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Private Sector markets for climate adaptation and resilience products and services

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November 2020

Question

What do private sector markets for climate adaptation and resilience products and services look like in LMICs in Africa and South Asia?

The focus requested was for products and services in:

- *Agriculture*
- *Financial services*
- *IT related services*
- *Data on risk anticipation (weather forecasting, storm surges etc)*

Contents

1. Summary

Private sector markets for climate adaptation and resilience products and services are already established in LMICs in both Africa and South Asia. Established products exist alongside emerging research and development initiatives. As climate risks worsen, public and private customers need to protect people, property, operations, supply chains and natural ecosystems from heat, drought, flooding, sea-level rise, and other threats. This need is already grasped as a business opportunity by many firms.

This rapid review draws from academic resources, resources from knowledge institutes and grey literature which yields a balance of information on discussion of the climate adaptation market (policy issues, private sector providers, client needs) and some case study examples of particular products successfully developed and trialled. Detailed mapping of products and services that are currently available is greatest in the agriculture sector yet even here draws from just one limited six country study. By mapping the existing landscape, to the extent that this has been possible, this review allows for informed decisions about how these markets can be developed further.

Climate adaptation is the process by which humans attempt to adjust to the many challenges that result from climate risks. One successful outcome is greater climate resilience. Until recently much of the work on climate adaptation and resilience has been done in the climate science and policy communities, with less attention paid to the role of private actors in producing technologies, products, and services that help people and organisations to become more resilient in the face of a changing climate. Initially Governments and funders have invested in technological advances to respond to climate change and in mitigation measures (to reduce carbon ouput). Now companies and investors are beginning to see climate change adaptation as an opportunity rather than simply a cost as climate impacts are generating a need for new products and services that present solutions for resilience. However, **companies rarely use climate terminology when describing their resilience solutions**. Thus, they may disappear from adaptation policy mapping reinforcing the perception that private actors are inactive in this area (PMCR, 2020: 4).

Although risks related to climate variability or climate change are generally well understood, the **language of business** (finance, risk management, marketing etc.) most often describes their activities, not climate jargon even if weather is used in the description of resilient products and services. The private sector is already providing many solutions, but just not referring to them as ‘climate change adaptation’ (PMCR, 2020: 9). Practical and cost-effective climate resilience solutions are already in place that are very specific to sectors, tasks, climate hazards and geography such as seeds of more drought-tolerant crop varieties, provision of communication services on weather and the (limited) availability of insurance products linked to weather variations over straight yield indemnity payments.

To date **very little systematic research or data is collected** anywhere on private-sector resilience solutions. One recently completed Private Markets for Climate Resilience (PMCR) study (2020) provides what seems to be an isolated example of an in-depth mapping. This study notes that the hundreds of solutions identified are a tiny fraction of the innovations in the two sectors studied (transport and agriculture), suggesting that the scope of private action in resilience is vast and remains poorly understood in its range and scope (PMCR, 2020:5). Indeed,

the literature on existing markets was eclectic rather than systematic – more easily providing detail on specific country level interventions rather than broader sector wide responses.

Public sector bodies or international agencies and NGOs provide some among a wide range of resilience solutions in agriculture, but **private actors dominate in providing most of the solutions strengthening climate resilience**. At national level, many of these actors are MSMEs meaning that scale is often limited. Many of the **barriers to market expansion were not specific to climate** but rather a general reflection of local market operating conditions and the difficulties of doing business; examples are a lack of government incentive for business innovation, burdensome regulations and taxes, and the inability for smaller players and start-ups to get access to capital or credit. Although most businesses acknowledge that greater climate resilience is an important goal, the lack of a recognised financial metric, such as a "return on resilience" measure, impedes private action in this area. It is a conundrum that **MSME are both more likely to be affected adversely** by climate risks since they are small and unable to spread risks as larger companies or multinationals would be able; and yet they are **most dominant innovators**, close to customer need and well able to provide cross cutting responses by virtue of their integration in value chains.

The contextual message to investors from this early PMCR project is clear: investors need no longer wait for a comprehensive global strategy to start addressing the effects of climate change – **technologies and solutions exist now and are ready for investment and scale up**. Climate resilience requires markets to take a more system-wide and forward-looking perspective. Effective long-term adaptation to climate change will require extensive stakeholder engagement, higher levels of expertise and prioritisation of proven resilience products and solutions to facilitate investment and move beyond project-based adaptation towards a more integrated systemic approach. The barriers to MSME expansion and scale up which exist independently of a climate adaptation market niche constitute a significant block to progress.

2. Understanding the nature of private sector climate markets

Adaptation means anticipating the adverse effects of climate change and taking appropriate action to prevent or minimise the damage they can cause or taking advantage of opportunities that may arise. It has been shown that well planned, early adaptation action saves money and lives later (EU Climate policy, Adaptation to Climate Change).

Climate resilience is the ability to anticipate, prepare for, and respond to hazardous events, trends, or disturbances related to climate. Improving climate resilience involves assessing how climate change will create new, or alter current, climate-related risks, and taking steps to better cope with these risks (Centre for Climate and Energy, 2019).

Put more succinctly, **climate adaptation is the process by which humans attempt to adjust to the many challenges that result from climate risks. One successful outcome is greater climate resilience,** or the capacity to identify, manage, mitigate, and withstand risks related to climate change (PMCR, 2020: 4). Until recently much of the work on climate adaptation and resilience has been done in the climate science and policy communities, with less attention paid to the role of private actors in producing technologies, products, and services that help people and organisations to become more resilient in the face of a changing climate. Companies and investors are beginning to see climate change adaptation as an opportunity rather than simply a cost as climate impacts are generating a need for new products and services that present solutions for resilience.

The private sector is generally a major investor in cities and feels a need to protect valuable urban-based assets. Self-interest drives corporate investments in fortifying the sector's climate-change resilience. However, the private sector still sees government shouldering the lion's share of the burden for the loss of livelihoods and the breakdown of essential services because of climate-related shocks (Rockefeller Study, 2014). Among resilience-building efforts, executives prioritise efforts to shore up the resilience of their own operations, but business is expanding its view of resilience, and coming to see a need to address a broader range of interrelated risks. Unrest, political instability, rising crime and corruption levels, and the growing urban wealth poverty divide are pressing risks to private sector enterprise. Increased climate risks—such as severe storms, rising temperatures, floods and cyclones—rank only fifth among nine challenges when survey respondents consider their markets.[1] Executives place a much higher emphasis on climate change as a risk when considering vulnerability of their supply chains; here climate-related threats rank second in the list of nine challenges. This suggests that there is a shifting private sector focus on non-climate related urban issues and climate related threats. Mitigation activities, reducing carbon footprint while adapting to risks in supply chains, goes hand in hand with responding to market demand for climate adaptation products and services and new business opportunities.

Small and medium sized enterprises are generally nimbler in responding to opportunities though other constraints to expansion may limit their flexibility in this market. The Proadapt Facility of the

[1] Executives at companies around the world were asked about the role of business in building urban climate resilience; companies in LMIC were included but formed a minor part (< 45%) of the sample

Inter-American Development Bank (IDB), is a programme to foster private climate resilience and related opportunities in Latin America and the Caribbean that is based on the following basic propositions:

1. Climate related risks are becoming more extreme.
2. The poorest countries are among the most vulnerable to climate hazards, and the least responsible for this threat.
3. Innovative and safe carbon neutral or negative technologies may come online and if so, they could be game changers, but we cannot rely upon this. Even with rapid and dramatic reductions in emissions, it is likely that the world is locked into many decades of escalating climate risk.
4. Climate resilience must become a major priority in developing countries because of threats to food and water security, livelihoods, settlements, and public health.
5. Demand for resilience drives business opportunities for many businesses, large and small. As climate risks worsen, public and private customers need to protect people, property, operations, supply chains and natural ecosystems from heat, drought, flooding, sea-level rise, cyclonic winds, and other threats. This need is a business opportunity for many firms.
6. Companies rarely use climate terminology when describing their resilience solutions. The language of business (finance, risk management, marketing etc.) most often describes their activities, not climate jargon even if weather is used in the description of resilient products and services. Thus, companies may disappear from adaptation policy mapping reinforcing the perception that private actors are inactive in this area (PMCR, 2020: 4).

This programme funded the **Private Markets for Climate Resilience study** (2020)[2] that is considered the first initiative to systematically evaluate the market for climate resilience solutions in the private sector. The private sector is already supplying products and services to help buyers better manage their exposure to climate risk but its separation from the climate adaptation policy sector may deprive public authorities of useful market intelligence that could inform national adaptation planning and other policies. Although the assessment focused research on adaptations in the transport and agriculture sectors only, its scope reached across the private market and innovation in six developing country economies from Africa, Latin America and South East Asia.[3] The study notes that the hundreds of solutions identified by the team are a tiny fraction of the innovations in just these two sectors, suggesting that the scope of private action in resilience is vast and remains poorly understood in its range and scope (PMCR, 2020:5).

Key findings appear more widely applicable propositions, namely that:

- Private-sector stakeholders are aware of how weather and extremes impact operations and are engaged in responding. In the face of growing climate variability, there are many business and investment opportunities arising from the demand for climate resilience solutions in the form of emerging technologies, analytics, market intelligence, as well as

[2] With funding from the Inter-American Development Bank (IDB) and the Nordic Development Fund (NDF)
[3] Country studies in Colombia, South Africa, and the Philippines, with desk studies in Nicaragua, Kenya, and Vietnam

new financial and investment models that better frame and manage climate risks. (PMCR, 2020: 2).

- The private sector is already providing many solutions, but just not referring to them as 'climate change adaptation' (PMCR, 2020: 9). Practical and cost-effective climate resilience solutions are already in place. These are very specific to sectors, tasks, climate hazards and geography.
- In the agriculture sector, smaller firms, including some microenterprises, are among the most innovative enterprises in climate resilience. Specialised consultancies offering knowledge and technical services are all very small, including those providing analytics or digital solutions for agriculture (PMCR, 2020: 6)
- Dealing with near-term impacts, remains the primary driver of action in private companies, which typically prioritise current risk and short-term profitability over longer-term business sustainability (PMCR, 2020: 9). This short-term imperative hinders strategic thinking and recognition of further opportunities driven by climate risks such as investing in product development for future (medium to longer term) adaptation markets.
- Many of the barriers to market expansion were not specific to climate but rather a general reflection of local market operating conditions and the difficulties of doing business; examples are a lack of government incentive for business innovation, burdensome regulations and taxes, and the inability for smaller players and start-ups to get access to capital or credit (PMCR, 2020: 11).

For small companies, the relatively high cost of doing business is a dampening force just as it is hard to articulate the business case for resilience or the "cost-benefit" of resilience activities. Although most businesses acknowledge that greater climate resilience is an important goal, the lack of a recognised financial metric, such as a "return on resilience" measure, impedes private action in this area. Also, the divergent framings of climate change by public and private actors, merits examination since neither public nor private action alone can address the climate threat (PMCR, 2020: 6). Private actors need the enabling frameworks and policies that foster transparency, trust and that facilitate investment and commerce. Smaller companies need access to finance. The public sector needs private innovation, creative problem solving and capital. The PMCR assessment notes that no one set of resilience solutions, technologies, products, or risk protocols can solve the challenges ahead. Research and development and continual improvements to processes and products will help companies adapt to risks and generate opportunities. Moreover, resilience building is not a "one-off" intervention, but part of a continual effort to feed emerging data and market intelligence into an organisation's production system and to inform its actions. Improving climate resilience involves assessing how climate change will create new, or alter present, climate-related risks, through analytics and risk monitoring and then taking steps to better cope with these risks taking advantage of adaptation products and services available.

Variety in private sector interventions

Much current resilience activity among private-sector actors is not classified as such but is often considered business as usual. The PMCR study finds that climate resilience actions are led by enterprises of all sizes and can be classified loosely into three main types (with many that can be considered crosscutting):

- *Defensive solutions* protect existing operations or infrastructure in the face of a changing climate.

- *Innovative solutions* involve new methods, practices and technologies that can give rise to new social or value-chain relationships. Many companies identified as providing innovative resilience services were often micro-, small- and medium-sized enterprises (MSMEs).
- *Transformative solutions* change the nature of a company or sectors, disrupting business as usual, or finding new applications for existing tools or practices. (PMCR, 2020: 10)

Other ways of categorising resilience responses would be:

1. By Sector – such as within the **agriculture** sector, right along the value chain from production and including storage and transport solutions; within the **health** sector responding to increased disease burden including livestock health issues, new vaccines, pharmaceuticals, measures and products to protect against vector-borne diseases, more resilient healthcare facilities and other solutions; in the **water** sector, using scarce water resources more efficiently, maintaining drinking water potential, managing flooding and irrigation; in the **energy** sector ensuring adequate back-up power generation, distribution, micro-grids and in **construction**, new building materials and construction methods, including more efficient ways to cool buildings, building flood defences and adapting building codes to future climate conditions or extreme weather events.
2. By Response – such as climate adaptation products and services or predictive climate intelligence. Both are a part of building resilience to climate hazards.This taxonomy has been fully developed as part of the Adaptation SME Accelerator Project (ASAP) an initiative led by the Lightsmith Group[4] (Trabacchi et al, 2020: 34). This is now expected to be 'road-tested' to inform the development of a user-centric online database of Adaptation SMEs that will more fully map private sector providers. The terminology is applicable across all above sectors as illustrated in a graphic to be found here: https://lightsmithgp.com/wp-content/uploads/2020/09/asap-adaptation-solutions-taxonomy_july-28

In the next section of this report this way of organising information is used and tailored to the pre-determined areas of primary focus.

3. Climate Adaptation Products and Services

As climate conditions worsen the challenge for all those in the agriculture sector, most especially smallholder farmers, is how to combat low productivity that is made worse by climate change. Rising temperatures, unpredictable rainfall, uncertain weather patterns, pests, and other threats to crops and livestock affect millions of farmers. Stakeholders in the agriculture sector are increasingly finding value-add in more precise and contextualised farming approaches and implementing good practices. These include adapting planting and harvesting schedules, actively managing soil health, diversifying products or using technology to optimise resources (land, water, other inputs). The following tables present all the current practice climate options, strategies and technologies for the **agriculture** sector identified by the PMCR survey. All options

[4] With funding from the Global Environmental Facility (with Conservation International as the Implementing Agency), and the InterAmerican Development Bank

listed here have a direct link to climate risk reduction or climate resilience strengthening, as identified by stakeholders from the sector. Each of these are solutions already delivered by private sector operators on some scale, frequently by MSME's so at limited scale.

Table 1: Products and Services provided by private sector operators in Agriculture

Product/Service	Current examples
Farm infrastructure and machinery	Mechanical land preparation and harvesting (no-till farming), soil management infrastructure, integrated pest management, automated post-harvest processes, mechanical dryers, washers and fermenting machinery, storage facilities, renewable energy sources, machinery for temperature regulation, all of which conserve soil and minimise product losses
Certified seeds and varieties and other farm inputs	Certified and good-quality seeds, climate-resistant seed varieties, seed multiplication, certified nurseries, organic fertilisers and inputs, soil moisture conservatives, etc.
Water infrastructure	Irrigation systems, water-management plans, systems for water harvesting, storage, treatment and transportation, drainage channels, water filters, wells, soil moisture conservation, etc.
Knowledge services	Expertise, special knowledge, capacity building and training, and technical assistance relating to agro-forestry systems, crop management and diversification, including soil conditions, planting techniques, input selection, use of fertilisers, irrigation, quality control, harvesting and others. Support for certification processes, conservation agriculture practices, good agronomic practices, etc
Good practice manuals, checklists and protocols	Good practice manuals, checklists, protocols, floral calendars and registers, staff health & safety.
Storage and milling facilities	Post-harvest facilities that consider climate risks and challenges for storage, drying, cooperative-type or farmer-owned enterprises, cold storage, on-farm grain silos, seed storage facilities.
Financial services	Farmer-friendly financing and loan packages, credit lines, relevant and accessible insurance, technical bank staff to support farmer-borrowers, financing mechanisms for post-harvest facilities, distribution and trading, contract farming, etc.
Research and market information	Research farms, piloting programmes, seed banking, research and development for climate-resilient production inputs, research on plant life-cycle relationships with climate, trading mechanisms.
National government policies, regulation and initiatives	Development of more agriculture resilience-focused laws and ordinances, stronger and better implementation of existing land use laws, climate-resilient farm-to-market roads and seaports, policies to ensure food security and stable pricing, price control mechanisms during post-disaster and emergency situations, buffer funds/aid for vulnerable groups during post-disaster and emergency situations, public awareness on policies in place, etc.

Source: Author's Own. Data adapted from information gathered in Private Markets for Climate Resilience study (Nordic Development Fund and Inter-American Development Bank, 2020, p. 24)

The PMCR study finds that private sector agents are not exclusive providers of a range of resilience solutions in agriculture, these may also be provided by the public sector or international agencies and NGOs. Nevertheless, private actors are providers of most of the solutions strengthening climate resilience, and at national level, many of these actors are MSMEs. (PMCR, 2020:26). However, MSMEs have lower technical and financial capacities to respond to climate and disaster risks and are therefore disproportionately more vulnerable to the effects of climate change. They are also particularly exposed because of the very local scale at which they operate in contrast to, for example, multinational corporations, which operate at much larger scales and can therefore more easily spread their risks (Schaer & Kuruppu, 2018: 13).

4. Climate Adaptation Intelligence

In the second category of resilience responses training in new methodologies is linked to the power of information, and access to knowledge services is becoming more valued. Climate projections, weather monitoring and forecasting, combined with early-warning systems, agro-climatic models designed to drive quality yield, water efficiency and crop management techniques, are all among the many promising resilience solutions studied (PMCR, 2020). IT related services provide data on risk anticipation such as monitoring locust populations and invasions, early warning systems for extreme coastal weather events and satellite imagery for monitoring and impact assessment.

Table 2: Data based intelligence /IT related services provided by private sector operators in Agriculture

Data based approach	Current examples
Meteorological products and services	Early-warning systems, climate datasets, climate projections, agrometeorological stations, local weather predictions, scenario analysis, etc
Environmental diagnosis toolkits	Farm mapping, cartography, mapping of soil classification and overall environmental conditions, soil analysis, diagnosis and classification, analysis of microbes and soil fungi, etc.
Software and other datasets	Software for weather, crop and yield projections and simulations
Regional approaches and improvement programmes	Watershed management, watershed reforestation, farmer cooperatives, alternative transport routes, large-scale shift to organic farming.

Source: Source: Author's Own. Data adapted from information gathered in Private Markets for Climate Resilience study (Nordic Development Fund and Inter-American Development Bank, 2020, p. 24)

This type of climate intelligence is often not available to those (smallholder farmers) who might find it most useful. The high level of expertise for the development and constant fine tuning of crop modelling, machine learning, and big data, hinders the creation of advanced weather services for small scale producers and there are technical and financial constraints to be overcome such as illustrated by this example:

In 2004 two agricultural economists set up a company to export dried chillies produced with large numbers of contracted smallholders in Kenya (van Casteren, 2018). At that time, there were no off-the-shelf ICT management packages that would allow commodity traders, farmer cooperatives and food processors in agriculture and livestock to aggregate future produce volumes along supply chains. They developed eProd, a supplier management service. The eProd handheld device collects the GPS locations and agronomic information such as soil type, seed variety and planting date. Connection must be reliable and must function in areas where internet is poor or absent. Access to weather data is also extremely important for eProd users. Advanced weather information systems exist, but small-scale producers are often unable to access these. aWhere is one of the leaders in the field of weather information for agriculture and serves agricultural businesses across the agricultural value chain from international seed companies to innovative start-ups. Even though they see the business opportunities of serving smallholders with localised services their traditional revenue model cannot deal with the relatively small transactions inherent of working with smallholders. In this case these entrepreneurs also integrated a weather service system within the agro advisory service for farmers in East Africa using a specially developed interface. aWhere combines this supply side information with their weather data so farmers can now be sent SMS weather forecasts, spray alerts, fertiliser advice and yield projections.

The combined package (eProd and aWhere) has subsequently been used at coffee cooperative level to relay sensitive climate information to farmers that will impact upon later yields. Accuracy of predicting yields via an interface with commodity chain actors (coffee traders, trading cooperatives or hedge funds investing in this commodity market) allows for better coffee price deals to be made, with greater return to grassroot producers. The example illustrates the technical challenges to overcome and the need therefore for a sufficiently large scale of end user to ensure product uptake. If these criteria are met the climate resilience for the end-farmer can be improved through better information pre-production and greater return on yields post-production.

Open data could offer significant benefits for smallholder rural communities in developing countries. For less specialised but far greater number of smallholder farmers there is huge potential to improve climate resilience if they can gain open access to data. Currently the lack of reliable and contextualised data works against smallholder farmers. Often, this is because the data needed to have local impact does not exist or is not openly available (CTA, 2017). Data that is shared or reused can have greater value than if it is simply used for its single original purpose. Advice combining agricultural knowledge with data from remote sensing and mapping provide farmers with early warnings of adverse conditions. Potential benefits for smallholder farmers are increased participation and self-empowerment, improved or new products such as logistical, extension, financial, input and trade services, more efficient value chains with better access to markets, higher and less perishable yields, greater availability of inputs and better pest control all important outcomes of adapting to climate change. Hence, giving smallholder farmers access to reliable data can translate into higher productivity, greater access to markets and better nutrition as well as for some new opportunities in agrobusiness.

Meteorological data is one area where open data is starting to make a real contribution to smallholders. Better satellite data is available, and more services are being created to send the most accurate information to farmers for a lower price. Success depends on the number of

mobile platforms that have been taken to market with users willing to pay for agricultural and financial information services. The mobile and ICT service operators are developing and hosting agricultural advice services on mobile platforms, providing information as text messages, structured menus, voice messages. Two examples are:

The Market-led, User-owned ICT4Ag-enabled Information Service (MUIIS), a multi-stakeholder initiative that looks to provide smallholder farmers in Uganda with satellite-based crop advice. Satellite data will be acquired from a number of sources and data analytics will provide intelligent agronomic tips on amount of inputs to use, daily weather on timing and length of season, preventive practices or early warnings, responses to pest and disease attacks, financial and index-based insurance services, and market intelligence on where and when to sell.

Studies in India have shown that such satellite data-enabled extension and advisory services can lead to about 40% increase in farmers' productivity. Examples of satellite-based crop monitoring services include Cropio, FarmSat, FieldLook and ClimatePro. (CTA,2017).

5. Financing and Financial Services

Microfinance is an effective means of facilitating climate resilience. Microfinance helps the poor build up their assets, establish or develop a business and protect against risks (Haworth et al, 2016: 37) Microfinance institutions (MFIs) have pre-existing networks of access to the poor, especially women, who are particularly vulnerable to climate change. Some are private sector institutions and are commercially oriented. Others (private or third sector) are socially oriented with the aim to support the poor in society and to improve their situation, using indicators such as the Progress out of Poverty Index and child well-being (Haworth et al, 2016: 51) Access to loans allows communities to diversify livelihood activities or invest additional resources in current practices to increase efficiency and improve resilience. Microfinance services cover not only the provision of loans and credit for income generation but also savings, insurance, payments, money transfer, remittances, and educational and health loans.

The nature of microfinance lending – high-volume limited value loans – is consistent with the fundamental nature of a majority of resilience-building actions, which will ultimately comprise thousands of decentralised actions by individuals, households and communities, as they continuously seek to internalise climate risks in their activities (Agrawala and Carraro, 2010, cited in Haworth et al, 2016).

However, difficulties like those noted for MSMEs that are most often the providers of climate resilience products and services, limit the operational capacity and impact for MFIs. MFIs often lack the technical abilities and financial resources to reach out to the rural poor expanding their services among those who sorely need them as a buffer to build their climate resilience. Owing to financing constraints, it is very difficult for MFIs to have in place a long-term approach based on the objective of increasing resilience for the population. The regulatory framework and ownership structure of MFIs creates low levels of competition within the market. MFIs also need technical support to understand portfolio risk management, particularly around climate risk (Haworth et al, 2016).

Insurance can provide businesses, farmers and affected households with rapid access to cash post-disasters, offering protection to livelihoods. However, there are challenges in developing

weather-index insurance markets in lower-income countries. In some cases, when weather data infrastructure is too underdeveloped and information on climate risks is sparse, a suitable index cannot be found. All this means insurance companies find it difficult to price the risk and set a premium, and therefore no insurance is offered (Haworth et al, 2016: 54).

Weather-index insurance presents a promising alternative to traditional agricultural insurance for many lower-income countries. In contrast with traditional indemnity-based crop insurance, the contracts are index-based, which means the insurer will pay the contractual claim if rainfall falls below a specified level, regardless of crop damage. In other words, index-based insurance is against events that cause loss, not against the loss itself (Tuvey, 2001, cited in Haworth et al, 2016). Costly in-field assessments of individual farms are not needed to verify damage, which makes insurance more affordable. Furthermore, the pay-out can be set up to occur as soon as the loss-causing event is detected, which helps smallholder farmers stabilise their incomes and recover more quickly from climate-related shocks. There is a growing market for drone use in this context both collecting and analysing geographical data that is important for resilience building and within insurance markets.

Overall insurance markets play a minor role, despite clear benefits for vulnerable populations (GIZ, 2015 cited in Haworth et al, 2016). Access to insurance services is still limited to a relatively small part of the global population, mainly from the middle and upper classes. Many insurance products are also still in the design phase, for example crop insurance (Haworth et al, 2016: 34). Both Governments and private sector providers are invested in research and development to improve climate resilience through insurance products as in the following example:

In India research has considered how crop insurance payouts could be sped up with the help of drone technology, preventing financial hardship and potentially helping more small-scale farmers get insured (Garg, 2016). Less than 23% of India's millions of farmers are covered by crop insurance, and even those who are insured regularly suffer financial hardship from delayed payouts. Payments are often deferred by the slow damage assessment process as land record office personnel travel from village to village to conduct inspections. This means that it takes insurers a long time to receive timely, accurate data while Indian farmers need to get their insurance payments faster.

India's central government has launched a technology-focused crop insurance pilot project called "Kisan" to address the problem. It is part of the Indian central government's new crop damage insurance scheme called "Pradhan Mantri Fasal Bima Yojna," which translates as "Prime-Minister's crop insurance scheme." Data is collected by unmanned drones and well as crowd sourced information provided by farmers via smartphones. The system is still experimental and not without some issues around drone use in some states. If successful in using these new data collection methods, insurers would be able to deliver a better, cheaper product that would make it possible for more farmers to get insured (Garg, 2016).

The market for climate adaptation products and services is constantly evolving with considerable information on research and development of new measures. Rather little has been done to systematically map this diversity and further research is merited.

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Acknowledgements

We thank the following expert who voluntarily provided suggestions for relevant literature or other advice to the author to support the preparation of this report. The content of the report does not necessarily reflect the opinions of any of the experts consulted.

- Evert-Jan Quak, Research Officer for the "Business, Markets and the State" research cluster, Institute of Development Studies

Suggested citation

Enfield, S. (2020). *Private Sector markets for Climate Adaptation and Resilience products and services.* K4D Helpdesk Report. Brighton, UK: Institute of Development Studies.

About this report

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