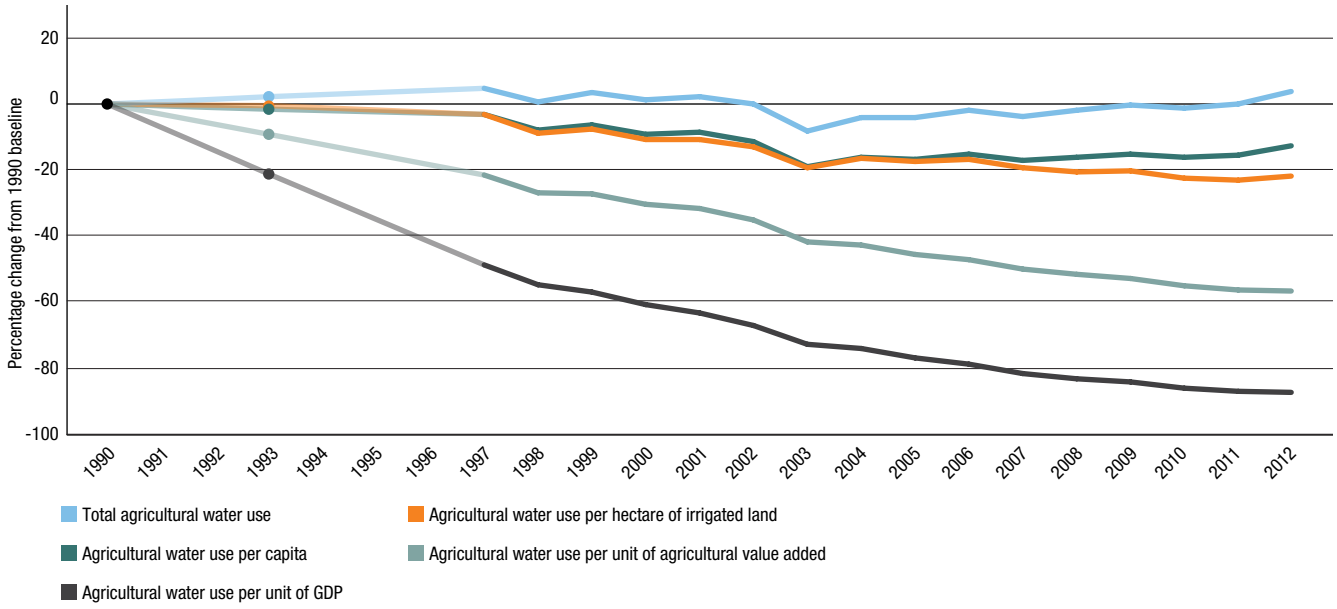
1. Balancing water for food versus water for growth

In a growing economy, it is normal for agriculture's share of output and employment to decline. China is no exception. For poverty reduction and food production, however, a healthy rural economy remains vital. The question of how to release water to growing urban areas and industries while continuing to increase farm production and rural incomes is therefore something of a political headache. The well-being of rural farmers is a sensitive political issue, and reallocating water from agriculture is no easy task. Faced with this challenge, the Government has adopted an incremental, 'learning by doing' approach to reform. This is reflected in the other three drivers of change discussed below, which have encouraged innovative solutions and attempted to reconcile competing objectives.

2. Institutional and policy reforms

The Government's institutional and policy reforms have incentivised local efforts to grow 'more crop per drop'. The reforms began with ambitious revisions to the Water Law in 2002 to shift the country towards more sustainable water resources management, supporting a variety of institutional reforms at both national and sub-national scales.

Figure 3: Agricultural water withdrawals in China, 1990-2012



Source: World Bank, 2014; NBS, 2014; Cheng and Hu, 2011

Notably, the law reformed the Ministry of Water Resources. This paved the way for three relatively independent institutional reforms: the strengthening of river basin commissions, the consolidation of some local water-related bureaus into water affairs bureaus, and the rapid growth of water user associations (WUAs) for agricultural water management. These three sets of reforms have helped to drive progress toward more sustainable agricultural water management at different levels. They did so by reducing water-use conflicts between regions and users and by promoting irrigation system improvements at the village level. For example, farmers have been given more say in how to manage water at a local level, with WUAs growing in number from around 2000 in 2002 to over 78,000 in 2012 (Chen, 2012). China's more recent 'three red lines' policy is a further indication of the priority now given to water resources management at the highest political level.

3. Sustained financial investment

High levels of investment in China's agriculture and water sectors have also driven progress. One statistical analysis by Fan et al. (2004) found that public investment spending drove the majority of China's agricultural growth in the 1990s, rather than institutional reform. The relative level of investment by the Government in agricultural water management has increased in the past two decades, compared with investment from farmers (Shen, 2014). In the 1990s, government funds were earmarked mainly for large-scale water infrastructure, leaving the responsibility for field-level irrigation spending to villages and individual farmers. However, after a dip in investment in the early 2000s, the Government increased its spending on farming and water conservation infrastructure (including field-level irrigation infrastructure) by over eight times, from 92 billion yuan (around $15 billion) to 759 billion ($124 billion), as shown in Figure 4.

4. Technical, economic and regulatory incentives

Technical incentives

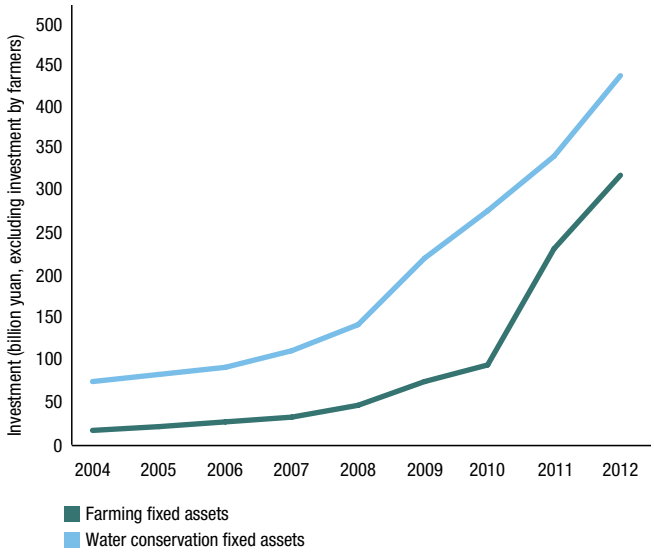
The development of new agricultural water management technologies and practices, and their widespread dissemination, has also helped drive progress. For instance, China spent about 12.3 billion yuan (around $2 billion) on agricultural research and development in 2007 – about 9% of which focused on water conservation technology (Chen and Zhang, 2011) – encouraging the development of new crop varieties and the improvement of field-level water management. The Government then disseminates these innovations through local agricultural technology extension centres.

These centres also promote the more efficient use of chemical fertilisers and pesticides. Their use has allowed the country to intensify its agricultural production with less labour and land, but have also contributed to the widespread pollution of rivers, lakes and groundwater. Farmers are now being encouraged to make better use of existing technology and new techniques are being developed for the more efficient use of fertiliser.

Economic incentives

Economic incentives also influence water management, either directly (e.g. through water pricing) or indirectly (e.g. with energy pricing). Currently, China's fee system requires payment for all surface and groundwater withdrawals, except those for rural domestic use and for emergency purposes (Shen, 2014). In practice, agricultural

Figure 4: China's growing agricultural investment since 2004



Source: NBS, 2014

water resource fees are rarely charged to farmers and the direct pricing of water by volume to individual users/entities is restricted to urban areas, where household and industrial use is metered.

In rural areas, area-based charging provides some degree of payment linked to volume. In practice, however, water charges are not set high enough to affect cropping decisions and water use, and farmers typically pay for water before irrigation, leaving little incentive to conserve water once irrigation begins. As one farmer put it in an irrigation district on the Yellow River, '*Water is not a big cost. The main thing we worry about is the price we get for our crops, and the cost of seeds and fertiliser*' (field visit to Hangjin Irrigation District, Inner Mongolia, July 2014).

Monitoring and charging for groundwater remains difficult given the large numbers of users involved. The Government is experimenting with indirect energy-based charging schemes on collectively owned village wells in some water-stressed northern provinces in an effort to encourage farmers to save water. Politically, any charging scheme – direct or indirect – that affects farm incomes remains contentious. Nonetheless, charging matters and a 'learning by doing' approach is being used to test different reforms. The difficulties associated with charging are also driving innovation elsewhere, particularly in regulatory reform.

Chinese farmer. Photo: © Nico Heerink for IFPRI

Regulatory incentives

In China, government agencies increasingly use regulations that define and allocate quotas or permits linked to water volume to mediate between agricultural, industrial and domestic users at the regional level, and between groups of farmers at the local level. The 2002 Water Law sanctioned a formalised system of water rights that has since been adopted at regional and local levels. In practice, domestic use usually gets first priority in these rights systems, followed by industry and then agriculture. To avoid negative impacts on farmers' livelihoods, some of these systems promote water efficiency investments and transfers between users. For example, China's autonomous region of Inner Mongolia has piloted a scheme in which downstream industries on the Yellow River are encouraged to invest in upstream agricultural water efficiency technologies, in exchange for the rights to the water saved.

China has also improved its use of a target-based reporting system to align its national and local interests. The system is pragmatic, performance-based and provides a high degree of flexibility on how targets are met: each level of government determines how and to whom to allocate responsibilities for meeting their assigned target(s) (Kostka, 2013). Good performance provides lower-level officials with bonuses and promotions, while poor performance brings the threat of punishment (Naughton, 2010). It's a sound concept, but the Government has struggled to make it work in reality for the achievement of environmental targets.

What are the challenges?

1. Economic targets taking priority

China's policy and institutional reforms are progressive in theory but, in practice, they continue to suffer from perverse incentives, unclear responsibilities, weak enforcement and a lack of transparency. This is the result, in part, of inconsistencies and differing levels of priority between environmental targets and economic targets for government officials. In practice, if an attempt to meet both sets of targets results in a clash, local officials will still prioritise economic targets at the expense of environmental ones. An official from China's Environmental Protection Bureau explains: '*Environmental and energy targets are binding targets but they are not our ultimate targets. No leader will be promoted because of their better achievements in environmental protection and energy savings. GDP growth is still the target we work hardest to achieve.*' (Kostka, 2013).

2. Regulating groundwater withdrawals

National policies and quotas on agricultural groundwater withdrawals have not been implemented effectively, nor have they provided appropriate local incentives to conserve

water (Wang et al., 2009). In most villages, farmers can drill new wells whenever and wherever they want without seeking approval. Some estimates suggest that the proportion of privately owned wells in the country increased from 42% to 70% between 1995 and 2004 (Shen, 2014). While groundwater typically provides a more reliable water supply, allowing farmers to shift production toward more water-sensitive and high-value crops, the rapid development of groundwater by millions of farmers has also increased water scarcity. In the absence of effective regulation, groundwater levels in some northern Chinese communities are falling by 1-2 metres per year or more (Wang et al., 2009). Policy-makers are now responding by piloting a number of different innovations. These include the manipulation of energy prices for irrigators in ways that encourage conservation and the introduction of water rights based on consumptive water use rather than simple water withdrawals in some water-stressed areas.

Water melon farmers in Ningxia. Photo: © Bert van Dijk

3. Social equity and labour availability

China has growing problems of social inequality. Income gaps between rural and urban dwellers, and among farmers themselves, are increasing. Water pricing and rights schemes can hit the poorest farmers hardest if not thought through properly, or unless the Government implements appropriate social protection and compensation schemes. The balancing of water efficiency and equity objectives is a tough political challenge, especially where the poorest people are those most dependent on the scarce water that others increasingly need.

Indeed, the incomes of many smallholder farmers are still insufficient for them to rely on farming alone. Many migrate to urban areas to make more money, often leaving women behind to carry a double burden of managing both farm and household. Yet Chinese water policies have largely overlooked gender issues. These changing labour dynamics have major implications for the 'who' and 'how' of agricultural water conservation in the country and trends toward land consolidation and increasing commercialisation could exacerbate social inequalities.

4. Water pollution

China's problems with water pollution are well known and represent a major challenge. Much of this pollution has been driven by the country's rapid industrialisation and urbanisation, although agriculture has also contributed, particularly from livestock and poultry rearing. Combined, these sources of pollution affect both surface water and groundwater. While surface water quality has improved a little in the past decade, groundwater quality is getting worse. A recent government report found that nearly 60% of the urban groundwater wells tested were polluted (Kaiman, 2014).

5. Future threats

A variety of threats may affect China's progress. Risky development policies in other sectors of China's economy will contribute increasingly to the pressures on the country's water. For example, more than half of the country's proposed coal-fired power stations may be built in areas with high water stress (Luo et al., 2013). As agriculture's share of GDP declines, the high levels of government investment it receives may be diverted to other uses, which could stall progress in agricultural water management, much as it did in the 1980s. China's growing demand for meat will also pose additional risks to water resources. The country already uses 70% of its water-intensive maize crops for animal feed and growing demand may create an additional maize deficit of 19-32 million tonnes by 2022 (Sharma, 2014). Measures to address these and other risks – particularly climate change – will require continued ambition and effort on the part of the Government to ensure that hard-won progress is not halted or reversed.

'Environmental and energy targets are binding targets but they are not our ultimate targets. No leader will be promoted because of their better achievements in environmental protection and energy savings. GDP growth is still the target we work hardest to achieve' - Official in China's Environmental Protection Bureau (Kostka, 2013)

Lessons learned

- **Promoting more efficient agricultural water use can encourage economic growth and is a good investment.** China's success in releasing water from its agricultural sector has allowed its industry and services to use the water saved to grow. This economic transition has helped lift millions of its citizens out of poverty. However, this progress can only be called 'sustainable' if it ensures that farmers and ecosystem services also benefit. Balancing the needs of multiple users is possible, and China's pragmatic and incremental approach to reform demonstrates how this can be done.
- **Strong national leadership can adopt ambitious policies at speed, but implementation is strengthened by engaging with citizens and local officials.** China's Government and its motivated leaders have driven the rapid adoption of new policies, technologies and practices related to agricultural water management, influenced in part by the country's growing environmental consciousness. Its single-party political system allows China to avoid many of the messy debates that accompany sustainable development policies in a democracy. However, top-down environmental targets and policy reforms have not always delivered intended outcomes, given their inability to account for complex local contexts and power dynamics. The Government has had more success when it has engaged citizens and local officials to gain a better understanding of who and what it is trying to incentivise and to adapt policies accordingly.
- **Reforms can be more effective when they focus on the problems and experiment with a variety of models for different contexts.** One reform path does not fit all. Rather than promote fixed blueprints, a 'learning by doing' approach to reform has created space for local innovation and piloting to see what works best in different contexts. China's environmental target system also provides significant flexibility for lower levels of government to define their own path to success. In sum, China has worried less about how something is achieved and instead focused on the end goal. Rather than enforce idealised procedures, the emphasis has been on the 'nuts and bolts' issues of rewards and incentives, and the clarification of roles, responsibilities and accountabilities among different users.
- **Engaging with power and politics is messy and difficult, but ultimately cheaper and more efficient than technocratic fixes.** As much as China illustrates the benefits of a problem-focused approach, it also illustrates the drawbacks of a technocratic one. China's historical focus on big infrastructure for agricultural water management has not returned equitable and sustainable results. The country is realising that its attempts to engineer itself out of its growing environmental problems are more expensive and less sustainable than a 'softer' and more comprehensive approach. The latter can ensure that technical solutions are appropriate, sustainable and well governed. Without tackling the behaviour and incentives that drive scarcity, technocratic fixes in isolation will only ever offer temporary relief.
- **Transformative change at scale requires sustained ambition and investment across all levels of society.** Since Deng Xiaoping's era, China's sustained and countrywide commitment to economic growth has had truly transformative effects – with few parallels in modern history other than the Marshall Plan. In the past decade, China has begun to apply this same cohesive energy and high-level political commitment to the principles of sustainable development and green growth and is beginning to see the positive effects. As a result, China has achieved huge scale-up on a variety of more sustainable agricultural water management interventions, often from a near-zero baseline. Its citizens and leaders increasingly understand the importance of sustainable development as a pragmatic response to pollution and resource overuse. If Deng Xiaoping's focus on a 'material civilisation' was China's first Marshall Plan, its shift toward an 'ecological civilisation' may well be its second. With the right mix of political ambition and citizen demand, other countries are just as capable of doing the same.

This summary is an abridged version of a research report and one of a series of Development Progress case studies being released at **developmentprogress.org**

Development Progress is a four-year research project which aims to better understand, measure and communicate progress in development. Building on an initial phase of research across 24 case studies, this second phase continues to examine progress across countries and within sectors, to provide evidence for what's worked and why over the past two decades.

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