CLIMATE LEDGER INITIATIVE

Digitalisation for Climate Action

EXPERIENCES FROM 8 USE CASES IN 6 COUNTRIES

Contents

Climate Ledger Initiative

The Climate Ledger Initiative (CLI) is an international, multi-stakeholder initiative at the intersection of climate change and the use of digital innovations. It seeks to accelerate climate action in line with the Paris Climate Agreement and the Sustainable Development Goals (SDGs) through innovative digital solutions such as blockchain and distributed ledger technology, internet of things (IoT), artificial intelligence (AI), and the use of sensors or remote sensing.

CLI brings together developing and developed countries, international institutions, climate change practitioners, digital experts and entrepreneurs. It facilitates the exchange of experience and joint learning from use cases on how to successfully deploy digital innovation for climate action. CLI creates knowledge products, such as the annual "Navigating Digital Innovation for Climate Action" report and other theme-specific publications. CLI also organises events, workshops and webinars to facilitate the sharing of knowledge and experience.

Working with use cases that show real-life applications of digital innovation to drive climate action is one of CLI's main pillars.

Since 2018, CLI has supported more than 15 use cases, 8 of which are profiled in this brochure. They illustrate how digitalisation can support low and lower-middle income countries to strengthen climate resilience and contribute to climate action and the SDGs.

CLI is jointly operated by INFRAS and the Gold Standard Foundation and supported by governments, major international organisations, companies and foundations.

CLIMATE LEDGER INITIATIVE

Digitalisation for climate action

Addressing climate change and achieving sustainability are among the most urgent issues facing our world today. The Climate Ledger Initiative (CLI) explores how digitalisation can help us to find solutions to these challenges. This brochure presents eight use cases and its lessons learned from six countries.

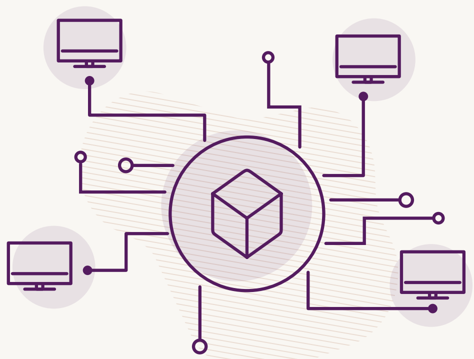
The Climate Ledger Initiative (CLI) explores how digitalisation can help us to find solutions to the challenges of climate change and sustainable development using technologies such as blockchain and distributed ledgers, sensors and the internet of things (IoT), artificial intelligence (AI) and big data, and remote sensing (Figure 1). These technologies open the door to innovations that can make climate mitigation and adaptation projects and efforts to advance sustainable livelihoods and development more effective and efficient. They can also support new business models that, for example, make crop insurance more affordable for small-scale farmers or help generate income from carbon credits. They can increase the accuracy of, and therefore public trust in data, and have the potential to foster increased stakeholder participation and empowerment.

Remote sensing

Remote sensing is a technology and technique used to observe and gather information about the earth's surface or other objects from a distance, typically from a satellite, aircraft or drone. It involves the collection of data without direct physical contact with the subject being studied. Remote sensing relies on sensors and instruments such as cameras, radar and spectrometers to capture data in the form of images or other measurements. The applications of remote sensing are diverse and include environmental monitoring and the management of natural resources including forests and water bodies.

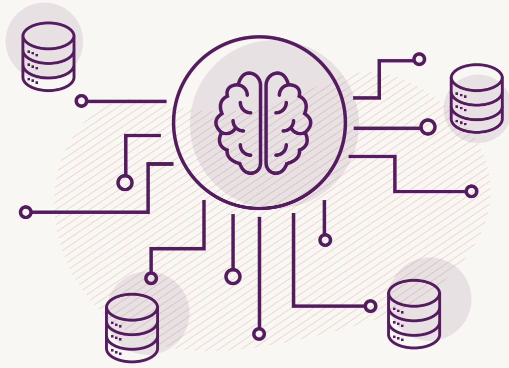
Sensors and internet of things (IoT)

Sensors and IoT refers to interconnected devices equipped with sensors that collect and transmit data, enabling real-time monitoring and control of physical environments and systems. For instance, soil moisture sensors in agriculture enable precise irrigation, improving crop yield, reducing water wastage and promoting sustainable farming practices. IoT-connected weather stations provide data for climate modelling and early warning systems that can support disaster preparedness and climate adaptation efforts.



Blockchain and distributed ledger technology (DLT)

In a simplified view, **blockchain** is an innovative form of decentralised database that provides new means to securely exchange and store data and digital assets, primarily designed for peer-to-peer transaction platforms. Each entity or actor holds a copy of the database, and each new entry into the database has to be verified through a consensus process by the entities participating in the network (i.e. nodes). This provides security and traceability. Such blockchain-based databases can be used not only to trace the transfer of money or other assets, but also to track greenhouse gas emissions, report on progress in the implementation of climate finance projects and give poor communities access to finance to tap into clean energy, for example.



Artificial intelligence (AI) and big data

Big data refers to the massive volumes of structured and unstructured data often available on a given topic. Big data can be processed using **AI** whereby machines or computer systems analyse the data, can recognize patterns and provide answers based on accumulated experience. AI has numerous applications across many sectors including climate science. For example, it can analyse vast datasets to model and predict climate trends, helping researchers understand complex climate systems and develop mitigation strategies.

Figure 1: Key digital technologies

Digital technologies offer opportunities across virtually every sector, from energy and transport to finance and investment (Table 1). Even within a given sector, the applications are multiple, ranging from data collection and knowledge-sharing to predictive analysis and systems management (Figure 2).

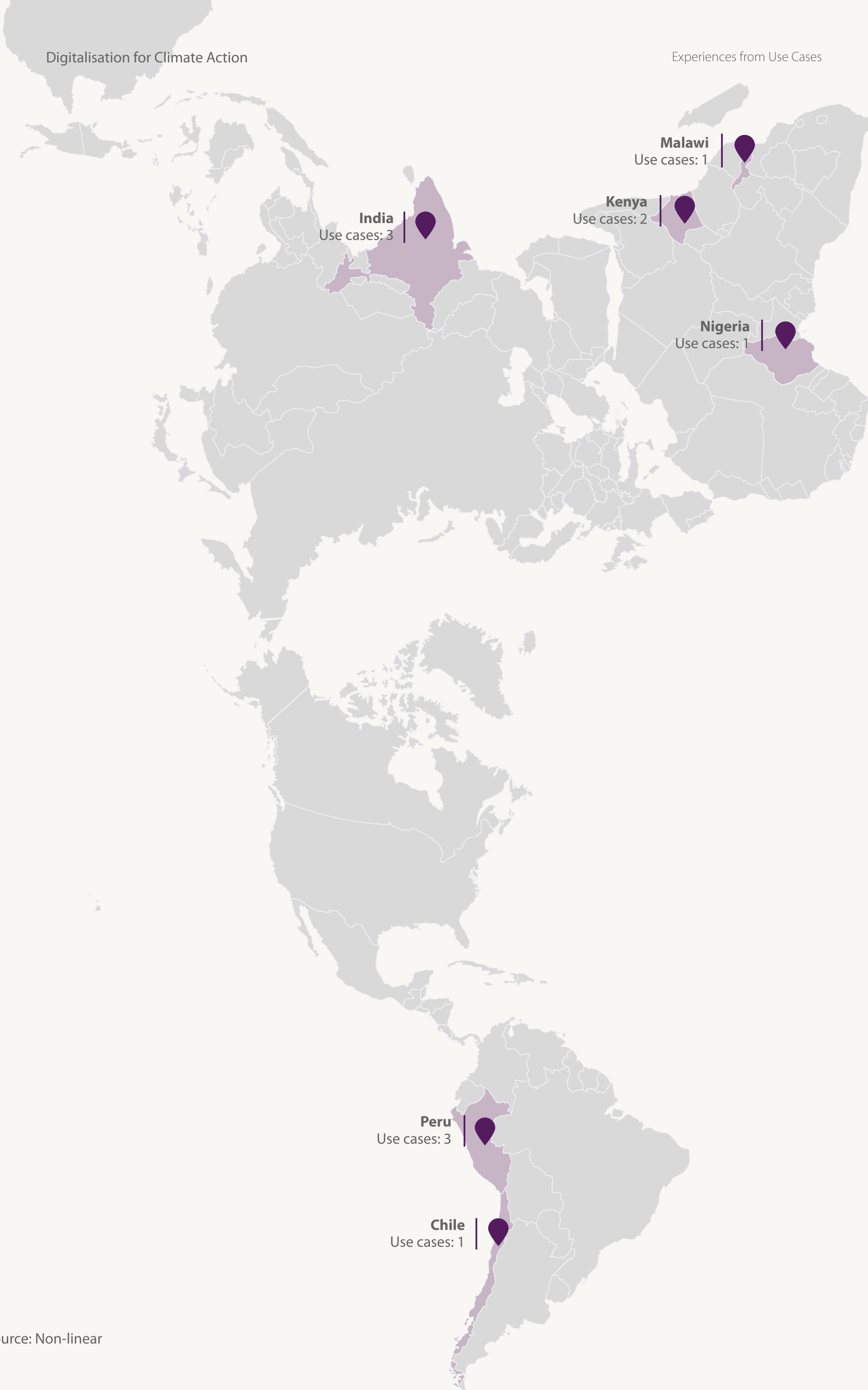
Digital technologies can be a valuable tool that helps achieve the objectives of a given project. However, they are not an end in themselves. The following table (Table 1) provides a non exhaustive list of opportunities for the application of digital technologies in different sectors.

Table 1: Opportunities for the application of digital technologies

Energy	Digital technologies can enhance the operation, grid integration and business models of renewable energy production systems including solar, wind and hydro. They can help incorporate renewable energy sources into power grids by using smart grid technologies and balancing production, storage capacity and load. They also enable new business models such as pay-as-you-go photovoltaics for households. Digital monitoring, reporting and verification (MRV) makes it easier to tap carbon markets for investments in renewable energy.
Transportation and infra-structure	IoT sensors and data analytics can improve traffic flow and reduce emissions by optimising traffic signal timings and promoting the use of public transportation. Autonomous vehicles and smart electric-vehicle charging networks further contribute to emission reductions. Mobility pricing is another area where digital tools can provide incentives for green mobility.
Supply chain optimisation and circular economy	Digital tools including blockchain applications can help track information along complex supply chains. They can also improve supply chain efficiency by, for example, optimising storage or cooling of food and reducing emissions associated with production and transportation.
Disaster risk management, weather and climate modelling and forecasting	Advanced modelling and forecasting tools based on big data and AI can provide more accurate and timely weather forecasts and climate projections, aiding in disaster preparedness and climate resilience planning.
Waste management	Digital solutions such as AI-based recognition of waste composition enable efficient waste collection and recycling and the recovery of valuable materials from waste streams. This can reduce demand for raw materials, volumes sent to waste-to-energy facilities and landfill emissions while promoting sustainable waste management.
Agriculture and forestry	Precision agriculture uses sensors and drones to optimise planting, irrigation, and fertilisation, reducing resource use. Satellite pictures combined with other remote sensing and ground truthing data can help monitor tree biomass growth and support reforestation efforts. In addition, remote sensing in combination with blockchain and digital payment systems can enable cheaper, faster and more transparent insurance for smallholder farmers.
Environmental monitoring	Sensors and other IoT devices, satellite images and other remote-sensing techniques can provide high quality data on air pollution, water levels, biomass and other environmental parameters. Data analytics can improve current models or allow for real-time monitoring of environmental conditions in support of, for example, pollution control and conservation efforts.
Water management	Smart meters enable real-time tracking of the levels, quality and consumption of water resources. Digital solutions can support water management in a water basin by identifying and reducing leaks and encouraging water conservation. Digital tools can also support equitable water sharing and efficient irrigation practices.
Carbon markets and corporate disclosure	Digital solutions can improve MRV systems to measure emission reductions and support carbon markets. Blockchains, for example, can help track international transfers as well as the trading of digital assets based on carbon credits. More generally, integrated reporting platforms help organisations comply with climate disclosure requirements, ensuring transparency and accountability in emissions reporting.
Finance and investment	Digital platforms can help identify climate-friendly investment opportunities and direct finance toward them. Digital technology also enables cheaper, faster and more transparent microfinance and insurance solutions, for example for smallholder farmers.

Figure 2: Applications and benefits of digital technologies

Digital technologies provide many benefits for project planners, implementers, users, service providers, etc. They can make projects more efficient and effective by decreasing the need for manual data input, increase trust by bypassing intransparent middlemen, enhance participation through user friendly online platforms and enable new business models that make existing services affordable. However, digitalisation does not come without risks. Artificial intelligence (AI) can magnify human bias, and energy-intensive activities such as bitcoin mining have their own environmental implications. The CLI seeks to apply these technologies wisely, harnessing their opportunities for climate change adaptation and mitigation while managing potential hazards. It advances the real-world applicability and scalability of digitalisation to leave no one behind in the face of the climate crisis.



Source: Non-linear

Use cases

Since 2018, CLI has developped a strong portfolio of use cases that show how digital technologies can enhance climate-related projects, eight of which are profiled below.

The projects were chosen through open calls and employ a range of digital innovations including sensors and IoT, remote sensing, blockchain and AI and big data. The use cases focus on climate change mitigation, adaptation and environmental protection, but with co-benefits for several SDGs (Table 2). They are based on solid concepts and robust partnerships with private sector actors, NGOs, research institutes, governmental entities and local communities. The CLI has provided limited funds for the development of Minimal Viable Products (MVPs) that allow approving concepts, road testing, for activities such as approving concepts, road testing, implementation, outreach and exchange of learnings with peers and policymakers.

Table 2 provides an overview over the selected use cases. In the following, we provide a separate factsheet for each of the use cases.

Table 2: Selected digital technology use cases

PROJECT	SECTOR	TECHNOLOGY
Wood Tracking Protocol, Peru Digital platform for forest management companies using smartphones and blockchain technology to counter illegal logging and reduce deforestation in the Peruvian Amazon by improving transparency and traceability to the timber industry. SDG9 SDG12 SDG13 SDG15 SDG16 SDG17	**Forestry**	**Blockchain, remote sensing**
Climate risk insurance, Kenya Mobile phone and blockchain-based insurance against climate impacts for smallholder farmers in Kenya. Satellite weather data (e.g. indicating drought) triggers direct payments. SDG1 SDG2 SDG5 SDG8 SDG9 SDG12 SDG13 SDG17	**Agriculture, finance and investment**	**Blockchain, sensors and IoT, remote sensing**
Smart cookstoves, India Clean cookstoves equipped with sensors to monitor cooking practices in 100 households in India and transfer data automatically to a platform that calculates climate impacts. SDG3 SDG5 SDG7 SDG9 SDG13	**Energy, environmental monitoring**	**Blockchain, sensors and IoT**
Low-cost indoor air pollution monitoring, Kenya Low-cost air pollution monitoring system developed and manufactured in Kenya and used to monitor indoor air quality related to different cookstove technologies in about 100 slum dwellings allowing to improve health policies. SDG3 SDG7 SDG9 SDG13	**Energy, environmental monitoring, policy support**	**Sensors and IoT**
Impact dashboard for cold-store app, India and Nigeria Integrating an impact dashboard into the Coldtivate app, a digital tool to improve cold room management and reduce post-harvest losses for farmers in India and Nigeria. SDG1 SDG2 SDG5 SDG7 SDG8 SDG9 SDG10 SDG12 SDG13	**Agriculture, supply chain optimisation**	**Remote sensing, AI and big data, sensors and IoT**
Green action tracker, Chile Blockchain platform to support MRV practices and track greenhouse gas emissions and resource savings from green actions in Chile, including renewable energy generation, e-mobility and waste recycling. SDG6 SDG7 SDG9 SDG11 SDG12 SDG13	**Energy, water, transportation, waste, policy support**	**Blockchain, sensors and IoT, AI and big data**
Land use and biomass monitoring, Malawi and Peru Verifying the concept of combined use of remote sensing (including satellites and drones) and youth-based ground truthing to monitor biomass and related sustainability attributes. SDG1 SDG4 SDG8 SDG9 SDG13 SDG15	**Forestry, Agriculture**	**Remote sensing**
Digital technology assessment, Peru Identifying opportunities for digital technologies to improve monitoring, project participation, and transparency in an initiative to improve water security. SDG6 SDG9 SDG12 SDG13 SDG15	**Water, Agriculture**	**Remote sensing, sensors and IoT**

PERU

Wood Tracking Protocol

TECHNOLOGY
Blockchain, remote sensing

PARTNERS
Mecanismos de Desarrollo Alternos, INFRAS

SDG9 SDG12 SDG13 SDG15 SDG16 SDG17

SECTOR
Forestry

FINANCIAL SUPPORT
CLI contribution from SDC, Government of Liechtenstein

Wood Tracking Protocol (WTP) provides a digital platform that leverages the features and technical possibilities of smartphones and blockchains to combat illegal logging and deforestation in the Amazon. WTP supports this objective by increasing transparency and traceability in the timber industry in Peru.

An estimated 35–80% of Peru's timber is obtained through illegal means. The forest loss accounts for a substantial share of the country's greenhouse gas emisisons. Currently, the wood tracking and tracing process for legal logging in Peru relies heavily on paper documents and computer spreadsheets, which are susceptible to corruption, alteration, duplication and forgery.

Deployed at key steps in the timber supply chain – logging, transportation and processing – WTP allows the collection of information on specific logs that is difficult to falsify, such as geo-location data, photos and timestamps, and cannot be manipulated or duplicated (Figure 3). The blockchain based platform can scale up to manage billions of records from thousands of companies simultaneously without requiring human oversight.

WTP includes a smartphone app that connects to the WTP platform and that timber operators can use to enter information for a specific log. A challenge that had to be solved is limited cell phone reception in remote areas. Thus, the data can be registered via app and uploaded at a later time to the platform when internet connectivity is available.

The tool, which includes the steps and information of the existing tracking and tracing process, adds a verification step to enhance the accuracy of data and can potentially reduce the administrative burden of wood companies and public authorities.

The WTP team is in discussion with Peruvian authorities on how the tool can be integrated into the national timber tracking and tracing system.

The current wood tracing and tracking process primarily focus on timber for export, leaving room for the consumption of illegally sourced wood within Peru. To unlock the full potential of the WTP platform, it is essential to increase national-level demand for legally sourced timber. WTP could also facilitate wood companies' access to international markets that require certificates of legal origin (e.g. due to EU regulation), potentially piquing the private sector's interest in adopting WTP.

> “Our WTP tool also promotes sustainable industrialisation by helping the forestry industry in Peru to reduce illegal logging.
>
> **Rocío García**
> Programme Manager CLI
> **Michael Fabing**
> IT Lead, WTP

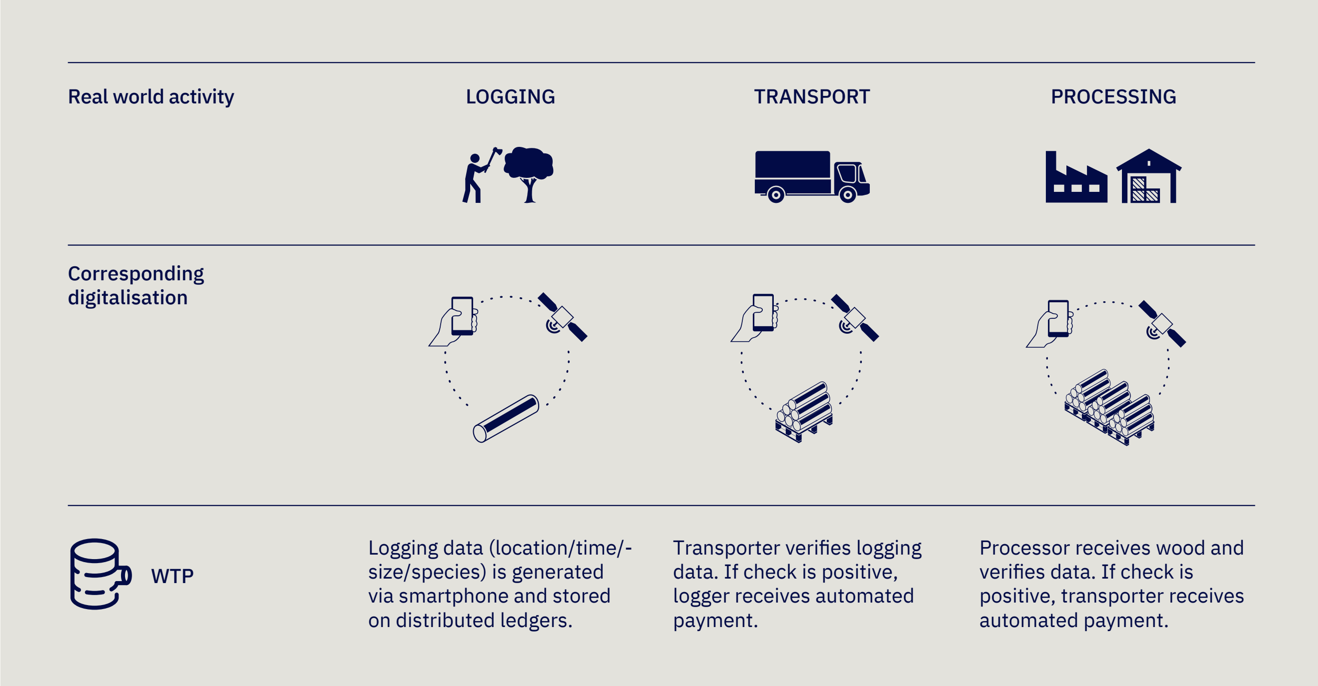


Figure 3: How the Wood Tracking Protocol works. Source: WTP and non-linear

Identifying a log labelled with a QR code before uploading the data to the WTP platform. Source: WTP

KENYA

Climate risk insurance

TECHNOLOGY
Blockchain, sensors and IoT, remote sensing

SECTOR
Agriculture, finance and investment

PARTNERS
Etherisc, ACRE Africa

FINANCIAL SUPPORT
CLI contribution from SDC, Decentralized Insurance Foundation of Etherisc, Chainlink, Ethereum Foundation, Mercy Corps Ventures

SDG1 SDG2 SDG5 SDG8 SDG9 SDG12 SDG13 SDG17

Etherisc and ACRE Africa provide mobile phone- and blockchain-based insurance against climate impacts for smallholder farmers in Kenya. Direct payments are triggered by satellite weather data, such as drought conditions.

Accessible and affordable crop insurance is crucial for smallholder farmers to protect their livelihoods and increase their resilience to the effects of climate change. Unfortunately, traditional insurance is not able to provide sufficient protection. In Sub-Saharan Africa, only 3% of smallholder farmers have access to agricultural insurance. Insurance can be expensive, and there is little trust in traditional insurers due to histories of delayed or absent pay-outs.

With support from CLI, Etherisc developed a platform using the Ethereum blockchain for ACRE Africa's BIMA PIMA insurance product. The aim is to make climate risk insurance cheaper, faster and more transparent. Using the platform, crop insurance policies are plugged into smart contracts and indexed to local weather. During extreme weather events, policies are automatically triggered by satellite data, enabling fair, transparent, and swift payouts through mobile payment services (Figure 6). This empowers farmers to reinvest early, secures their ongoing season, and reduces transaction costs. Mercy Corps reported 80% reduced operational costs.

Farmers buy the insurance together with seed in the form of a scratch card containing a unique registration code. The basic insurance premium is prepaid and included in the price of the seeds. Top-up payments can be made using a mobile payment system to increase coverage. Farmers can activate the policy using their phone by sending an SMS containing the registration code from the scratchcard (Figure 4).

> “Automated end-to-end insurance policies based on smart contracts eliminate the need for human processing during their lifecycle. This makes agricultural insurance cheaper, and allows for almost instant payouts when the farmer incurs a loss.
>
> **Jan Stockhausen**
> Chief Legal Architect, Etherisc

Close to 100,000 insurance policies have been issued on Etherisc's platform since the first pilot was started with Acre Africa in 2021. Etherisc has further developed the platform by integrating soil moisture data and creating risk pools in stablecoins (a type of cryptocurrency). After the pilot had demonstrated the technology's efficiency and scalability, Etherisc has started to deploy the insurance platform in other developing countries and has already gone live in a second project with Lemonade Foundation and Pula in Kenya as well as a project in Burkina Faso.

Favourable conditions for blockchain-based climate risk insurance solutions include a supportive legal and regulatory environment for blockchain technology; government-supported farmer training on the advantages of agricultural insurance; and widespread adoption of mobile phones and mobile payment systems.

Preparatory work on the next project have started, where Etherisc collaborates with a number of partners in Uganda to make agricultural insurance more affordable by unlocking additional revenue streams from the voluntary carbon markets that will pay for the premium.

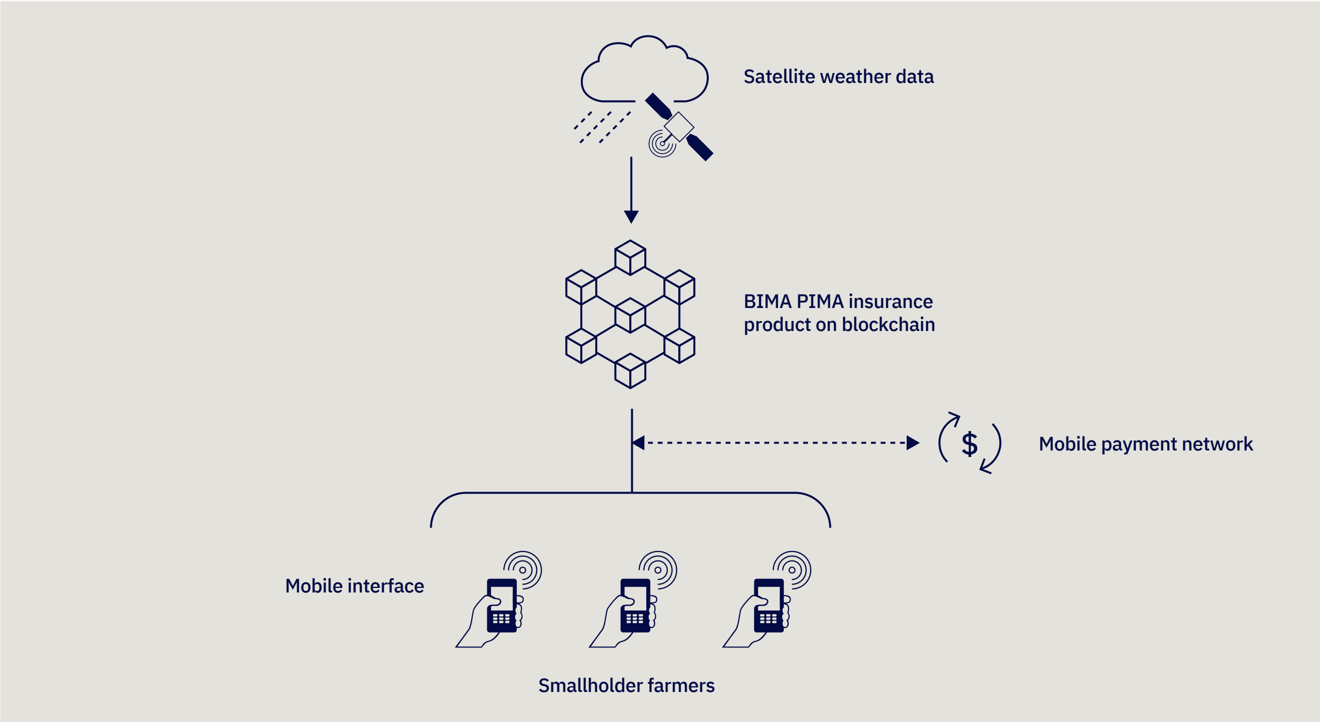
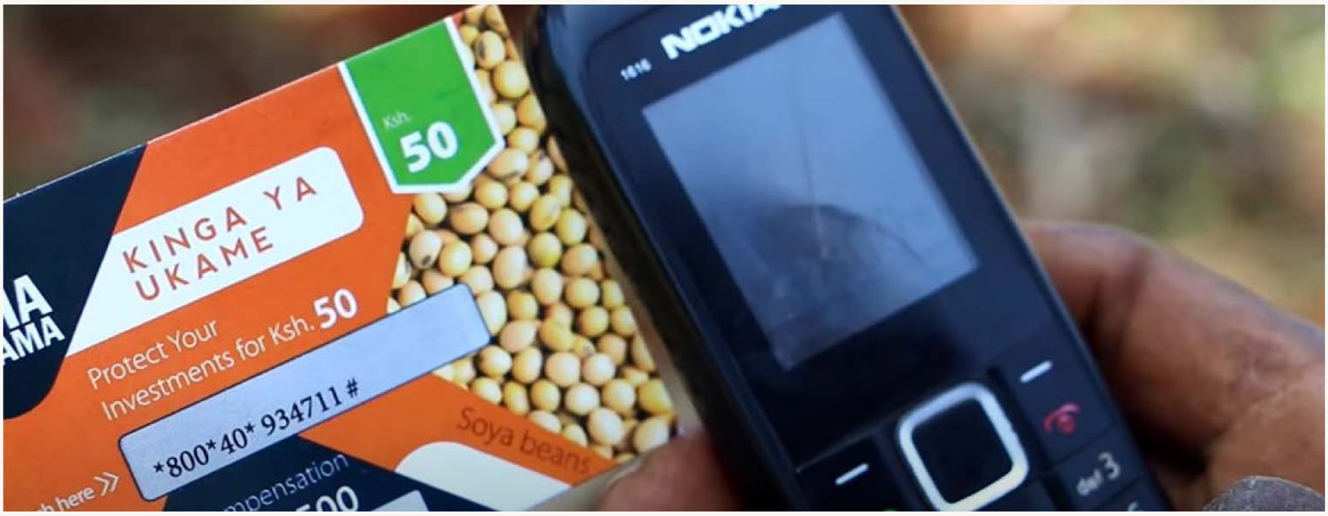
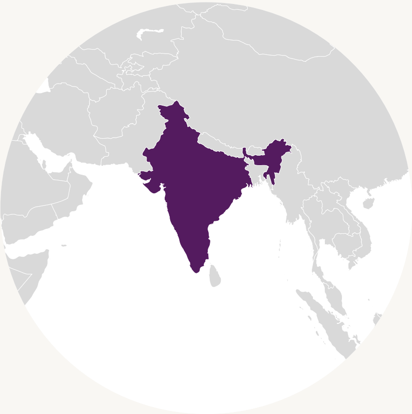


Figure 4: How mobile phone- and blockchain-based insurance enables satellite weather data to trigger direct payments to farmers.



Farmer using the registration code from a scratchcard to activate the insurance policy. Source: Etherisc



INDIA

Smart cookstoves

TECHNOLOGY
Blockchain, sensors and IoT

SECTOR
Energy, environmental monitoring

PARTNERS
FairClimateFund, Nexleaf Analytics, Kinetrix, Janarah Samua Mutual Bene-fit Trust

FINANCIAL SUPPORT
CLI contribution from SDC

SDG3 SDG5 SDG7 SDG9 SDG13

FairClimateFund's aim is to give vulnerable households access to clean cooking technology and empower women throught the use of climate finance. It supplies households with clean cookstoves equipped with cost-effective sensors to monitor cooking practices and transfer the data automatically to a blockchain-based platform to calculate and validate climate impacts.

Cooking indoors on a traditional open fire causes health problems, deforestation, and climate change. The huge social burden falls especially on women, who are often responsible for cooking and collecting firewood. CLI supported a pilot project by FairClimateFund that provided women in 100 households in Raichur, India, with clean cookstoves. The stoves were equipped with heat sensors capable of detecting cooking activity in real-time, allowing for the continuous tracking of stove usage. The data is automatically transmitted to a blockchain-based platform for the calculation and validation of climate impacts (Figure 5). The collection of accurate, robust and trustworthy data enabled the generation of carbon credits offered for purchase on the platform. By eliminating intermediary actors, women gained direct access to the carbon market, increasing their economic independence while also giving them access to cleaner cooking solutions.

In the use case, households used the clean cookstoves for two-thirds of their cooking time, based on data from the heat sensors. Similar projects that rely on survey-based monitoring typically report higher usage rates, indicating the potential for climate impacts to be overestimated. In contrast, IoT-based monitoring provides more accurate and reliable data on emission reductions, enhancing the integrity of any resulting carbon credits.

A challenge to scaling up this application is the absence of blockchain and cryptocurrency regulation in some countries, which can hinder cross-border carbon trading and direct payments to cookstove users. Another is sensor cost and cookstove design. A follow-up project in Rwanda plans to use a wood pellet-fuelled cookstove to generate greater health benefits and carbon savings than the stoves tested in India.

> "It is extremely important that low-cost solutions are available. We firmly believe that lower costs will expedite upscaling.
>
> **Jasmeet Singh**
> Director India, FairClimateFund

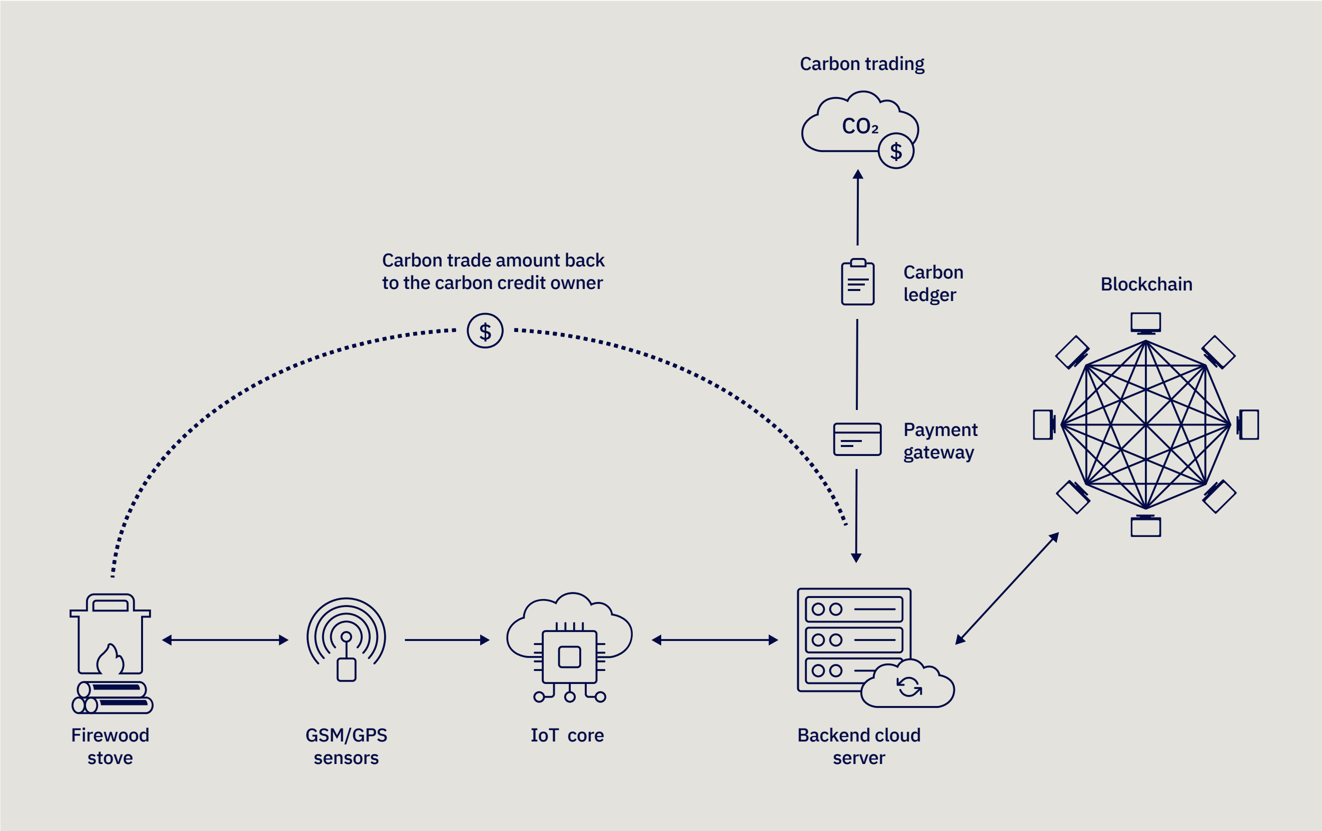


Figure 5: How smart cookstoves can earn carbon credits for rural households. Source: FairclimteFund and non-linear

Handing over a smart cookstove to an Indian woman. Source: FairClimateFund

KENYA

Low-cost indoor air pollution monitoring

TECHNOLOGY
Sensors, IoT

SECTOR
Energy, environmental monitoring, policy support

PARTNERS
EED Advisory, Berkeley Air Monitoring Group

FINANCIAL SUPPORT
CLI contibution form SDC

SDG3 SDG7 SDG9 SDG13

EED Advisory developed and manufactured a low-cost IoT-enabled household air pollution monitoring system to prompt data-driven and appropriate policy action.

Every year, about 4 million people die prematurely from illnesses attributable to household air pollution (HAP), including 23,000 in Kenya. The use of traditional cooking fuels, such as wood, crop waste and charcoal, is a main contributor.

To address this issue, EED Advisory and partners, with support from CLI, developed OpenHAP – a locally developed and manufactured IoT-enabled HAP monitoring system. In a pre-study, the performance of different low-cost air pollution sensors was tested. The best-performing sensor was integrated into an optimised OpenHAP monitoring system that was subsequently deployed in 100 households in two low-income areas of Nairobi (Figure 8). Data recorded by the devices showed that cooking with a wood-fueled cookstove leads to pollution 4–5 times higher than cooking with kerosene or Liquefied Petroleum Gas (LPG). Other factors influencing HAP were also examined. For example, the air exchange rate in a single-room household is considerably lower than in a multi-room household, indicating that people living in single-room households are more exposed to high HAP levels. The results from the study can help to prompt governments to take appropriate policy actions (Figure 6).

The use case demonstrated that low-cost sensors can measure HAP with sufficient accuracy, and thus the feasibility of deploying the monitoring system at scale and over extended time periods.

Experience gained in the OpenHAP project has helped EED Advisory to engage with Kenyan authorities on their air pollution strategies.

Going forward, OpenHAP remains focused on implementing digital monitoring tools in areas like energy, air pollution, and clean cooking to promote sustainability.

> “The information gathered through OpenHAP will inform policymakers in the cooking and clean energy sector, and enable them to launch targeted initiatives to reduce exposure to HAP.
>
> **Martin Kitetu**
> Manager, EED Advisory

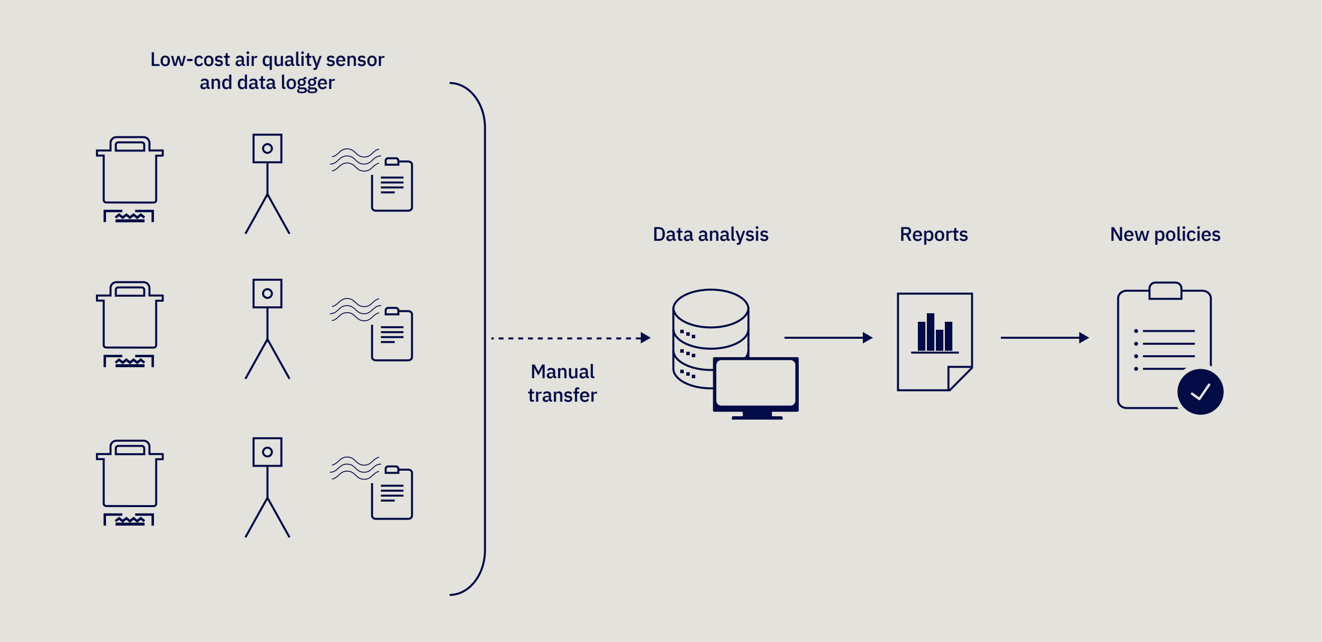
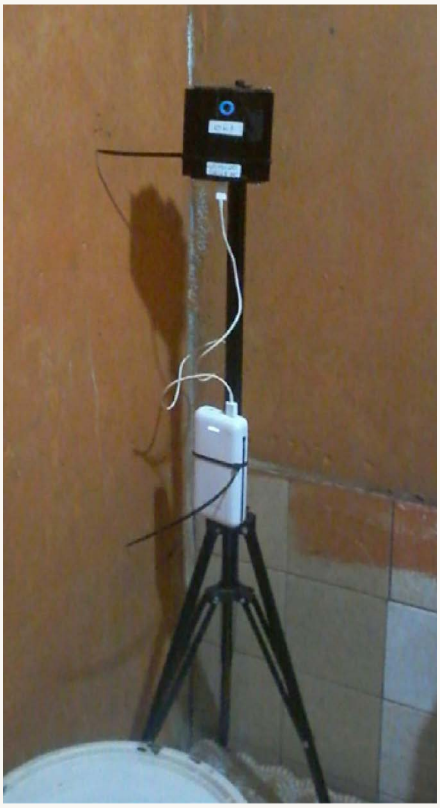


Figure 6: The OpenHAP monitoring systems can contribute to improved policies to combat indoor air pollution.



OpenHAP devices in the cooking area of one-roomed households in Nairobi. Source: EED Advisory

INDIA & NIGERIA

Digital dashboard to reduce foodwaste

TECHNOLOGY
Remote sensing, AI, sensors

SECTOR
Agriculture, supply chain optimisation

PARTNERS
BASE Foundation, Swiss Federal Laboratories for Materials Science and Technology (Empa)

FINANCIAL SUPPORT
CLI contribution from SDC, GIZ

SDG1 SDG2 SDG5 SDG7 SDG8 SDG9 SDG10 SDG12 SDG13

Your VCCA ("Your Virtual Cold Chain Assistant") aims to improve cold room management and reduce post-harvest losses for farmers. A new impact dashboard for the project's Coldtivate app will allow cold store operators to easily track and analyse the effects of their operations on their business, farmers, and the environment.

Many smallholder farmers and market sellers worldwide lose income because they lack access to a proper cold chain. The Your VCCA project aims to fill this gap to improve livelihoods while also reducing food waste and carbon emissions.

Your VCCA has collaborated with solar-powered, decentralised cold room providers in India and Nigeria to reduce post-harvest losses of horticultural crops. It replaces manual registers by providing the free-to-use, data science-driven Coldtivate app that enables farmers and cold room providers to optimise their production and management decisions and gain access to affordable and sustainable cooling solutions. Based on scientific knowledge on the perishability of food and temperature sensors in the cold rooms, farmers receive real-time information on their stored goods, including assessments of when to sell them to maximise their market value. The app also allows cold room operators to track performance, finances, and cold room occupancy. (Figure 7).

Cooling companies and farmers have struggled to consistently map and showcase their impact due to the absence of a unified methodology and centralised platform. With support from CLI, Your VCCA is now working on integrating a new impact dashboard into the Coldtivate app. With this innovative tool, cold store operators will be able to easily track and analyse the effects of their operations on their business, farmers and the environment.

> "Your VCCA aims to reduce food loss for smallholders by 20% and increase their yearly income by nearly 30%.
>
> yourvcca.org

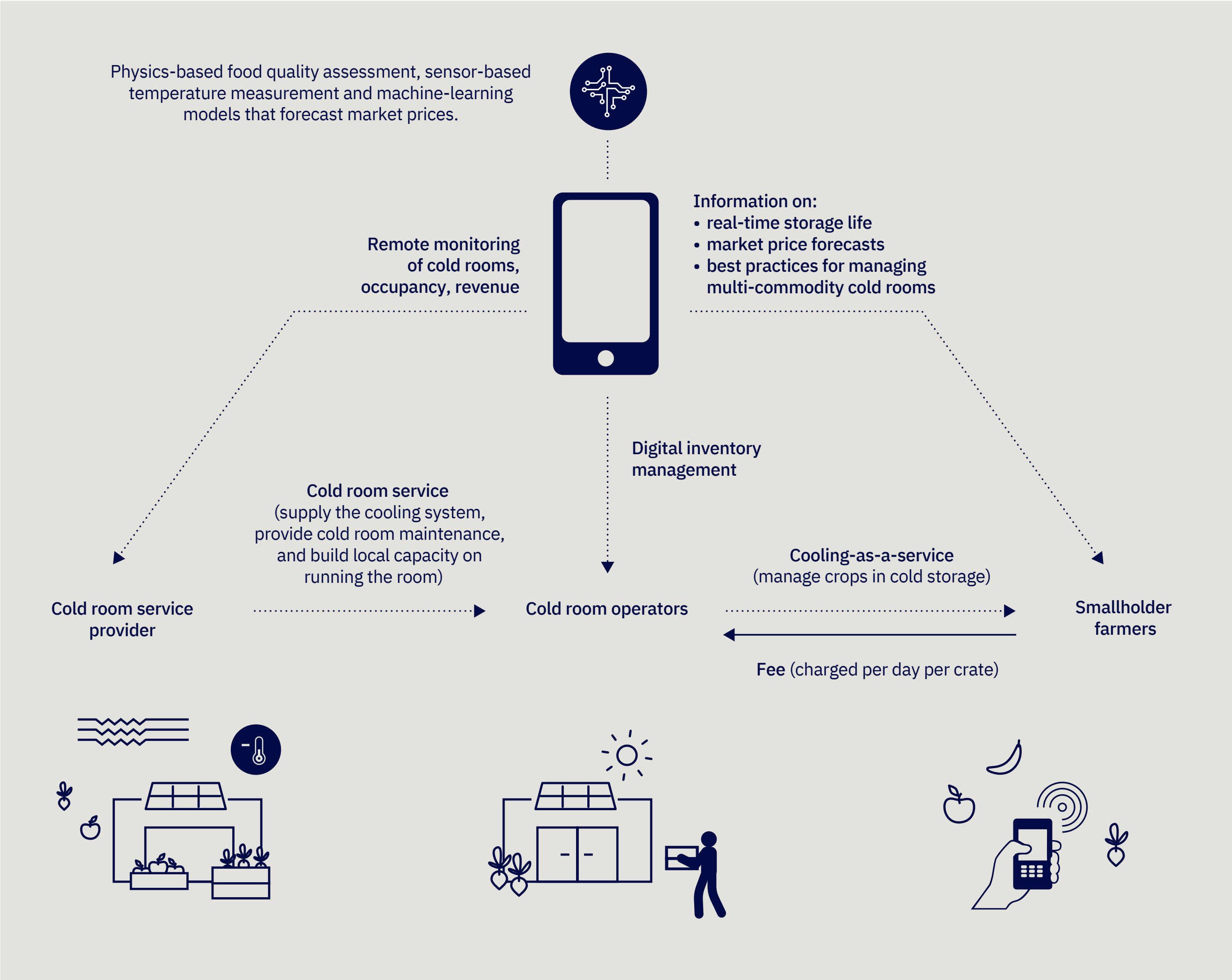


Figure 7: How the Coldtivate app benefits cold room operators and farmers. Source: Your VCCA

Extract from a brochure training farmers to use the Coldtivate app. Source: Your VCCA

CHILE

Green action tracker

TECHNOLOGY
Blockchain, sensors and IoT, AI and big data

SECTOR
Energy, water, transportation, waste, policy support

PARTNERS
EnergyLab

FINANCIAL SUPPORT
CLI contribution from SDC, EnergyLab and local partners

SDG6 SDG7 SDG9 SDG11 SDG12 SDG13

Green Tracker is a transparent and traceable tracking system for environmental results from actions such as renewable energy generation, e-mobility, recycling and reducing water consumption. It aims to provide high-integrity data that can support the transfer and/or sale of environmental assets such as carbon credits.

Monitoring, Reporting, and Verification (MRV) is a crucial component of climate action reporting. Without robust MRV systems, the proper tracking of greenhouse gas emission reductions, claiming of carbon credits or reporting about mandatory or voluntary mitigation actions become challenging. Conventional tracking systems are often neither efficient nor scalable and have low credibility because they are prone to errors.

Green Tracker is a locally developed blockchain-based platform for the calculation, monitoring and verification of environmental benefits. CLI supported Chilean company EnergyLab in enhancing the functionality of the platform by incorporating an automated MRV system for environmental benefits from renewable energy generation, e-mobility and material management and recycling (Figure 8).
In recycling facilities, machine learning enables the platform to distinguish different types of waste. For e-mobility providers, the platform tracks vehicle movements and calculates resulting emission savings and other environmental benefits. Additionally, emission savings are monitored remotely for solar and wind power plants.

The platform allows users to build trust and confidence in their environmental performance and/or environmental assets. It uses internationally approved methodologies to calculate and cross-check benefits, and allows users to publish and exchange the results through a publicly available registry. The platform can also be used to sell tokenised enviornmental assets (i.e. digital representation of real physical assets on a blockchain or other distributed ledger technology) like carbon credits and energy or water savings. Currently, Green tracker is monitoring large-scale wind and solar power plants as well as electric fleets. It has been used to track more than 200,000 tonnes of CO2 reductions and 243,000 renewable energy attributes during the first nine months of 2023.

Key challenges and lessons learned include the importance to choose environmentally friendly blockchain technologies, while also defining a right balance between data comprehensiveness and cost-effectiveness of the solutions. Other valuable insights relate to protocols that facilitate the restoration of data gaps, prevent conflicts with existing data blocks, and mitigate losses in internet connectivity.

> “The more standardised the data and sensors, the easier and faster the system can be deployed. This is critical to achieving the desired scalability and environmental impact.
>
> **Cristián Mosella**
> Co-Founder and Managing Director, EnergyLab

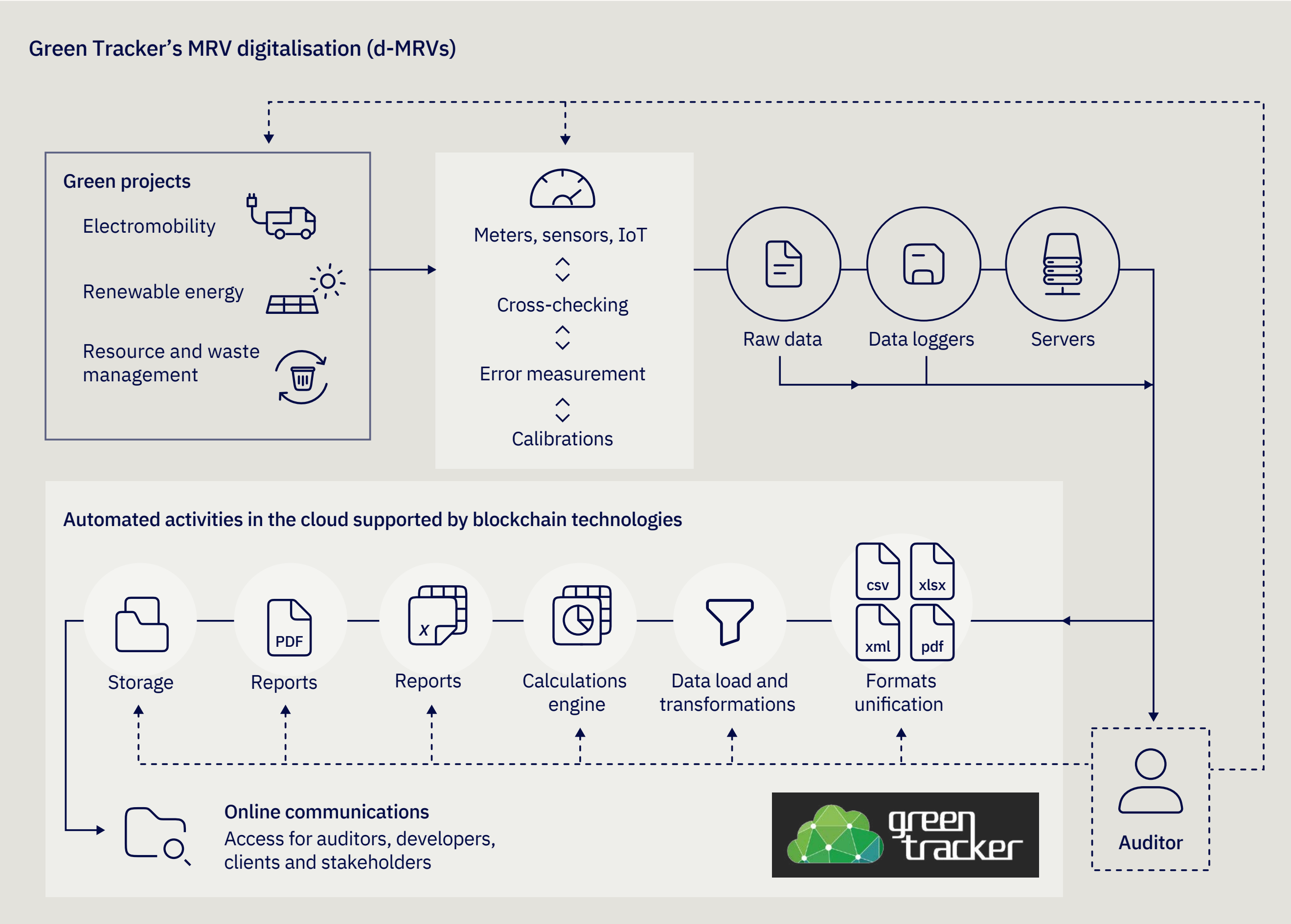
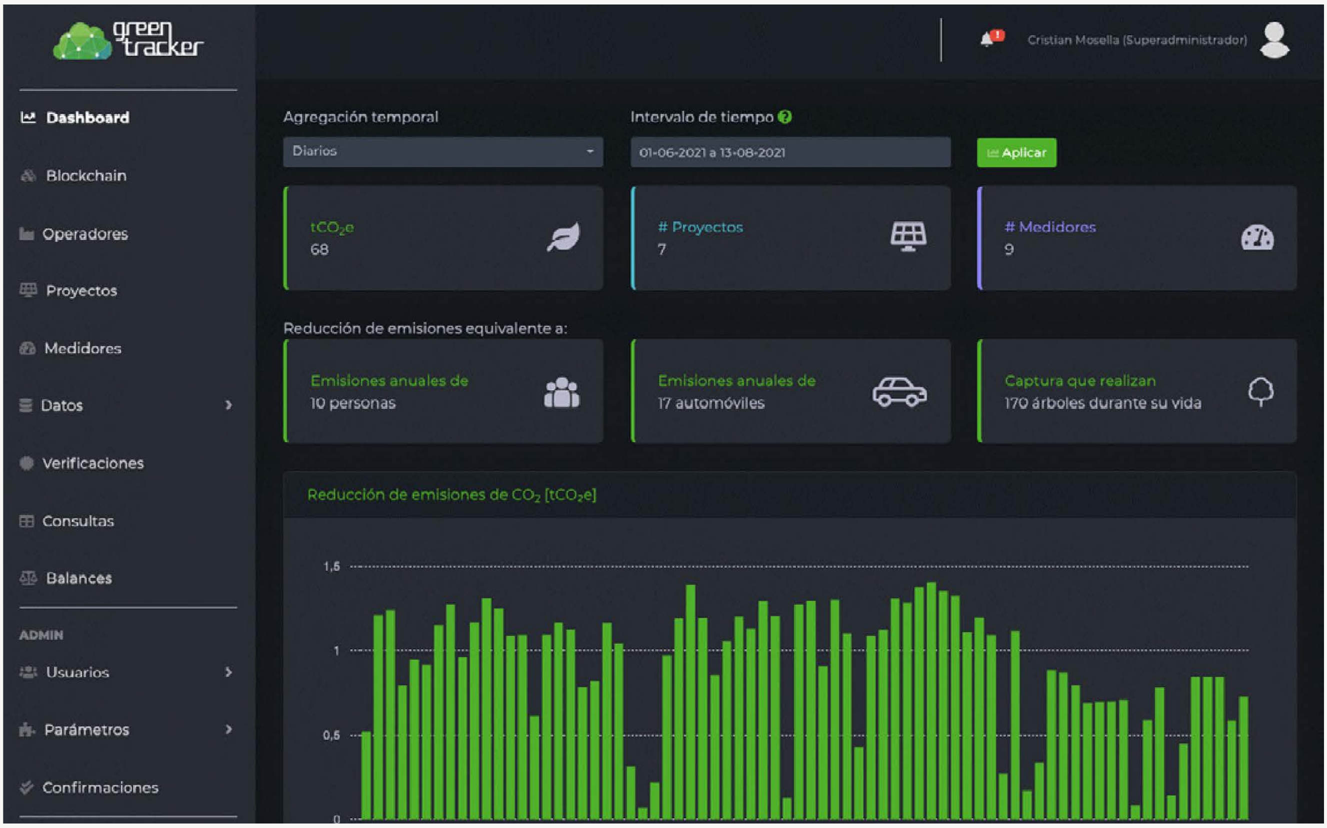
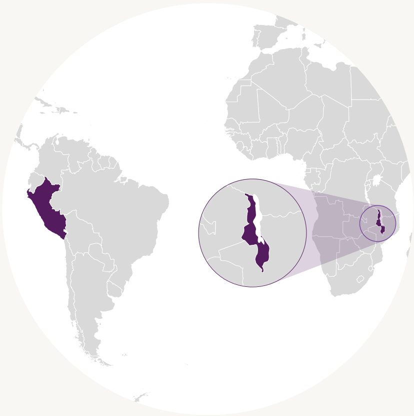


Figure 8: Green Tracker replaces conventional monitoring, reporting and verification with digital processes processes supported by blockchain technology. Source: Green Tracker



Green Tracker's dashboard, showing CO2 reductions in a given period. It also indicates the number of projects and IoT devices connected. Source: Green Tracker



MALAWI & PERU

Land use and biomass monitoring

TECHNOLOGY
Remote sensing

SECTOR
Forestry, agriculture

PARTNERS
UNICEF Yoma (Youth Marketplace Agency), Wyss Academy for Nature, Bio-verse Labs, European Space Agency, Wells for Zoë, INFRAS, Geoville, Hat-field, CLS

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SDG1 SDG4 SDG8 SDG9 SDG13 SDG15

The Yoma Ground Truthing project aims to verify the concept of combined use of remote sensing (including satellites and drones) and youth-based ground truthing for monitoring biomass and related sustainability attributes.

Remote sensing is widely used in various fields, including agriculture and environmental monitoring. However, its reliability and accuracy can be imperfect and ground truthing can be essential for validating and improving the accuracy of remote sensing data. For this reason, CLI is supporting use cases in Peru and Malawi to test the combined use of remote sensing and youth-based ground truthing.

In Peru, road development – especially a new highway connecting Peru and Brazil – is leading to land use change. in the southeast of the country. The Yoma Ground Truthing project aims at capturing changes in land use and biomass in the region.

In Malawi, ecosystem restoration projects lack monitoring data during the initial years. High-resolution satellite imagery alone is not sufficient for monitoring tree growth. The Yoma Ground Truthing project aims to validate remotely sensed hotspots of low/high tree growth with ground truth data (Figure 9).

Both explore the potential of combining local observations by youth equipped with smartphones with data from satellites and drones. The aim is to learn about the feasibility of the combined approach in a concrete setting.

In these ongoing projects, remote sensing specialists have prepared geospatial datasets and are identifying regions where ground truth data might be of particular value. A mobile application for the ground truthing activities has also been developed. Preparations for initial tests with young people performing ground-truthing activities in the field are currently underway.

> “The Yoma platform incentives personal growth of youth with digital tokens that can be swapped for digital services or physical goods, such as credit for mobile phones or access to skill building courses.
>
> Yoma

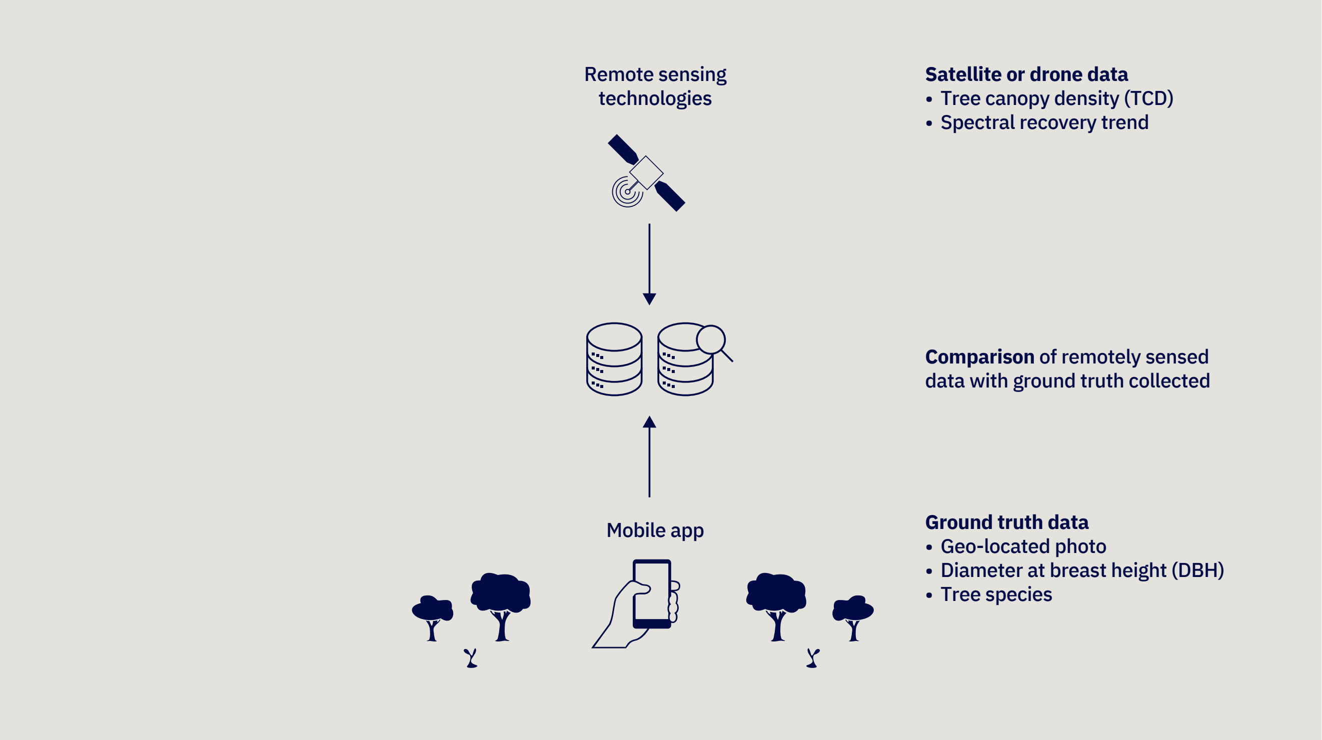
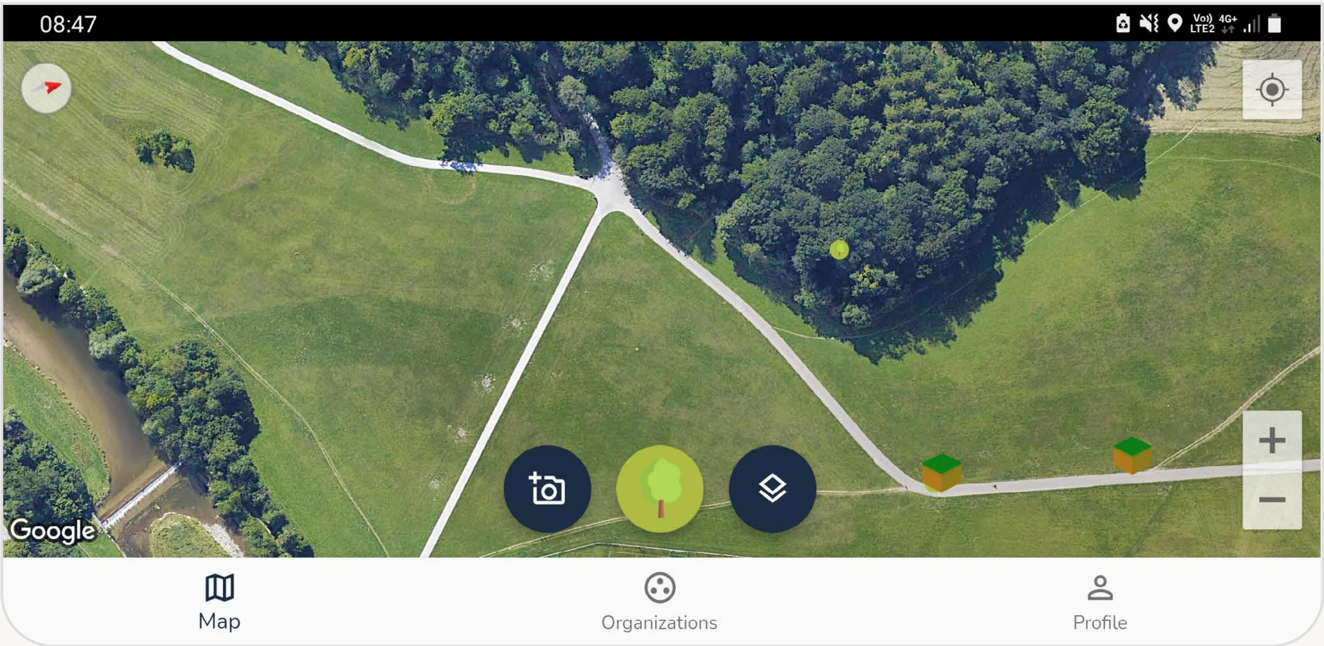


Figure 9: The concept behind the Yoma Ground Truthing Monitoring use case to validate reforestation in Malawi.



Yoma Ground Truthing's mobile app provides the locations and information for collecting ground truth data.

PERU

Digital technology assessment

TECHNOLOGY
Remote sensing, sensors

SECTOR
Water, agriculture

PARTNERS
Helvetas

FINANCIAL SUPPORT
CLI contribution from SDC

SDG6 SDG9 SDG12 SDG13 SDG15

The digital technologies for ecosystem services (DTES) use case identified opportunities for digitalisation to improve monitoring, increase participation and enhance transparency in a project to improve water management in Peru.

The project Aguas para Abancay aims to guarantee the availability, provide equitable access to, and strengthen the responsible use of water in the Peruvian city of Abancay and surrounding communities. With support from CLI, the project team initiated the DTES use case to assess challenges in terms of monitoring, participation and transparency and identified potential digital solutions to address them.

DTES consisted of a review of the Aguas para Abancay project documents as well as workshops and discussions with project stakeholders. It was inspiring to realise the existing knowhow within the project team and the possibilities to leverage on this for drafting solutions. This collaborative and inclusive process identified two opportunities for the use of innovative digital technologies to overcome key challenges (Figure 10):

- **Remote data collection:** Water availability data gathered by sensors is collected manually and irregularly, meaning that the population of Abancay does not receive accurate and timely information. To improve data collection, the use case proposes the creation of an interconnected sensor network to allow the remote collection and storage of data, as well as real-time data access and a model to generate forecasts and information about water availability and present or future risks.
- **Access to stakeholders and information sharing:** Digitalisation can also address challenges related to a lack of participation, awareness, and information regarding water and water scarcity. DTES proposes a variety of technologies to deliver targeted communication, including alerts about water availability, such as social media and SMS. Communication could also be supported by the use of analytics and a general website, including information on where the water comes from and what the regular payments are used for.

> “The DTES use case can serve as a blueprint where possibilities for digitalization to overcome challenges in existing projects are identified through a structured process.
>
> **Jürg Füssler**
> Managing Partner, INFRAS

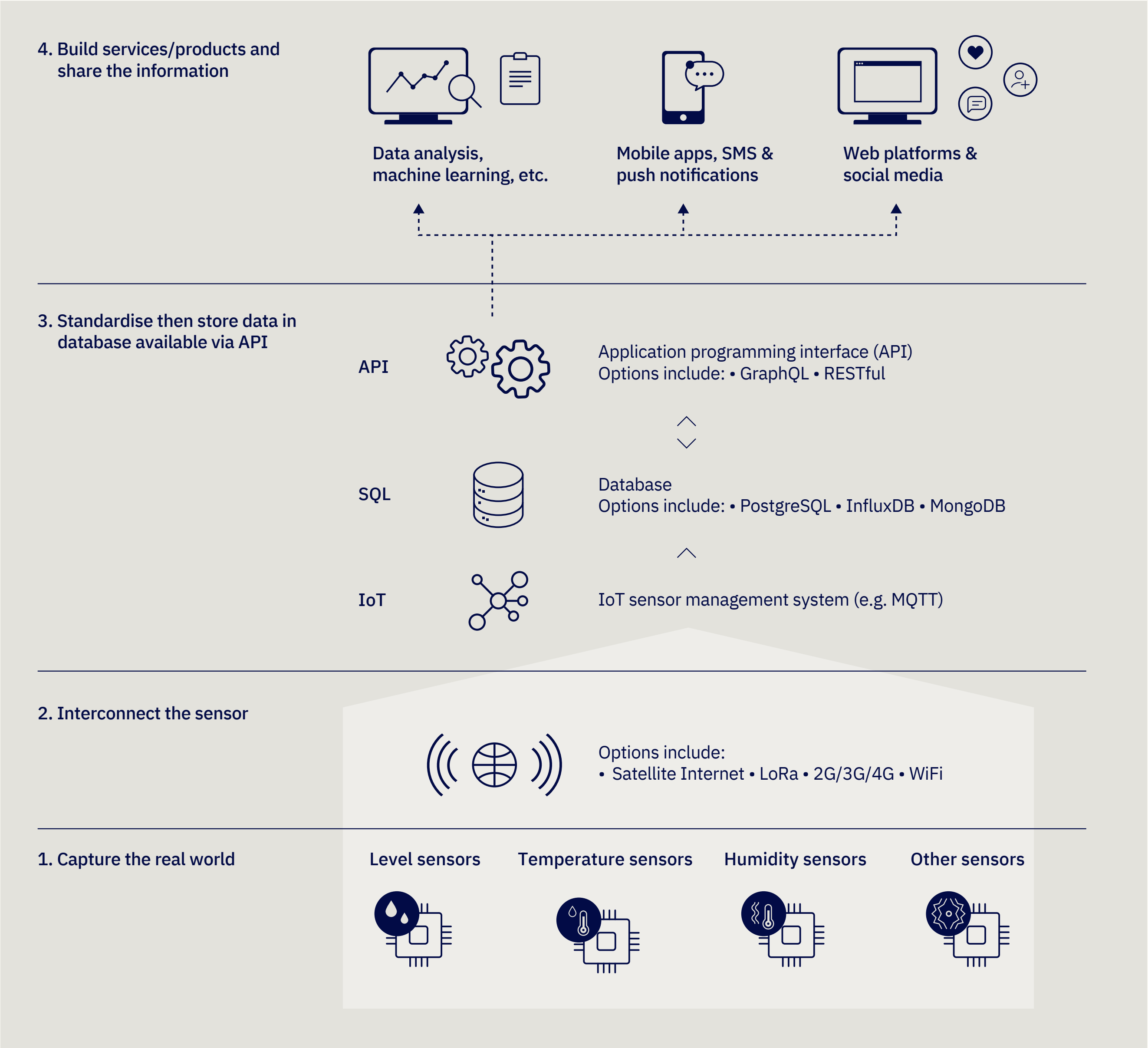


Figure 10: Proposal to improve data collection, monitoring and participation in the Aguas para Abancay water project. Source: Aguas para Abancay project.

Digitalisation can help to turn data from weather stations, such as this rainfall gauge, into timely information on water availability. Source: Jan R. Baiker

CLI has drawn on the experience and lessons learned from DTES and other use cases to create a step-by-step guidance on how to identify the potential for digital innovations to improve the design and implementation of development projects.

Key lessons learned

The work of CLI and its partners since 2017 has demonstrated that digital technologies can drive climate action. Key lessons learned from our work and CLI-supported uses cases can be summarised as follows:

01

Build on available local technologies and knowhow where possible:

Depending on the local circumstances, many different technological solutions may already be available. Profiting from local technological knowhow leads to more sustainable and long-term solutions. Merely relying on popular technologies and international expertise adds additional risks. For example, the CLI OpenHAP use case developed a low-cost sensor to measure indoor air pollution locally. This was then tested and calibrated for broader use. Similarly, the CLI Green Tracker use case developed their own platform based on blockchain and the recognition of waste composition based on AI.

02

Low-cost and open-source options are key to upscaling:

When it comes to environmental monitoring, bringing down the costs of remote data capture is key. High sensor costs are an obstacle to upscaling data monitoring. In some instances, low-cost technologies may be used, if their potential lack of accuracy is offset by better statistical approaches, such as a much greater number of data points, to generate reproducible results of sufficient quality. Low-cost options are supporting the upscaling of technical solutions for climate action. Open-source data and code enable collaboration, profit from existing solutions and improvements in verifiability, and support scaling and sustainability. For example, the CLI OpenHAP use case demonstrated that low-cost measurement devices can provide a good option to assess indoor air pollution and therefore impacts on health. In addition, the data collected facilitates studies on a larger scale.

03

Find solutions for limited internet connectivity:

Many pilot projects rely on mobile phones or the internet. Over the past decade, networks have expanded rapidly, providing access to an increasing proportion of the world's population. However, connectivity is often still poor, especially in more remote rural regions. Therefore, solutions that also work independently of internet connectivity and allow data transfer and updates at a later stage when connectivity is available again are important. The CLI Wood Tracking Protocol use case, for instance, allows wood to be registered with a mobile phone and data to be uploaded to the platform at a later stage.

04

Check for technical and non-technical interoperability:

Interoperability between different digital systems is essential for solutions to work. This is particularly important for technical aspects, so that proposed solutions can talk to each other and be connected to relevant existing digital systems. The lack of interoperability and wide range of standards, often in the context of proprietary digital systems, are a major obstacle to the seamless implementation of different technologies in different sectors, and the related scaling. In addition, interoperability extends beyond the technical aspects and is also required for institutional or legal aspects, for example. The CLI Wood Tracking Protocol use case showed the importance of checking the interoperability of the blockchain-based approach with timber companies' IT systems, as well as the local authorities' current approach to wood tracking.

05

Keep it simple:

Digital solutions have been hyped up on various occasions in recent years. It is essential to consider rationally whether a digital solution really offers additional benefits compared to simpler or even analogue solutions. Digitalisation should not be an end in itself. Depending on the project, an Excel-based solution might provide a better and more versatile solution than introducing a blockchain, for example. Or using existing apps that most users have on their smartphones might provide a better communication channel than a new and customised online platform.

06
Data protection and governance are key:

Data protection refers not only to traditional data protection such as backups and archives, but also to data security and data privacy. Protecting data from corruption, compromise or loss is also key to digital solutions for climate action. What data is collected, used and shared must be clarified thoroughly. Particular attention is needed to provide solutions that comply with current laws on data protection, such as the European Union (EU) general data protection regulation (GDPR), that also affect organisations outside the EU that collect and process the personal data of EU citizens and residents. While data protection and governance were relevant in most use cases, the issue was addressed in depth in a report on governance and blockchain produced jointly by CLI and the International Association for Trusted Blockchain Applications (INATBA).

07
Engage local and national authorities:

For new digital tools to succeed in practice, a particular effort is needed to inform relevant national and local authorities to get them on board. Sufficient time for collaboration with the relevant authorities is perceived as a key element in understanding local circumstances and regulations with regard to digital approaches. In this way, government actors can be helped to understand the potential and limits of innovative digital technologies. They are also empowered to assess how use cases can support government efforts and design tools that complement governmental work. The CLI Wood Tracking Protocol use case, for example, shows how important it is to engage early on with local authorities to explain the blockchain-based approach and possibly integrate the digital solution into a public system.

08
Digital solutions can enhance data availability:

Low-cost sensors and other remote sensing options can enhance data availability and accuracy. There is often a lack of reliable empirical data as a sound basis for policymaking, carbon credits with a high degree of environmental integrity, or other measures for climate action. In addition to more available and more accurate data, digital solutions also allow data for enhanced climate action to be analysed and presented in good time. In the CLI use case from FairClimate-Fund, for example, accurate, automated monitoring of cooking data in India ensured that emission reductions are calculated correctly, without overestimation. Similarly, the CLI Green Tracker use case showed how AI-based data analysis can provide timely information on, say, waste. Finally, the Yoma ground truthing project improves the availability and accuracy of data on biomass by combining satellite data and data collected on the ground by youths on their smartphones.

09
Digital solutions can enhance trust:

Trust can be increased in various ways by digital solutions. Digital applications allow for a direct flow of data from the sensor or IoT device and lower the need for manual data entry, significantly reducing errors. This improves the credibility of the available data. In addition, the immutable nature of blockchain applications can generate increased transparency and trust for its users. Finally, digital solutions allow transaction costs to be avoided and prompt direct transfers of information or money without any intermediary. The CLI use case by Etherisc for crop insurance in Kenya used blockchain technologies to automate an insurance product for farmers. They could reduce costs and increase confidence in the product. Digitalisation and the use of mobile phones increases transaction speed, allowing payments to farmers in near-real time, in contrast to the weeks or months of delay with conventional systems. The CLI Your VCCA use case, that provides an app for cold room operators and the farmers using them increases trust. Farmers have up to date information on food quality and their stored products. Cold room operators can make their management of cold rooms visible, and more easily access loans for new cold rooms.

10
Seed funding enables the testing of digital innovations for climate action:

The CLI-supported use cases have shown how modest financial support makes it possible to test key ideas in the form of a “minimal Viable Product” (MVP), identify how digital technologies can solve problems and learn from the results. Identifying use cases that offer good prospects of success are key to attracting the funding needed for solutions to climate action to be scaled up.

CLIMATE LEDGER INITIATIVE

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