

The smart climate observation network that covers all Africa

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Weather data
for agriculture

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Weather Data: a vital component to the agriculture value chain

Chipo Msengezi and Dorah Nesoba

All agricultural stakeholders have an interest in accurate, localised and reliable meteorological data. Having access to such data means that organisations and entrepreneurs can translate raw weather data into accessible weather information, which is crucial for farmers to make well-informed farm management decisions and for effective risk mitigation.

Weather data and services have a high potential to enhance support for smallholder farmers in taking operational decisions on farm management. Plant growth is driven by weather variables and therefore agricultural production is directly dependent on weather conditions. Many agricultural activities (e.g. sowing, harvesting, and fertiliser application) are dependent on weather conditions for planning and effectiveness. Given this, all agricultural stakeholders are interested in some form of meteorological data.

Data has risen high on the food security policy agenda.

Access to open data and particularly weather-related data was identified as a key factor in transforming agriculture and nutrition by the G8 in 2013. Open data is simply defined as data that can be used, re-used, shared and built-on by anyone, anywhere, for any purpose. By making meteorological data available as open data it not only becomes easier to share, but also allows the development of specialised information services by infomediaries targeting specific user needs and the prediction of suitable conditions for farm activities.

Climate change presents major risks for long-term food security and low and middle-income countries may suffer the greatest share of damage in the form of declining yields and greater frequency of extreme weather events. The 2017 FAO publication “The future of food and agriculture: Trends and challenges” estimates an aggregate negative impact of climate change on African agricultural output up to 2080-2100 to be between 15% and 30%. The necessary production increases need to come primarily from increases in yields and cropping intensity, however, the current trend is not sufficient to meet food needs.

Access to weather data

The challenge is therefore for technology to address this problem. Data has risen high on the food security policy agenda. The last decade has seen an exponential increase in the volume and types of data as the benefits for agriculture are potentially huge. Releasing the enormous stock of data will encourage cooperation and collaboration to solve long-standing and evolving problems, benefit farmers, provide informed based decision for businesses and policymakers and will improve the health of consumers. In many areas of the world, agriculture is already a data-driven business, with precision farming making extensive use of GPS, weather, and satellite data, alongside soil information and crop production statistics.

In an effort to address the global agriculture challenges with open data, the Global Open Data for Agriculture and Nutrition (GODAN) Action project focused on accessible weather data in 2017. The partners collaborated on several events, to identify ways to better provide value added services for smallholders using open weather data in developing countries.

Investing in infomediaries

During the Africa Hydromet Forum, in Addis Ababa, 12-15 September 2017, the Technical Centre for Agriculture and Rural Cooperation (CTA) partnered with Regional Centre for Mapping of Resources for Development (RCMRD) as part of the GODAN Action project hosted a side event titled “Leveraging Weather Data for Agriculture and Nutrition Challenges in Africa” on 12 September 2017. The panel session determined that by making meteorological information available as open data, it not only becomes easier to share, but also allows the development of specialised information services by infomediaries targeting specific user needs measures, and the prediction of suitable conditions for farm activities. It concluded that the weather and meteorological service community needs to act quickly to provide weather data and open data in order to meet the goals of 2030 UN Agenda for sustainable development and in particular food security.

The Hydromet forum closed with a firm commitment from AMCOMET member-states to promote national and regional ownership for the modernisation of national meteorological and hydrological services for delivery of more accurate, timely and reliable weather, water and climate services to accelerate socio-economic development.

Creating impact for smallholders with weather data

Another major event in 2017 was organised on 21 and 22 November 2017 by CTA with partners Ministry of Agriculture, Nature and Food Quality in The Netherlands, GODAN Action, and Wageningen University & Research, who together hosted two workshops titled “Using weather data to support smallholder agriculture in Africa” and “Creating impact for smallholders with weather data”.

The purpose of the workshops was to share experiences and learning from existing initiatives that focus on providing added value services for smallholders using (open) weather data. It focused on ways to achieve impact for smallholders and the role of standards and capacity building. The workshops brought together actors from different networks to discuss good practices for the application of weather data and viable business models that all actors in the data value chain to co-create value added services in an international context that generate impact for smallholders.

The findings from the two workshops indicated that it will require collaborative efforts and partnerships to develop viable business models for the producers of the data; entrepreneurial incentives for intermediaries to develop localised services from raw weather data; increased engagement with farmer communities; increased use of open data standards for increased data interoperability and the addressing of major capacity gaps in the open weather data value chain.

Data value chain

This issue of ICT Update portrays how various stakeholders in the data value chain are working with and creating agriculture services from weather data while showcasing some of the best practices and the most common challenges in this field. ●



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Nesoba is Communications and Outreach Expert at RCMRD.

Related links

RCMRD's open data portal
<http://opendata.rcmrd.org/>
GODAN Action webpage
<http://www.godan.info/godan-action>

Using weather data to support smallholder agriculture in Africa

Evert-Jan Quak

Providing added value services for smallholders using open weather data in developing countries is challenging. Therefore, on 21 and 22 November 2017 practitioners, policy-makers and academics gathered in The Hague, the Netherlands, to explore in two workshops the practical and strategic challenges they face to work with open weather data and how to address them.

The two workshops were part of GODAN Action (Global Open Data for Agriculture & Nutrition), a three-year project funded by DFID that seeks to enable data users, producers and intermediaries to engage effectively and practically with open data in a developing context, and maximise the potential for impact by building the capacity of stakeholders. Open and accessible climate and weather data was chosen as GODAN Action's first thematic topic to become a catalyst for business development and capacity development with the aim to put research into practice and achieve impact.

An important outcome of the workshops is the acknowledgement that providing weather data based support to farmers goes beyond being familiar and being able to work with weather data. It requires a broader view on standards, entrepreneurship, partnerships and ways to combine all kinds of data. The two workshops enabled a

better understanding of the opportunities and challenges of open weather data for smallholder farmers and gave stakeholders knowledge and insights to establish improvements in the open weather data value chain.

Challenges

During the two workshops many challenges for the further development of open weather data and its infrastructure were mentioned by the participants. For example, one challenge is to ensure that data remains accessible and services that are built around open weather data are affordable for end-users, like smallholder farmers and farmer organisations. However, weather data is often regarded as a strategical and commercial asset, as data means control and meteorological departments are under pressure to earn money themselves.

Even with complete freedom to innovate with open weather data, people will face limitations because of bureaucracy and regulations. For example, who regulates the introduction of innovative weather services? Other constraints to make weather data more accessible to farmers, farmer unions and extension workers is that the context is rather technical. It requires significant knowledge and capacity to collect and analyse the data. High investments in capacity development are needed to add value to translate data into timely, localised, readable and useable information. In the development context, though, capacity and skills are still lacking behind.

Value chain approach

The participants agree during the workshops that the open weather data value chain, which includes data providers, intermediaries that translate weather data into services, and the consumers, must be demand-driven and as short as possible to reduce costs and make services cheaper.

A farmer centred approach is necessary to create impact with open data as there is no one-way direction of providing weather services to farmers, as service providers should integrate into their products local structures, local languages and indigenous knowledge. Rural communities can also play a vital role in weather data collection and maintaining remote weather stations with citizen observatories. Hence, co-creation in the value chain could increase much needed levels of trust with local stakeholders.

Four areas of interest were identified on which open weather data can have immediate impact for farmer services: weather forecasting, weather alerts, index-based insurances and improved farming monitoring tools. Enablers for impact for these areas of interest that were mentioned during the workshops are capacity building (tailor-made for all stakeholders in the value chain), financing (of resources and aggregation as costs come down with larger farmer groups), infrastructure (as more weather stations need to be equipped, maintained, and more technical support is needed for data collection and analysing), communication channels (to connect supply with demand), and policy (as governments can increase incentives for investment and collaboration).

Business opportunities

Fortunately, there are several opportunities for the further development of open weather data to achieve impact. Better satellite data and data from drones help to improve weather data collection. Also, integration of weather data with geo-data becomes easier through ICT solutions. It was also mentioned that there are increasingly better entrepreneurial opportunities in Africa, like support for business innovation that increases creativity. Young entrepreneurs are more likely to work in agriculture by making use of ICTs. Finally, pilots with crowdsourcing show the opportunity of citizen science, although there are still challenges to check data quality and how this implicates with standards.

The key issue for sustainability are solid business models, beyond project funding and subsidies. It is not an option to provide localised services for free and expecting them to continue in the long term. When funding stops, projects stop and in-worked teams break-up. It is the bundling, packaging and selling that is the way forward to create business models; less focus on stand-alone weather information services. Another solution could be for farmers to pay just a small subscription fee after they can choose between a premium and freemium service, where premium is paid for highly specialised services. Adding advertisements to services is what some entrepreneurs do as well.

Partnership and collaboration

Co-creation in the open weather data value chain requires collaboration with many stakeholders. In such way they

create trade-offs between initiatives and stakeholders on which competition can be channelled. Governments should drive this process to create the best environment in which multi-stakeholder partnerships can thrive. Currently, government actors are not moving quickly enough to do this. Therefore, it is key to motivate private sector and farmer organisations and cooperation to become the main drivers that work together with national meteorological services. This is only possible with a clear business case or if new markets can be reached. To become attractive for business it is important to focus on: reliability, affordability, branding and marketing.

More is needed to guarantee verifiable, quality weather data. That is why the introduction of standards is important: it creates reliable markets, quality checks for data and guidance to improve specific tasks and skills. It seems for now that for observational data, one of the issues is that different stations work with different standards and produce data that are not easily and straightforward to merge. It would be a step in the right direction if some collaborative work was done to improve on this. The GODAN Action map of standards and the work on weather data standards of ODI can be a first start.

Action agenda

One of the key results of the workshops is the start of a Community of Practice that will map partnerships and leverage existing networks with the aim to improve the open weather value chain and provide management advice to smallholders. It will share knowledge on the use of crowdsourcing, citizen observatories, inclusive business models and cost-effective structures. The community will not be financially driven, but solution driven to motivate stakeholders to participate.

The assurance was given to look for practical ways to make the value chain more demand-driven, for example with knowledge platforms where farmers and farmer organisations can engage and share with other stakeholders their issues with weather data, feed-back mechanisms and needs. Hackathons will be used to engage with young entrepreneurs to look for innovative solutions and make use of open weather data. Furthermore, participants promised to clarify and communicate better about the benefits of open weather data for agriculture. ●



About the author
Evert-Jan Quak is a freelance research editor for ICT Update magazine.

Related links
Article and video from the workshops
<https://goo.gl/HfhUNw>

It is key to motivate private sector and farmer organisations cooperation to become the main drivers of open weather data that work together with national meteorological services.

The suitability of existing open data weather data for agro-meteo advisory

Tomaso Ceccarelli, Allard de Wit and Rob Lokers

Open data in the weather domain could address the information needs of agro-meteo farm advisory systems. However, is open data 'fit-for-purpose'; does it match the needs of being reliable, relevant, timely and accessible? Some answers come from the CommonSense project targeting smallholder farmers in Ethiopia.

With relevant, reliable, timely and accessible weather information, smallholder farmers can make important farming decisions, especially for the semi-arid to arid environments such as those found in Ethiopia. Therefore, weather information, in the form of forecasts and Near Real Time (NRT) observations or estimates, is essential for any farm advisory system targeting smallholder farmers.

Is open data best suited for agro-meteo advisory services to smallholders?

Open data in the weather domain could address the information needs of agro-meteo farm advisory systems. However, is open data 'fit-for-purpose'; does it match the needs of being reliable, relevant, timely and accessible? Some answers come from the CommonSense project targeting smallholder farmers in Ethiopia.

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The CommonSense project is exactly working into this, by bringing together Communities and Sensors in Ethiopia. The project is funded under the Geodata for Agriculture and Water (G4AW) facility of the Dutch Ministry of Foreign Affairs and executed by the Netherlands Space Office (NSO).

Although having a broader scope, CommonSense has an important weather service component, which runs in collaboration with the National Meteorology Agency of Ethiopia (NMA) and the Sesame Business Network. Partners in this component include the Dutch weather services company Weather Impact, the Ethiopian IT company Apposit and Wageningen Environmental Research, also based in the Netherlands. One of the aims of the project is to assess what weather information should be part of a national agro-meteorological advisory system. To achieve this, CommonSense works with the Federal Ministry of Agriculture and Natural Resources (MoANR) and other Ethiopian government organisations, like EIAR and RARIs.

Open weather data sources

Weather data that are used in agricultural advisory systems can be categorised in meteorological observations from stations (NRT and historic archives), simulated weather variables from numerical weather models either for historical periods (so-called 'reanalysis') or weather forecasts for the coming days or months, and finally NRT and archive products derived from remote sensing.

Currently, open weather data comes from several sources. Open meteorological observations include the Global Summary of the Day of the US National Oceanic and Atmospheric Administration (NOAA), while open products based on remote sensing include rainfall estimates (such as CHIRPS-USGS CHG) and Incoming Solar Radiation (MSG-LandSAF). Short-term weather forecasts, based on open data, include the Global Forecast System (GFS) from NOAA's National Centres for Environmental Prediction (NCEP).

Of course, many other weather data are available, although subject to restrictions. These typically include datasets generated by most national meteorological agencies, but also data from numerical weather prediction models. Examples of the latter are weather forecasts generated by the European Centre for Medium-Range Weather Forecasts (ECMWF). In contrast, ECMWF reanalysis datasets such as ERA-INTERIM and the upcoming ERA5 are available as open data as part of the European Copernicus programme. With reference to forecasts, for instance GFS short term forecasts can be freely obtained, while ECMWF data undergo restrictions and are usually subject to license fees.

It is therefore important to assess pros and cons, costs and benefits of the datasets in respect to the requirements of the advisory systems envisaged, and ultimately of the smallholder farmers operating in specific environmental conditions.

Indicators

While it is relatively simple to evaluate the costs associated to the datasets (in terms of license fees or data processing), the benefit side needs much more elaboration since it requires knowledge of end user requirements and the value added when making use of a specific dataset.

There are, however, indicators for relevance, reliability, timeliness and accessibility of the data that can be used as proxies for such added value. Consequently, most of the effort would then be in the assessment of compliance of available datasets with the requirements of the system.

If we take once more short-term weather forecasts as an example, what would be the requirements of the proposed advisory system? What time range and interval, spatial resolution, accuracy (skill) of the prediction would serve the purpose? Is the knowledge of the uncertainty associated to the prediction also important? These are all questions which should be guiding decisions in the choice of the data and that CommonSense has been confronted with.

GFS for instance provides 10-days range predictions, at a 0.25° (~28km at the Equator) spatial resolution. ECMWF provides a short range (1-3 days) as well as a medium range (4-7 days) forecast; it generates both a deterministic high-resolution prediction (HRES) with 0.1° resolution (~11km), and an ensemble one (ENS), with a spatial resolution of 0.20° which corresponds to 22 kilometres.

Quantifying quality of weather data

According to the World Bank Ethiopia Socioeconomic Survey 2015-2016, the average field size for the country is 0.13 hectares. Although still far from matching the size of the average Ethiopian fields, the ECMWF forecasts (both HRES and ENS) do provide a better spatial resolution than

GFS and are thus considered better fit-for-purpose from this perspective.

In the context of CommonSense we are also conducting a statistical validation of the accuracies of different weather variables (namely rainfall occurrence and amount) between GFS and ECMWF predictions. This is done by comparing the two against observations from all National Meteorological Agency's synoptic weather stations. The work is still on-going, but results so far indicate that ECMWF outperforms GFS forecasts not so much in terms of occurrence, but especially in terms of amounts, which is again critical information to support actual farming practices.

Good interpretation of uncertain forecasts such as rainfall, can only be done if uncertainty can be quantified. A forecast expressed in probability terms, such as ENS, seems therefore more useful than a single prediction (like for HRES or GFS) for making decisions related to farming. For example, planting operations in Ethiopia are highly dependent on the onset of rainfall. Therefore, the forecast can be tailored to provide high certainty that rainfall will fall on the predicted date. Similarly, sesame plants at maturity stage are highly susceptible to damage due to wind and rainfall. Therefore, the forecast can be tailored such that even low probabilities of such conditions in the forecast are reported to farmers.

A first 'test bed' for the forecasts, based on ECMWF predictions, has been a pilot SMS service run over the 2017 growing seasons in the regions of Tigray and Amhara and reached 1,520 users including farmers, extension workers and research staff. Users' perception of the forecast is positive, which enforces the CommonSense point of view that high quality weather forecasts are a basic requirement for smallholder farmers.

It can be expected that more open weather data will become available in the future, hopefully better suited for the purpose of agricultural services for smallholders.

From this perspective the still scarce sources might suggest that open weather data are less fit-for-purpose, which might currently result in opting for paid, non-open services. Nevertheless, it can be expected that more open weather data will become available in the future, hopefully better suited for the purpose of agricultural services for smallholders. ●



About the authors

Tomaso Ceccarelli, Allard de Wit and Rob Lokers are senior researchers at Wageningen Environmental Research, Earth Informatics Team, in the Netherlands. They are working, among the others, on IT applications to agriculture in developing countries.

Related links

More information on CommonSense on its webpage <https://goo.gl/WfA9PH>



Cost efficient integration of weather data into agronomic advice

Jan Willem van Casteren

Two innovative enterprises have integrated a weather service system within an agro advisory service for farmers in East Africa. The eProd handheld device collects the GPS locations and agronomic information such as soil type, seed variety and planting date. aWhere combines this information with their weather data so farmers can now be sent SMS weather forecasts, spray alerts, fertiliser advice and yield projections.

In 2004 two agricultural economists developed eProd, a supplier management service, after setting up a company to export dried African Bird's Eye chilies produced with large numbers of contracted smallholders in Kenya. At that time, there were no off-the-shelf ICT management packages available and even today it is difficult to find a complete Enterprise Resource Planner (ERP) that is affordable.

The system developed into one of the most complete and appropriate ERPs for managing agricultural supply chains with scale producers and manages contracting, field inspections, surveys, extension services, communication, mobile payment, incentives, credit, traceability, collections, etc.



eProd comes with a field application for mobile phones or tablets and can use Bluetooth scales and printers for field collections. It can easily be integrated with hardware and software, for example, quality measurement devices for quality-based payment and specialised financial software or other ERPs. One important service of eProd is the integration of weather forecasting, production advice for farmers and field staff, and management on weather information.

Connection must be reliable and has to function in areas where internet is poor or absent. eProd is developed in Delphi and uses a MySQL database. It comes with a handheld application for Android devices. It can function in the cloud, but for most clients internet speed is too slow. It efficiently synchronises with the network, or even a simple laptop at the office.

In 2015 the software was piloted for various sectors and eProd Solutions Ltd was registered in Kenya to commercially offer the management solution to aggregators. Even though it is now used even outside agriculture (it is used in about 20 sectors), the target users are commodity traders, farmer cooperatives and food processors in agriculture and livestock. The company has an office in Nairobi and currently 65 users reach about 250,000 farmers in Kenya, Uganda and Tanzania. The company prepares to expand further in the region.

Revenue model

Access to weather data is extremely important for eProd users. Advanced weather information systems exist, but the high level of expertise for the development and constant fine tuning of crop modelling, machine learning, big data, etc. hinders the access for small scale producers. aWhere is one of the leaders in the field of weather information for agriculture and they serve agricultural businesses across the agricultural value chain from international seed companies to innovative start-ups. However – even though they see business opportunities of serving smallholders with localised services – their traditional revenue model cannot deal with the relatively small transactions inherent of working with smallholders.

‘From daily SMS weather forecasts, agronomic advice,

like spray alerts and fertiliser advice, aggregators now have a platform to manage efficient and cost-effective the information flow between the individual producers and aWhere,’ says John Corbett, Chief Science Officer at aWhere. For example, the platform can manage commercially weather forecasts services through a subscription model, and payment can be through a check-off system after product deliveries have taken place. eProd can send SMS and email management reports such as yield forecasts in coffee for example. It can now affordably feed into aWhere models additional and highly accurate information. Via an application program interface (API) integration, eProd and aWhere exchange information which results in SMS or reports prepared for the individual farmers or managers. In addition, eProd can create an enabling environment for many more services, for example: managing weather index crop insurance, access to finance by enabling micro-financial institutions to bulk screen loan applications and manage repayment, manage contract farming, certification, household surveys, etc. All integrated in one platform.

The eProd handheld device collects the GPS locations and agronomic information such as soil type, seed variety and planting date. This information is communicated via eProd to aWhere for advanced analytics and information can now be pushed to farmers as SMS Weather forecasts, spray alerts, fertiliser advice, or email management reports with agronomic advice for field staff and management.

Weather service for coffee farmers

A specific pilot that aWhere and eProd conduct together with coffee stakeholders in East Africa focuses on the development of weather services at coffee farmer cooperative level. Coffee is one of the most widely traded commodities in the world and millions of people depend directly or indirectly on the production and sale of coffee for their livelihoods. The global market for coffee is characterised by volatile prices and experts on the world coffee market often refer to the “coffee paradox” as lowering prices for coffee farmers result in declining incomes and profits affecting millions of people in the world’s poorest countries, while there is a coffee “boom” in consuming countries with rising sales and profits for coffee retailers and roasters.

Coffee farmers can benefit from the management options that eProd facilitates, including certification (e.g Fair Trade, Organic, UTZ), to reach premium prices, but also through providing agronomic information services. ‘Coffee trade is all about predicting yields. The party that is best at predicting, whether it is the coffee trader, farmer cooperative or hedge fund, will make the best deals,’ says Lutz Bayerkoehler, former MD ECOM Tanzania. Models have become better at yield forecasting, but the information is typically too general for use at farmer cooperative level. An essential step will be to develop accurate and affordable localised crop monitoring and yield forecasting at the coffee farmer cooperative or local coffee trader level. If used in a smart way this can assist to build trust between producers and buyers and benefit all parties.

The coffee plant, particularly Arabica, is vulnerable to decreased production due to many factors from too warm night time temperatures to variable rains and drought. Taking between 30-35 weeks from flowering to harvest-ready, the warming atmosphere and increased weather variability results in the risk of stressed periods being much greater now than ever. Stressed trees are more



susceptible to disease and insect damage. Stress models use numerical simulation techniques in conjunction with detailed information of soil and crop properties to evaluate the evapotranspiration deficit (Etd). The deficit, or not, and the timing (growth stage) strongly correlates to yield.

To calculate Etd aWhere leverages potential evapotranspiration – the water demand of the environment. PET is calculated by utilising most meteorological variables and in this way aWhere understands the impact of wind, sunny skies, low humidity, and heat – exactly the conditions that impact productive coffee trees. aWhere has operationalised the FAO water balance approach to yield modelling and has also developed 20 pest and disease models.

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.

The combination of appropriate management support systems for aggregators and access to quality weather information services impact on smallholders and can transform the landscape in which they operate. ●



About the author

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Related links

Official website eProd
www.eprod-solutions.com
 Official website aWhere
www.ewhere.com

Building a business case for agro-weather services

Boniface Akuku

Most of the business models for weather services to smallholder farmers in Kenya are financially too unsustainable to scale-up. To do so it requires capacity building and establishing quality management system geared toward validating the impact.

The past two decades have witnessed a spectacular growth in the use of ICTs as a mechanism for improving access to agricultural information and knowledge. The dissemination of climate information and advisories using ICTs to farmers has proved to be very useful in Kenya. This includes SMS, mobile applications and knowledge-bank web portals. The diversity of open weather data services provides evidence on the importance of weather data in supporting adaptation and resilience for smallholder farmers.

An important element is the design and delivery of weather data as a product and service in a more relevant, cost-effective and usable format to enable farmers to make informed decisions and improve farm management capabilities as they face climate risks. A closer look to open weather data services, reveals that SMS notifications are currently the preferred way to provide smallholder farmers with weather information services and products in Kenya. The experience of KALRO's agro-weather digital platform shows that cost structures and timeliness are some of the reasons smallholder farmers prefer SMS to other innovations.

Other innovations such as mobile application and web portals require farmers to own basic smart phones from where they will access a designed portal with weather outlook information, weather forecast information and weather season information. However, in case of SMS the agronomic recommendations, which are matched with weather forecasts, are provided to farmers either on demand or through broadcasts (pull and push technology). In other innovations, farmers are required to download the app on their smart phones and have access to internet or data bundles.

SMS services are available on all types of mobile phone, even the most basic ones. The weather information service that KALRO provides to smallholder farmers incorporates tailor-made climate information and agronomic recommendations to farmers. Such service gives farmers access to real-time location specific information and location-specific recommendations for example on crop varieties, soil preparation, sowing rate and time, irrigation, fertilisation, pest and diseases control, harvest time, and storage options based on weather forecasts. In addition, the

innovation is implemented open data and open science principles in this case using open weather data and ICT innovations for improved agricultural productivity, resilience and income for farmers.

Lessons learned

In Kenya, systems that integrate weather data and agronomic information are still very ineffective. As a result, farmers are "weather data watchers" since the majority of farmers are not able to make sense from the weather information as well as agricultural data sets as provided by both meteorological professionals and agricultural research scientists. This situation has led to farmers using their own experiences to adapt to agricultural practices. However, these old-ways advisories cannot cope with the changing climate and extreme weather events. The ever-growing complexities in markets, production and management in different agricultural value chains exacerbate the problem. In addition, access to usable weather data, information and knowledge remains problematic.

This situation requires appropriate design, delivery and effective use of climate-related information by smallholder farmers. The agro-weather tool of KALRO has improved the way farmers manage weather risks through maximising their productivity and minimising the environmental impacts due to access to timely information. This has resulted in improved decision-making on better farming practices. Through the agro-weather SMS tool, farmers are now able to make the right choices based on synthesised weather data in combination with a crop calendar and agronomic advisories.

Various lessons have been learned from this Kenya case. Our experience reveals critical gaps in the design, delivery, and effective use of open weather-related data and information for risk management among smallholder farmers. There are various areas that need attention. Firstly, salience that is tailoring content, scale, format, and lead time to farm-level decision-making. The special needs to provide timely access to information to remote rural communities with marginal infrastructure is another lesson learned. Furthermore, legitimacy must be built-in to ensure that farmers own climate services and shape design and delivery. Equity through ensuring that specific groups as women and socially marginalised groups are served is another point for attention. Finally, integration and provision of climate information must be part of a larger package of agricultural support and development assistance, enabling farmers to act after receiving information.



Challenges

Mapping of stakeholders' value chain priorities and farmer registration process is time consuming. In addition, majority of smallholder farmers are low-income earners. There are also cases of high illiteracy levels, which requires translation of advisories into local languages.

The main challenge is the cost of sending information to the farmers. Attempts have made to adopt a hybrid cost-value pricing strategy where farmers pay reasonable premium rates based on the perceived value of the service to the farmers, while providing cover for the cost of the service. This model however takes a social enterprise approach that is more service driven than it is commercially reliable. The implication is lack of sustainable structures to ensure continuity of services and products.

A successful pricing structure largely depends on reaching a high number of users, which is difficult for a service that is new in the market. The agricultural sector in Kenya is largely smallholder farmers and a very conservative community; this has led to incurring marginal loss in operations of the services arising from the infrastructure set-up costs, marketing and efforts of recruiting subscribers. Continuous efficient management and cost sensitive approach will minimise overheads.

Sustainable business model

Revenues from advertisements and specialised services through the platform will contribute to the profit margins. However, a better sustainable approach is to seek for impact investors and donors for partnership and collaboration. The diversity of SMS-related weather information services required by farmers in Kenya reflect a relatively well-developing industry. However, some of the barriers to more effective SMS service provision and delivery include limited technical capacity and the absence of a framework to evaluate the impact of the services provided.

Most of the business models used by public, international, and for-profit and not-for-profit providers in Kenya are moreover financially too unsustainable to expand to the scale needed. Rapid scale up of the products and service require prioritisation of capacity building and establishing quality management system geared toward validating the impact. It is evident that there is greater need and demand for timely, relevant weather data and information that co-designed with research scientists, based on properly downscaled weather forecasts at the farmer level. Key priorities for sustained success include strengthening farmers' knowledge on benefits that facilitate the use of processed weather data in decision-making. ●



About the author

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Related links

<http://agroweather.kalro.org/>
<https://asalkhub.kalro.org>
<http://www.aidforum.org/reports/planet-of-the-apps-at-the-global-disaster-relief-development-summit-2017>
 for mobile apps download from Google play, Play store and Safaricom store

Facilitating the sharing of open weather data

Leigh Dodds

Ensuring that data can be easily accessed, used and shared requires the use of data standards. If you are currently working on a data project you should take time to consider what standards might be available to you to help to achieve the goals of your project.

Ensuring that data can be easily accessed, used and shared requires the use of data standards. If you are currently working on a data project you should take time to consider what standards might be available to you to help to achieve the goals of your project.

Data such as statistics, maps and real-time sensor readings help people to make decisions, build services and gain insight. A strong data infrastructure is critical to

Once data is published in standard formats, it reduces the costs of working with new data, because existing code and analysis can be applied to the new datasets.

fostering business innovation, driving better public services and creating healthy, sustainable communities. Local, national and global data infrastructure will only become more vital as populations grow, and economies and societies become more reliant on getting value from data.

Data infrastructure consists of data assets, the organisations that operate and maintain them, and the guidance and processes that describe how to organise, use and manage that data.

Sustainable publishing of high quality data in standard forms is an important element of a strong data infrastructure. The value of data comes from its use. It is important to reduce friction that may stop data from being accessed, used and shared. A recent survey reported that data scientists spend the majority of their time cleaning and tidying data.

Open licenses give permission for anyone to access, use and share data. But it is by publishing data using common

consistent language, identifiers and formats that it becomes easier for people and machines to create value from it.

What are open standards for data?

Data standards are documented, useable agreements that help organisations to publish and exchange data in consistent ways. There are many different types of data standard, reflecting the different types of agreement that are needed to support the consistent representation of data.

For example, we can standardise the words and concepts that we use to describe things in a dataset. By using consistent language, it becomes possible to confirm that datasets are measuring and describing the same things. It is also possible to standardise the ways in which individual data items are measured, and how data can be organised to make it machine-readable.

Take, for example, the reporting of temperature observations from a weather station. There are many things that can be standardised in this dataset alone. The means by which temperature readings are carried out (e.g. the frequency with which observations are made), the units in which temperature is reported (e.g. Centigrade or Fahrenheit) and the format in which dates and time are recorded against each measurement are obvious starting points. But standards can also define how the temperature readings and timestamps are organised in data files, like spreadsheets.

Or how specific data formats (e.g. CSV, XLS, or JSON) are used to exchange the machine-readable data. The metadata used to describe the dataset, including an identifier for the weather station and information about the data publisher can also be standardised.

These standards may be developed at different times, by different communities. Standards development is a collaborative process, involving an international community. Open standards are those that are created in ways that conform to the OpenStand principles: using open processes and published under terms that allow them to be freely used for any purpose.

By building on the work of other communities it is easier to create new standards that help to improve data is published to support new applications and services.

How do standards create impact?

The most immediate benefits of creating and using open standards for data is in ensuring that data can be easily accessed and used. Once data is published in standard formats, it reduces the costs of working with new data, because existing code and analysis can be applied to the new datasets.

Standards can also encourage the creation of new tools that are designed to help support those who are publishing and using datasets that conform to that standard. But the technical impacts are just the most obvious benefits that a standard can bring.

Standards can help to create ecosystems and drive innovation. The availability of collection of consistently organised data can enable start-ups to create new tools and services that will help others to create value from that data. For example, the adoption of the GTFS standard by transport authorities around the world has enabled a range of new services that help millions of people around the world to make the most of public transport. Transport for London have reported that their publication of open data using this standard may be contributing up to £130 million a year to the local economy.

Standards can also help to enact policy or legislation,

helping to change markets and improve delivery of public services. For example, the UK's open banking standard was imposed by the competition regulator to create a more competitive and innovative banking sector.

Standards can also be used to drive social change by encouraging governments and private sector companies to publish data in consistent ways to help create transparency. The Aid Transparency, EITI and Open Contracting Partnerships are each using standards as an important tool to enable change.

Challenges in standards development and adoption

However, creating good data standards is hard. There are often many different competing standards that could help support the publication of a dataset. But they are often poorly adopted, and it is not clear to users which standard might be the best to use.

At the Open Data Institute, we have been researching the factors that contribute to the failure to create and adopt data standards, and some approaches towards addressing those challenges. We have been conducting user and desk research, and have been collaborating with other organisations involved in data standards to better understand the challenges faced in standards development.

As part of the GODAN Action project, the ODI has also been working to understand the range of standards used in the agricultural sector, e.g. to share weather data. The goal is to identify some useful interventions that may help encourage greater adoption of standards in the sector.

The project has already identified several needs. Firstly, developers need better tools to help them discover relevant standards. The recently launched map of agri-food data standards will help to address this issue in the agricultural sector, while the open data standards directory has a wider scope. Secondly the project has highlighted that more guidance is needed on the process of standards development to help organisations collaborate to create well-designed standards. Finally, standards developers need to think more about how their standard will be adopted and the types of tools, documentation and engagement that will ensure their standard is successful.

There are also potential benefits in building better peer networks between organisations involved in standards development, and between those people involved in developing standards and the organisations and communities that might benefit from them.

The ODI will be working with partners in the GODAN Action project to implement solutions to some of these issues, whilst also working to publish a new guidebook to support the development of new standards. ●



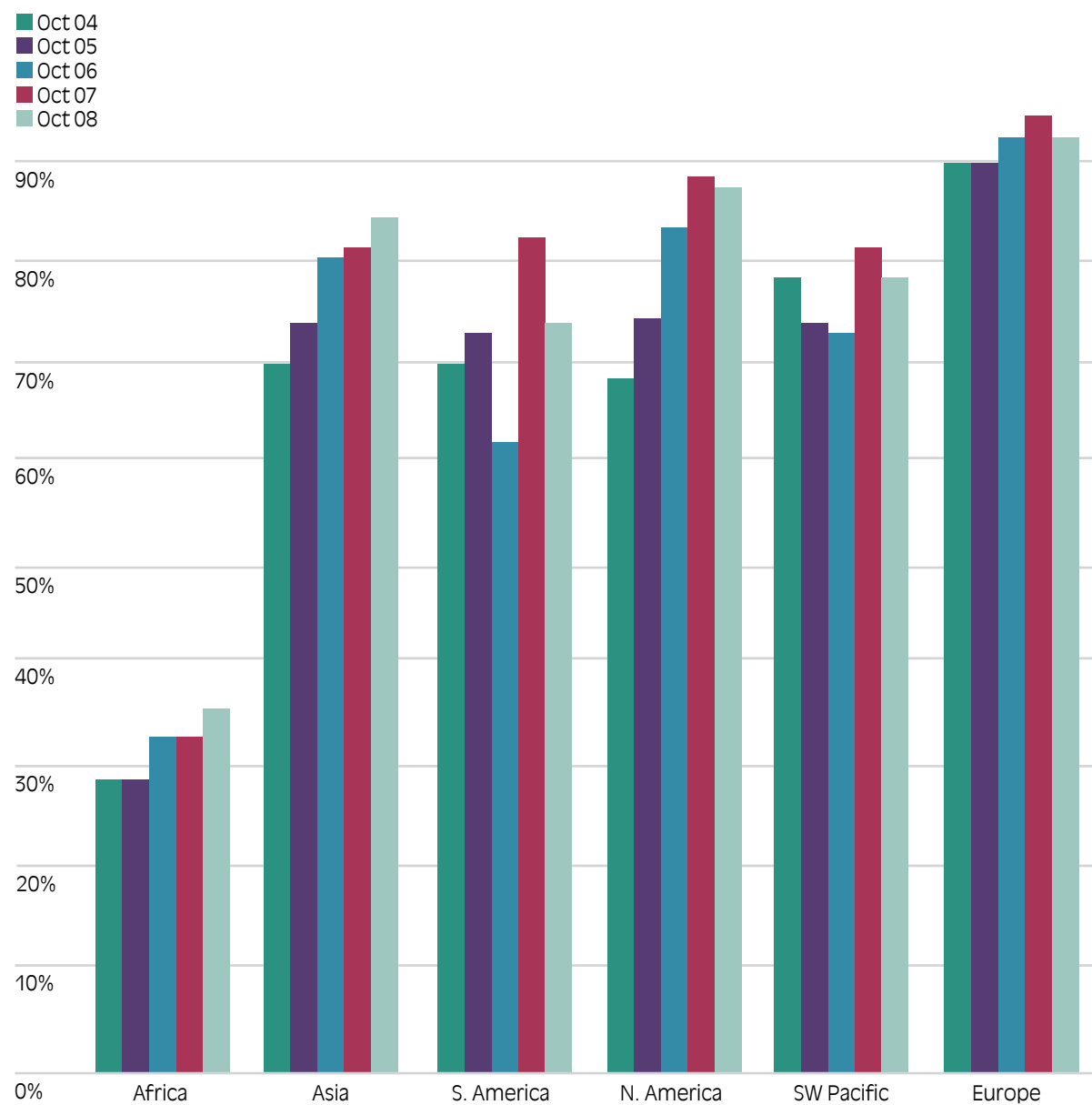
About the author
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Related links
Open Data Institute website
<https://theodi.org/>
Map of agri-food data standards
<http://vest.agrisemantics.org/>
Open data standards directory
<http://datastandards.directory/>
OpenStand principles
<https://open-stand.org/about-us/principles/>
Link to survey of data scientist
<https://goo.gl/Nv3KdB>

Overcoming challenges in the availability and use of climate data in Africa

Tufa Dinku

Figure 1: Percentage of CLIMAT reports received compared to what is required
(Data Source: WMO)



Availability of and access to climate data and information products is critical to achieving climate resilient development. However, climate information is not widely used in Africa. Useful information is often not available or, if it does exist, is inaccessible to those that need it most. Efforts are being made to alleviate the problem of data availability and use.

One of these efforts is the ENACTS (Enhancing National Climate Services) initiative that has been led by the International Research Institute for Climate and Society (IRI), at the Earth Institute at Columbia University. The ENACTS initiative delivers robust climate data, targeted information products and training specifically relevant to the needs of farmers and food security decision-makers at multiple levels, empowering a diverse range of actors to use past, present and future climate information in agriculture and food security-related response actions with confidence. ENACTS has so far been implemented in Ethiopia, Ghana, Gambia, Kenya, Madagascar, Mali, Rwanda, Senegal, Tanzania, Uganda, and Zambia.

Challenges in availability of climate data

Africa is well-known as having inadequate and inefficient observation networks, for example as mentioned by the African Climate Policy Centre. The state of the in-situ climate observing system is seriously inadequate, with the number and quality of weather stations in many parts of the continent in decline. The available stations are unevenly distributed with most of the stations located along the main roads. Figure 1 presents the percentage

of CLIMAT reports (monthly climatological data assembled at land-based meteorological surface observation sites and sent to data centres) received from the different regions at World Meteorological Organisation (WMO) during 2004-2008 compared to what is required. The contribution from Africa, at about 30% of what is needed, is the least of all. Besides, a significant proportion of that is from South Africa, where density of stations is significantly better than other parts of Africa.

Figure 2 shows that the number of stations sending data to the Global Precipitation Climatology Centre (GPCC) has been declining drastically since the early 1980s. This decline may be attributed to two factors. The first reason is that data is available but may not have been provided to GPCC, while the second reason is actual decline in station

Even the best data has no value if not accessed and used. In Africa weather observation was less of a priority compared to other issues.

network at national level. For example, the second case is evident in Madagascar, which shows dramatic decline in observations over the last 50 years.

There are different factors contributing to sparse distribution of the observation network and its decline over the years. These may include difficult and remote geography, disperse nature of rural population, conflict,

Figure 2: Number of stations that were used in the GPCC full-data product from Africa
(Data Source: GPCC (<https://www.dwd.de/EN/ourservices/gpcc/gpcc.html>)).

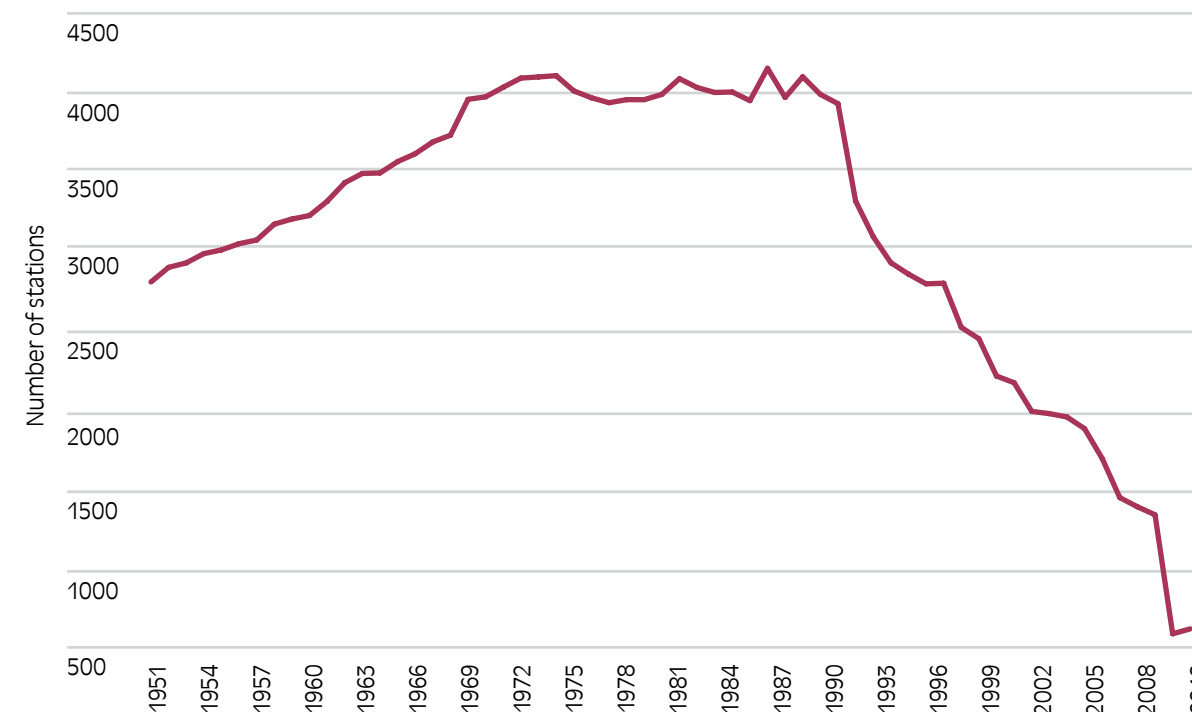
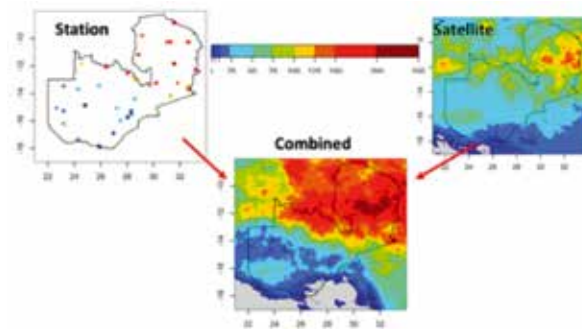


Figure 3: Station observations (top left) from the operational network in Zambia are combined with satellite rainfall estimates (top right) to produce a spatially complete and more accurate product (bottom).



lack or decline of investment. A difficult geography, such as mountainous and desert areas, can deter investment in observation stations as they require larger capital, operational, and maintenance investments.

Conflict or political upheaval can result in missing observations and therefore gaps in the data record. An example is the 1994 genocide in Rwanda. The meteorological observation network was devastated during this period and it took close to 15-years to revive the stations. Furthermore, lack or declining investment in the establishment and maintenance of weather stations has been a major challenge in Africa, because weather observation was less of a priority compared to other issues.

Bridging gaps in climate observations and use

The International Research Institute for Climate and Society (IRI) at Columbia University, in collaboration with partners, has been leading an ambitious effort to simultaneously improve the availability, access and use

of climate information at national level through its ENACTS initiative. ENACTS focuses on the creation of reliable and actionable climate information that is suitable for national and local decision-making.

The ENACTS approach has three major components: improving data availability, enhancing access to climate information, and promoting the use of climate information.

Improving data availability involves filling spatial and/or temporal data gaps. The approach adopted by ENACTS to accomplish this is combining quality-controlled station measurements with satellite rainfall estimates for rainfall and satellite and/or reanalysis for temperature datasets (see figure 3). The main advantage of the satellite and reanalysis products is that they offer spatially complete data and are freely available. Satellite rainfall estimates now go back over 30-years while reanalysis products go even further back in time. Thus, the approach combines the spatial information from the satellite or reanalysis proxies with station measurements. The final products are datasets with 30 or more years of rainfall and temperature time series for every four-kilometre grid across a country.

Enhancing Access to Climate Information

Even the best data has no value if not accessed and used. The ENACTS approach enhances access to climate information products by making information products available online. This is accomplished by customising and installing the very powerful IRI Data Library at the National Meteorological Agencies and developing an online mapping service that provides user-friendly tools for the analysis, visualisation, and download of climate information products, like the “Meteo Rwanda Map Room” that shows in maps and figures all kind of climate trends.

Generating climate information products and making them available online may not necessarily lead to their uptake. Users need to be engaged on the value and application of such information products. User need to be aware the existence these products and be trained to understand and use the products. Users should also contribute to the development of relevant information products. Therefore, ENACTS also promotes the use of climate information by engaging and collaborating with users. ●



About the author

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Related links

ENACTS website
<https://iri.columbia.edu/resources/enacts/>
ENACTS data library
<http://iri.columbia.edu/resources/data-library/>
Article “Leveraging the Climate for Improved Malaria Control in Tanzania.”
<https://goo.gl/zMhPYt>

Partnerships to increase open weather data's impact

Kiringai Kamau

Climate warming affects the water cycle, which impacts negatively on agricultural production and derails the cyclical effects associated with weather predictions and agricultural seasonality. Making use of weather data could help farmers to mitigate to the circumstances and increase farm productivity. To succeed, pragmatic public-private multi-stakeholder partnerships are required.

Smallholder farmers rely on the rain for their production and at times get confused, because of climate change, by unreliable weather. It is therefore necessary to invoke the role that technology plays in localising agronomic weather through data collection instruments to interpret and tailor agricultural data for a well-designed farm-based management plan of choice crops. While digital thinking is good for efficiency, it has the draw-back in that collection of weather data results in a data glut that makes it necessary to think costs wrought by the implementation of processes that can utilise the data effectively.

The investment needed to provide quality weather data and to make it accessible for service providers, calls for pragmatic private public partnerships.

The investment needed to provide such statistics and make it accessible for service providers, calls for pragmatic private public partnerships (also called PPPs) that promote mutually beneficial interactions between internal and external partners, or operators who share knowledge, resources, and expertise to address weather and agricultural related investments.

The Global Open Data for Agriculture and Nutrition (GODAN) consistently promotes knowledge driven efforts that support evidence-based decision-making in agriculture, particularly to advice on what can promote food and nutrition security. By doing so it also enables and stimulates partnerships between various actors. With its focus on enabling effective use of open data to address food security and nutrition challenges, the GODAN Action network of data producers, users, and intermediaries which work through supportive partnership of collaborative capacity building of stakeholders, participated during the AMCOMET Africa Hydromet Forum 2017 with some of its African partners

comprising of the Regional Center for Mapping of Resources for Development (RCMRD), the Programme for Agricultural Capacity Development in Africa (P4ACAD Africa), and the Center for Agricultural Networking and Information Sharing (CANIS) of the University of Nairobi to demonstrate how weather data can be used to drive food and nutrition data provision for decision-making through engagement and partnerships.

Learning internship

Take P4ACAD Africa, an organisation created to support data aligned work in tertiary colleges and universities in Africa, which presented the model of data acquisition through student led farmer owned Agriculture, Technology and Extension (aTex) Hubs through which new knowledge or information to smallholder farmers is delivered through students participating in a learning internship for experiential learning. In the process of farmer-student interactions, students using simple data collection devices, such as GPS or mobile phone with digital cameras capture critical data on the farming engagements. Students get their information/knowledge from researches, university/tertiary college faculty, and development actors or through contextualised knowledge platform developed with artificial intelligence capacity to anticipate commonly asked questions. The farmer cooperatives weigh the produce by farmers during collection at produce collection centres using digital scales. This generate data that forms the basis for paying the farmers once the cooperative has received payment for what it generated.

ICT infrastructure, hosted within the aTex Hubs, needs to be an investment that farmers who come together as a cooperative can afford. The hub becomes the organisation through which data from satellites and sensor-based equipment such as drones to help them advise the farmers is acquired. Given the (lack of) resourcefulness among smallholder farmers, their governments at national and subnational levels, development partners, research organizations, universities and the private sector provide the necessary collaborative framework to ensure there is resource mobilisation from a multi-stakeholder base that ensures sustainability.

Building local and international partnerships on weather data and its impacts is urgently needed, as weather variability has consistently been left out of the agricultural value chain debate. More efforts will have to be made to address weather variability as the earth's atmosphere warms up. It is the accuracy of such weather variability data that farmers have to follow so that they can know when to dam to irrigate their land rather than rely on the rain for their production, a matter that is critical for Africa – where farmers continue to rely on the rain (as irrigation methods are sparse). This will become a critical now more than ever before as rains are consistently becoming unreliable, yet agriculture must produce more food for a growing world population. ●



About the author

Kiringai Kamau (kiringai@gmail.com) is the Founder and Executive Director of P4ACAD Africa.

Related links

<http://geoportal.rcmrd.org/>
<http://canis.uonbi.ac.ke/>
www.vacidafrica.or.ke

Weather Index Based Insurance for the Pacific

Below: Viti Levu, Fiji

Smallholder farmers in the Pacific have no access to weather index-based insurances, while flooding is a real threat for them. Preliminary research in the region suggests that weather and agricultural data, and the exact locations of farmers is weak in the region.

Catastrophe risk insurance can provide quick payouts in the wake of a major disaster. The Pacific Catastrophe Risk Insurance Pilot (PCRIP) was a pilot that tested a multicounty index-based risk pooling programme. It was established by Marshall Islands, Samoa, Tonga, and Vanuatu to increase their financial resilience against natural disasters, like tropical cyclones, earthquakes and tsunamis. The World Bank acted as an intermediary between those countries and a group of reinsurance companies. Payouts are triggered by specific physical parameters for the disasters (e.g. wind speed and earthquake ground motion) taken from the Joint Typhoon Warning Centre and the US Geological Services (USGS).

The pilot made two payouts for an aggregate amount of US\$3.2 million, in each case within 10 days of the disaster. Tonga received a payout of US\$1.3 million following Tropical Cyclone Ian in January 2014. Vanuatu received a payout of US\$1.9 million following Tropical Cyclone Pam in March 2015. The payouts were the first injections of cash received in the immediate aftermath of the disaster. These events demonstrated the pilot fulfilling its purpose: to provide governments with a quick, but limited, cash injection in the aftermath of a major disaster to finance immediate expenditures.

However, there is an urgent need to complement the catastrophe risk insurance with other financial solutions to cover more frequent, less severe events. For example, the small island states of the Pacific consist of a potential for weather index based agricultural insurance. With as much as 80% of the population of some countries in the Pacific

involved in agriculture, there is a potential for an affordable weather index based agricultural insurance that could provide some form of coverage in the case of failure of crops. Given the low levels of income earned by farmers, traditional agriculture-based insurance products would be too expensive to meet these requirements. Until now, there are no existing index-based insurance schemes in the region. Fiji is the most advanced country in the region that works on developing an index-based insurance product.

Risk of flooding

In a report by the Agriculture Ministry in Fiji, it is noted that the worst damage for farmers could come from a flooding submerging crops for 2 or 3 days. It also states that after such event root crop prices could increase 2-3% and vegetable prices could increase 5-80%. This represents a double impact to a farmer – they have less income due to the failure of their crops and they have to pay more for food due to lack of supply. The report also states that if a weather index based agricultural insurance was developed to mitigate the risk of such events, it would be based on the principle of “low premium, low payouts”, offering just enough coverage to provide resilience to adverse agricultural events at an affordable price. It is most likely that this product would be based on abnormally detrimental rainfall during critical growing periods during the year.

The country’s capacity to collect, analyse, and report on weather data in support of any weather-based index must come from the Fiji Meteorology Service (FMS), a department of the Ministry of Rural and Maritime Development and National Disaster Management. FMS maintains the national data base with historical data on Cyclone intensity and tracks, rainfall events and drought. In addition to Fiji Met there are regional bodies based in Fiji that maintain weather data including SOPAC at South Pacific Regional Environment Project (SPREP) and the University of the South Pacific (USP). The Fiji Meteorological Office also maintained 38 weather stations collecting rainfall and other data, 29 of which were manually operated and 14 of which were automated (9 stations had both). Stations report data daily, and information is stored electronically, but often there are stations that do not report as a result of the irregularity of collection of this data by caretakers, or due to malfunction among automated ones.

Risk modelling

In 2012, the Pacific Financial Inclusion Programme (PFIP) assessed the feasibility of weather-index insurance. It concluded that the weather station density as well as the reliability of the weather information infrastructure was not sufficient to develop detailed rainfall-indexed products. The Applied Geosciences and Technical Division of SPC (SOPAC) have advised that most of Fiji does not have any topographic flood plain data, and where there is data, the highest resolution is 20 meters. This resolution is probably not refined enough to use for developing an insurance model and the development of sophisticated flood risk modelling is time consuming and expensive. As a guideline for developing weather index based agricultural insurance, there needs to be at least 20 years of historical daily data and the missing data should not exceed 3% of the total daily data set. It is also advisable that the weather stations are automated. The data available in Fiji does not meet these requirements.

The FMS can theoretically provide this data on a case

by case basis for no charge to those who submit official requests; however, the process is time consuming. This also represents two issues. Firstly, it is unclear whether the data available is of high enough quality and detail to develop an index-based insurance. Secondly, if a product was developed, the ability for an underwriter to get timely information from the FMS weather stations to trigger claims payments is doubtful. Timely payment of claims is essential for weather index-based insurances to be successful as farmers who suffer a loss need the payout as soon as possible.

Furthermore, demographic and agricultural data in Fiji are weak. PFIP could not locate any large-scale mapping showing concentrations of farming communities. Further, there are few examples of monoculture farming in Fiji, or farming on large scales. The average size per farm in Fiji is small at 3.9 hectares and farmers generally plant a mix of different crops. The existence of monoculture farming is a key requirement to development of weather index-based insurance schemes as different crops have different tolerances to weather. The mix of different crops planted by farmers in Fiji makes the designing of a policy with set loss triggers difficult.

The one agricultural product that does have data is sugar cane. Fiji produced 2.3 million tons of sugar cane in 2008, on 50,907 hectares of land. Crushing and exportation of the cane is managed by the Fiji Sugar

There are no existing index-based insurance schemes in the Pacific region. Fiji is the most advanced country in the region that works on developing an index-based insurance product.

Corporation Limited (FSC), which oversees the 14,000 active members of the Sugar Cane Growers Council (SCGC). The SCGC has are interested to develop weather index-based insurances, but struggle with capacity constraints.

Information in this article was mainly derived from the Pacific Financial Inclusion Programme’s Focus Notes publication “Weather Index-Based Insurance in Fiji: Brief on Initial Scoping” (March, 2012), authored by Barry Maher and Michael McCaffrey. Currently, CTA works on a new study that investigates the conditions, readiness and potential for weather index-based agricultural insurance in seven countries in the Pacific region. ●

Related links

Publication of PFIP on Weather Index-Based Insurance in Fiji (March 2012)
<https://goo.gl/qjm4Q5>
 Publication about the Pacific Catastrophe Risk Insurance Pilot: From design to implementation – some lessons learned (July 2015)
<https://goo.gl/Lc7VuX>

Public Private Partnership success for a start-up

Dominique Mvunabandi

The start-up enterprise Severe Weather Consult in Rwanda succeeded in receiving support to develop a business model and is now involved in a public private partnership that allows them to make use of weather data for an alert advisory service to farmers.

Severe Weather Consult has developed an innovative weather information system technology, named iHewa, that combines the power of ICTs with data from ground weather stations, satellite and lightning sensors to support education, agriculture, water, tourism and disaster management sectors in Rwanda. The technology uses innovative low-cost lightning detectors to track lightning strikes in an area and sends alerts to people in the city of Musanze in Northern Rwanda.

Working in a PPP construction with data providers is important to sustain the supply of and access to quality weather data.

It integrates lightning data with robust, low cost and automatic weather stations parameters (rain, wind, temperature, humidity, solar radiation and air pressure) provided by the TAHMO network, and combines this with satellite data. The result is a detailed dataset of effective, timely and GPS localised weather information, predictions and alerts on floods and lightning for the city's residents and the neighbouring farming communities.

The three founders of the start-up found each other in a common goal to start a social private company that solves societal challenges by making use of ICTs. However, none of them was aware how bumpy the road would be to get the dream turned into reality. Starting a company is very difficult and challenging, especially without an entrepreneurial background. The team required additional skills apart from technology and science to develop a business model, payment system, marketing strategy and financial modelling.

Technical and entrepreneurial support

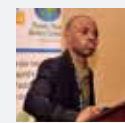
Fortunately, the founders could find support to kick-start and scale-up the company from Delft University of Technology, Trans-African Hydro-Meteorological Observatory (TAHMO), Truvalu.start-ups and VIA WATER. They offered intensive trainings on climate technology, turning technology into a viable entrepreneurial business case, business development, financial management, marketing etc.

It has been proven important for Severe Weather Consult to improve the network with professionals in weather technology and services, learn from existing Public Private Partnerships (PPPs) in weather and climate services, and work together with small business operators also in weather technology and ICT advisory services to learn from their successes, challenges and envisioned tangible solutions. Occasions like the AMCOMET-Africa Hydromet Forum that was organised in Addis Ababa, Ethiopia in September 2017 are important for small enterprises such as Severe Weather Consult to increase the network.

As a social enterprise Severe Weather Consult wants to contribute to increase the accessibility of weather and climate data to farmers. Therefore, data sharing is at the heart of the social mission as it helps to enable effectively planning and decision-making for farmers. But open data is also important for running the company. Open weather data means data that can be freely used, re-used and redistributed by anyone to develop a sustainable business cases.

Working in a PPP construction with data providers is important to sustain the supply of and access to quality weather data. In such partnership model Meteorological agencies, knowledge institutes and business operators agree on a framework how to use and improve open weather data.

Since January 2017, Severe Weather Consult has implemented this project that works on a severe weather warning system on floods and lightning in Musanze city. The project now tests the weather monitoring platform, that issues alerts on extreme weather conditions, and provide useful weather information advisory services to its users. Data are gathered from weather stations and sent to a server located at Meteo-Rwanda. The data is accessible for Severe Weather Consult and TAHMO for data processing, analysis and information and advisory dissemination. ●



About the author

Dominique Mvunabandi is CEO of Severe Weather Consult Ltd. in Rwanda and works as visiting lecturer at

both University of Rwanda and Kigali Independent University (ULK).

Related links

Severe Weather Consult website
<http://www.swcrwanda.com/>
 Stories about Severe Weather Consult
<https://goo.gl/i7Y9h5>
<https://goo.gl/XiBXMB>
<https://goo.gl/6mZUyM>

Weather data to weather forecasts for Zambian farmers

Lillian Mzyece

In Zambia, the Meteorological Department opens its weather and climate data by providing informative weather products to end users. For example, it publishes the 10-day crop weather bulletin.

The Crop Weather Bulletin is a 10-day (dekad) weather and climate information publication produced by the Zambia Meteorological Department (ZMD) that is used by farmers and as a tool to update the seasonal rainfall forecasts. The bulletin is shared to the public through a mailing list, it is downloadable from the ZMD website and broadcasted through community radio stations. Among the recipients on the mailing list are District Agriculture Officers and Agricultural Extension Officers in the country who distribute it to farmers in their locations.

The bulletin gives highlights of the rainfall distribution in the last 10 days, showing which stations recorded higher and lower rainfall amounts and number of rain days. It also gives a cumulative rainfall performance from the beginning of the rain season to the same dekad period under review. Though the bulletin covers the whole country, it gives details according to regions.

Data for the bulletin is collected from 41 manual weather stations mainly using SMS to MET head office on 1st, 11th and 21st of every month as all stations are installed with GSM phones. The publication of the bulletin is produced and shared within two days after data collection.

A 10-days weather forecast is given for each region in the country. The agro-meteorological conditions give an overview of the crop (maize) condition based on the crop stage and amount of rainfall received so far. A summary of the crop weather bulletin gives rainfall amounts and number of rain days for all stations that sent their reports for that period, cumulative amounts received since the season started, normal rainfall amounts up to that dekad and a departure from the normal.

Currently, ZMD prefers to make a shift towards providing informative weather products like the crop bulletin to end-users rather than opening all its raw data. The reason is to ensure that the data is quality controlled. Moreover, ZMD is mandated and has the expertise to generate meteorological product and services for the sectors.

Challenges

This service like other weather services and products are sustained through government funding to the Met Department. Users, like Agricultural Extension Officers and farmers, do not pay for services because ZMD has no legal framework to charge for its services and products.

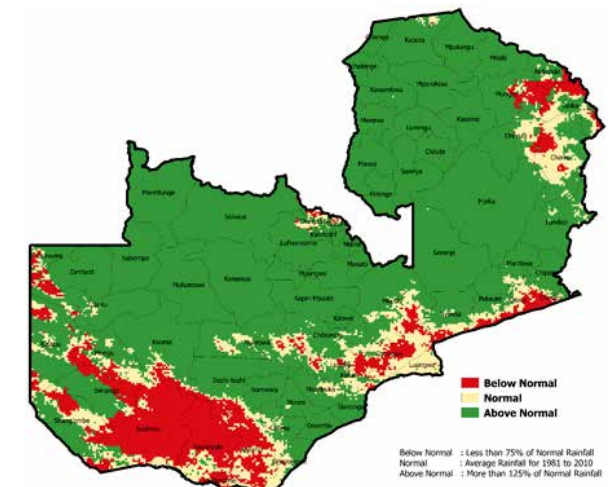
There is no complete user database, because the bulletin is redistributed by intermediaries, who are not mapped into the user database. Furthermore, distribution of the bulletin is mainly through the internet, which many farmers in remote regions have no access to. SMS service is currently being considered as farmers have better access to mobile phone services, but it comes at a cost. Nevertheless, most

farmers can get the information, as it is broadcasted on community radio stations.

ZMD is getting feedback mainly from institutional stakeholders and this has helped improve the information and presentation of crop weather bulletin product with more visualisations. Now, there are more pictures and maps included that show details. Feedback from users of the bulletin indicates that they would like to have more information pertaining to other crops besides maize.

The major challenge is fewer station network. Another challenge is to get all the data from the manual weather stations on time to be included in the bulletin, due to telecommunication issues. Investment capacity is required, both in technology and skills to improve the bulletin, data collection, data assimilation and numerical weather modelling. Further, the services and products require being published in local languages for a better understanding of smallholder farmers. ●

Rainfall Departure Map from the bulletin (Period: 1st July to 31st December, 2017)



About the author

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Related links

Zambia Meteorological Department website
www.zmd.gov.zm

The smart climate observation network that covers all Africa

John Selker, Nick van de Giesen and Frank Annor

There is a lack of weather and climate observation stations in Africa, while food production, harvest predictions, and disaster mitigation would benefit from improved data-accessible observation. A new smart and sustainable weather and climate observation network now addresses the important challenge of monitoring the weather in the continent.

Only 300 official weather stations in Africa report to the World Meteorological Organization (WMO). They are spread unevenly; most found in northern and southern Africa, leaving huge data gaps in the central continent. Consequently, national governments, regional planners, insurers, and farmers, do not have data to make critical decisions regarding weather and climate-impacted activities or investments in infrastructure to address climate resilience. Additionally, the few climate data there are held tightly by meteorological offices, generally inaccessible.

With an increase quality sensors at ever lower costs, and widespread cellular communication infrastructure to take data from weather stations to the internet, Africa can move forward towards the goal of obtaining accurate climate data. This is exactly the idea behind TAHMO (Trans-African Hydro-Meteorological Observatory): to develop a dense network of weather and climate monitoring stations in sub-Saharan Africa with no more than 30 km between stations in areas of significant human activity. This requires the installation of 20,000 stations.

School to School

By applying innovative sensor technology and ICTs, TAHMO stations are both inexpensive and robust. Stations are mostly placed at schools, where they are integrated in the educational programme, adding richness to the curriculum and helping foster a new generation of climate aware and resilient citizens. Data from the stations are uploaded automatically to an internet server, and schools are provided with software and

Furthermore, TAHMO field staff are paid according to the data quality, so they are highly motivated to respond to text messages indicating that a station needs attention.

classroom education tools to view and analyse the local weather data that their station and the stations at other schools are recording. TAHMO partners schools throughout Africa with sister schools in the United States and Europe (see School2School.net).

At the start of 2018 TAHMO has over 500 stations reporting from 18 African countries, with most having over 20 stations spread across the entire land area. With its data TAHMO is committed to serving the public by advancing the free and open exchange of weather data and closing the existing hydro-meteorological data gaps in Africa and increasing the communication and application of this information.

Smart measurement tools

Weather monitoring starts with a set of sensors. Since the development of the smart phone, sensing technology has advanced dramatically in cost, robustness, and precision. TAHMO stations leverage all of these advancements.

Precipitation drives hydrology, and yet is subject to myriad errors when measured with the standard tipping bucket gauge. Any slight angle in the station installation ruins the calibration. Any dust, pollen, insects, or seeds deposited in the buckets do likewise. A spider web can stop the bucket from operating. TAHMO decided that there would be no moving parts in its stations. Using technology that now has been tested in the field for six years, precipitation is measured by counting the drops that fall off a guide leading from the funnel collector. The size of these drips is dictated by the surface tension of water and the force of gravity – universal constants on earth (no calibration required).

The TAHMO stations measure wind speed with a rugged, research-grade sonic anemometer. Accuracy far exceeds mechanical devices, reading to zero wind with resolution of 0.01 m/s with a range going from 0 to 60 m/s. No maintenance is required, and since it is based on the speed of sound, it never needs calibration once it leaves the factory. The TAHMO sonic anemometer requires 100 to 1000 times less power than other ultrasonic anemometers, allowing TAHMO stations to run the entire sensor suite for months on the standard five AA batteries, even if the solar panel fails.

Accuracy

The TAHMO stations solve the problem of over-reporting temperature and under-reporting relative humidity that happens normally in enclosed sensors by using an independent thermometer to measure the free-air temperature independently of the temperature measurement taken with the humidity sensor. In fact, temperature is measured three times on the TAHMO station: with sound (the speed of sound is a function of air temperature); with a needle thermometer built into the sonic anemometer opening; and with a high-precision, Swiss-built sensor that measures temperature per relative humidity (T/RH), that is built into the top of the sonic anemometer. The sonic and needle air temperatures are unaffected by heating of the housing, providing exceptional accuracy, and are then used to correct values reported by the T/RH sensor in the protection of the station housing.

All TAHMO stations also include sensors for solar radiation (pyronometer), GPS location, compass heading, and orientation (a digital accelerometer tell us if the station is vertical), lightning detection, along with GSM cell-phone communication.

Repairs

All hardware fails eventually, and the failures can be quite subtle – e.g., diminished solar radiation due to dirt; elevated



temperature due to a cracked shield. Therefore, TAHMO plans “local” redundancy on each TAHMO station by including multiple measurements for solar radiation (photo diode and solar panel), temperature (three independent measurements), and rainfall (two measurements). We plan spatial redundancy by placing TAHMO stations close enough together (e.g., 30 km spacing), to achieve high spatial correlation in sensor values.

Time-series modelling of the joint probability distribution among the local and spatially-redundant sensors allows us to detect when one or more sensors are failing. These models can also predict the value of the target quantity (air temperature, solar radiation, precipitation), which will allow TAHMO to infer these quantities even when some sensors have failed. Furthermore, TAHMO station caretakers are paid according to the data quality, so they are highly motivated to respond to text messages indicating that a station needs attention.

Data collection

The TAHMO weather station uses the solar-powered EM60G data logger from METER. This data logger has been specifically developed with a small solar panel supplying enough energy for the station to function and keep the 5 AA batteries charged. The logger is a 6-port, self-contained data logger especially suited for field research (collaboration welcome!). The TAHMO station occupies only one port, leaving 5 ports open for local studies that might include soil moisture, stream flow, groundwater level, etc. This device is housed in a weather-resistant enclosure, making them suitable for long-term outdoor operation. Measurements

from the EM60G are sent wirelessly to TAHMO’s cloud-based data system where the data are processed using advanced quality assurance and control before being delivered to governments, schools, and other clients.

The TAHMO station network averages advancements across the spectrum of electrical engineering, computer science, geodesy, and telecommunications, allowing Africans to make better use of water resources and to produce food for the own population and the rest of the world. Accuracy in observation gives insurance companies the data they need to keep premiums to a minimum, and will ensure that farmers who have experienced crop failure get the compensation they deserve. ●



About the authors

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Related links
TAHMO website
<http://tahmo.org/>

Resources



Weather data Community of Practice

This Community of Practice aims for its member to share experiences, ideas and learn from existing initiatives that focus on providing added value services for smallholders using (open) weather data. As actors along the weather data value chain, working together, sharing knowledge and best practices we can better be able to co-create and deliver farm weather data driven services for farmers. Interested, register via the link. <http://tinyurl.com/COPWeatherData>

GODAN Action on open weather data

GODAN Action is a three-year project to enable data users, producers and intermediaries to engage effectively with open data and maximise its potential for impact in the agriculture and nutrition sectors. It works to strengthen capacity, to promote common standards and best practice and to improve how we measure impact. In its first year GODAN Action focusses on open weather data and does this with meetings, workshops and publications. <http://www.godan.info/godan-action>

World Weather Watch

To predict the weather, modern meteorology depends upon near instantaneous exchange of weather information across the entire globe. The World Weather Watch – the core of the World Meteorological Organisation (WMO) programmes – combines observing systems, telecommunication facilities, and data-processing and forecasting centres (operated by

Members) to make available meteorological and related environmental information needed to provide efficient services in all countries. With one core component dedicated to provide quality-assured, processed data, analyses, and forecast products on a wide range of temporal and spatial scales in the Global Data-processing and Forecasting System. https://www.wmo.int/pages/prog/www/index_en.html <https://www.wmo.int/pages/prog/www/DPS/gdps.html>

White paper: The State of Weather Data Infrastructure

This report of the Open Data Institute in cooperation with the MET Office in the UK, explores the current state of weather data infrastructure. By looking at the different aspects of the data infrastructure used to collect, access and share weather and climate information, the publication gives better understanding about challenges. <http://tinyurl.com/COPWeatherData>

Open Weather Map

The mission of the OpenWeatherMap company that works on big data and geospatial technologies, is to provide a global geospatial platform which is affordable to users and enables them to operate with earth observation data like satellite imagery, weather data, and similar data sources. Users can build new data-driven products for example for agriculture. <https://openweathermap.org/>

Video: Open Weather Data Concepts

Presentation of Charlie Ewen, Chief Information Officer at the MET Office (UK), on how the meteorological society relies on open data concepts. His presentation was part of the Open Data Institute's Summit 2014. <https://vimeo.com/110883641>

Video: Creating Impact for smallholder farmers with open weather data

During the workshop "Creating impact for smallholders with weather data" in The Hague in November 2017 experiences in existing initiatives were shared to further the services for smallholders using (open) weather data. This video gives an impression and insights from participants. <http://tinyurl.com/COPWeatherData>

Book: Open Data in Developing Countries

This book (published by African Minds, November 2017) gives insights in what is needed to build an evidence base of what works and how with open data in developing countries. Authors Stefaan Verhulst and Andrew Young show with several case studies that a lot is already happening with open data around the world. One chapter is dedicated to Aclimate in Colombia, a project to opening up weather data and creating accessible weather information for farmers. <https://bit.ly/2HeUw1Z>

Working Paper: Making data work for smallholder farmers

In this CTA publication (November 2017) the authors look to for each stage of the crop cycle where open data can make the difference for smallholder farmers. <https://bit.ly/2HeUw1Z>

KUKUA Weather Stations

KUKUA works on closing Africa's weather information gap by leveraging new weather station technology and improved weather forecast accuracy. It provides accurate weather data and forecasts to smallholder farmers, commercial farmers and other stakeholders throughout Africa. The London Business School Review published an article about KUKUA in its 2016 issue. <https://www.kukua.cc/>

Climate Services for farmers

CCAFS research on climate services and safety nets works with a range of organizations to support the development of effective climate information and advisory services for farmers and climate-informed safety net interventions. These resilience-building services provide an enabling environment for smallholder farmers to transition towards more climate-smart production systems and climate-resilient livelihood strategies, while protecting them from climatic extremes. Read stories and research results for example about weather insurances and early warning systems on the website of CCAFS. <https://bit.ly/2HeUw1Z> ●