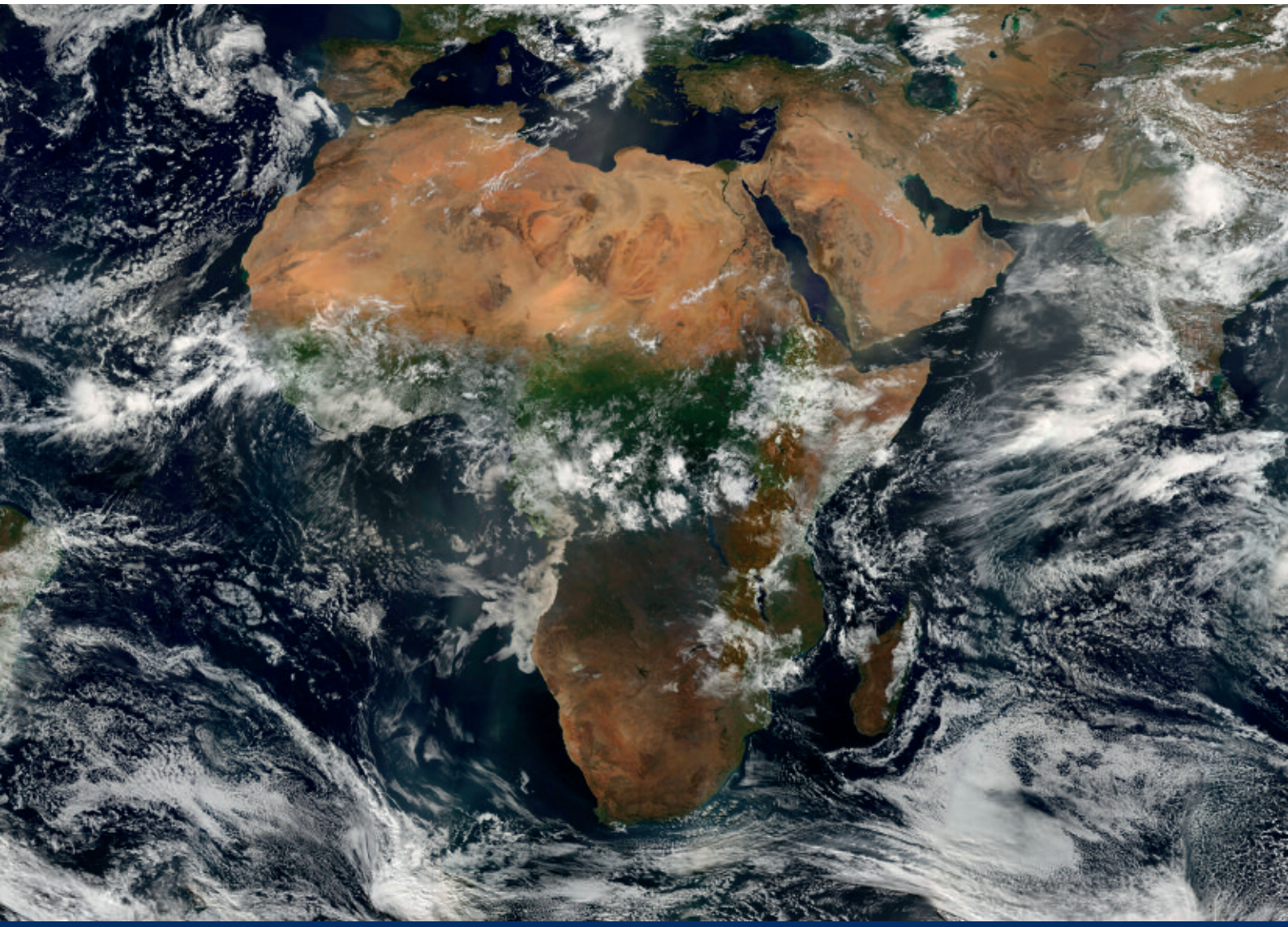
TAHMO



BELLAGIO CONFERENCE REPORT

Prepared by the Trans-African Hydro-Meteorological Observatory (TAHMO)

ROBUST CLIMATE OBSERVATION IN AFRICA AND LOW RESOURCE COUNTRIES: DEVELOPING PRACTICABLE PUBLIC PRIVATE PARTNERSHIP MODELS

Acronymns

AfDB	- **A**frican **D**evelopment **B**ank
AWO	- **A**frican **W**eather **O**pportunity
FAO	- **F**ood and **A**griculture **O**rganisation
GAIP	- **G**hana **A**griculture **I**nsurance **P**ool
GRP	- **G**lobal **R**esilience **P**artnership
HNI	- **H**uman **N**etwork **I**nternational
IBM	- **I**nternational **B**usiness **M**achines **C**orporation
KMD	- **K**enya **M**eteorological **D**epartment
NGO	- **N**on-**G**overnmental **O**rganisation
NMA	- **N**ational **M**eteorological **A**gencies
NMHSs	- **N**ational **H**ydrological and **M**eteorological **S**ervices
PPP	- **P**ublic-**P**rivate **P**artnership
PREPARED	- **P**lanning for **R**esilience in **E**ast **A**frica through **P**olicy, **A**daptation, **R**esearch and **E**conomic **D**evelopment
SAWS	- **S**outh **A**frica **W**eather **S**ervice
TAHMO	- **T**rans **A**frican **H**ydro **M**eteorological **O**bservatory
UN	- **U**nited **N**ations
WCPPP	- **W**eather and **C**limate **P**ublic-**P**rivate **P**artnership
WISER	- **W**eather **I**nformation **SER**vices
WMO	- **W**orld **M**eteorological **O**rganisation

Contents

Plates

Figures

Executive Summary

From 7-11 March 2017, participants sought to advance Public-Private Partnerships for Weather and Climate services in Africa. The conference was sponsored by the Rockefeller Foundation and held at their Bellagio Conference Center, organized and facilitated by the Trans-African Hydro-Meteorological Observatory (TAHMO). The 19 participants represented the donor community, World Meteorological Organisation (WMO), National Meteorological Agencies (NMAs), Academia, International NGOs, Private Consultants and Businesses. The conference alternated group and plenary discussion, with in-depth and focused small-team breakouts dedicated to generating illustrative prototypes of innovative partnerships.

Sustainability through Transparent Partnership

To maintain a concrete connection to current issues, country/continent specific enterprise models were developed using the business model canvas template for each Weather and Climate Public-Private Partnership (WCPPP) with the ability to contribute to the Global Observing System. Four key elements were found to be requisite to the success of WCPPP in Africa. These included forming an **equitable** partnership that will develop sustainable, useful, actionable products and services (i.e. communicating timely and relevant weather information "the last mile") with the involvement of stakeholders. Partners should provide added value, and should have a **transparent and sustainable** funding and revenue sharing mechanism. Sustainability in climate WCPPP's demands that the private parties attend to their financial stability (income versus expenses). Data management practices (data rescue, archiving, protection and use) must **respect local laws and** regulations. This generally requires sales of climate products, which must be understood and appreciated by their public-sector partners as being essential to the greater good. A crucial conclusion was that **donor community insistence on no-cost** distribution of climate products **to all users might preclude sustainability**. On the contrary, laws in many African countries, which make weather data exclusively a government asset and the concerns of Meteorological service that private weather services will undermine their future, are crucial issues to be addressed as well. Models that provide data freely to public institutions while selling data and services to private parties were found to satisfy the goals of donors while allowing sustainable operation and the WMO Resolution 40.

Partners should provide added value, and should have a transparent and sustainable funding and revenue sharing mechanism.

Deep Collaboration

Participants were in consensus that WCPPPs must add value to meteorological agencies, thus strengthen them, recognizing that they **do not replace** agencies core social functions (e.g., identifying and disseminating weather and climate information to the public). It is important that meteorological agencies do not feel threatened by engaging the private sector, rather each sector focusing on being successful in their roles. It should be noted that National Meteorological Services stand to benefit greatly from support from the private sector with improved sensor technologies and development of capacities in data assimilation (including the increasing availability and accuracy of satellite data) and Numerical Weather Predictions, which are best undertaken at continental and global scales, and require a great deal of non-meteorological skills and computational resources.

Conference evaluations showed that most participants found it uniquely enlightening, benefiting from the diverse backgrounds and perspectives. The venue and program provided a powerful atmosphere to advance models for public private partnerships. The business models developed will be implemented by the participants with the support of other partners across Africa. However, some questions were still left open and may need further discussions. This includes the relationship between PPP observation networks and the principles of the Global Observing System especially WMO resolution 40. A preliminary discussion on this is given in Annex 2.

1. Introduction

1.1 Background

There is broad agreement that national meteorological services in Africa have not been able to sustain adequate meteorological observation or forecasts over the past 50 years. Some argue that short-term project-based funding from donors have undermined governmental support for national meteorological services by making it appear that donors might provide resources for day-to-day operations. Some donor funding also went to procurements of equipment without sufficient support for the staff training, maintenance, and other budgetary support required, resulting in the widespread existence of non-reporting systems. Acknowledging the collapse of many public-sector services in the area of meteorological observation in Africa (Figure 1), Public-Private Partnerships (PPPs) have been touted as one solution to this decline, but real-world examples in developing countries of sustainable PPPs that assist national meteorological services are hardly found except in South Africa and Kenya where this is currently being tested. Is there a role for donors in PPPs in developing **sustainable** climate observation in Africa?

The goal of this meeting was to bring a team of representatives of the key players in African meteorology to develop a concrete framework for sustainable PPPs to address the long-term observation and forecast needs of Africa. The Trans-African Hydro-Meteorological Observatory (TAHMO) called for, organized, and facilitated this meeting reflecting TAHMO's mission to improve climate observation throughout the African continent. TAHMO's strategy is to improve meteorological observation through deep and sustainable public-private partnership with National Meteorological and Hydrological Services (NMHS) and other partners to provide accurate forecasts across Africa. As of November 2017, TAHMO will jointly operate over 500 meteorological stations with Meteorological services across Africa (relative to Figure 1, this is an average of 20 per 1,000,000 km^2 in Sub-Saharan Africa, though they are not uniformly distributed), with an ultimate goal of 20,000 stations operating across the continent (selected to provide for one station per 1,000 km^2). Reliable weather prediction is essential to improve crop yield, and to build early warning systems, and for cli-

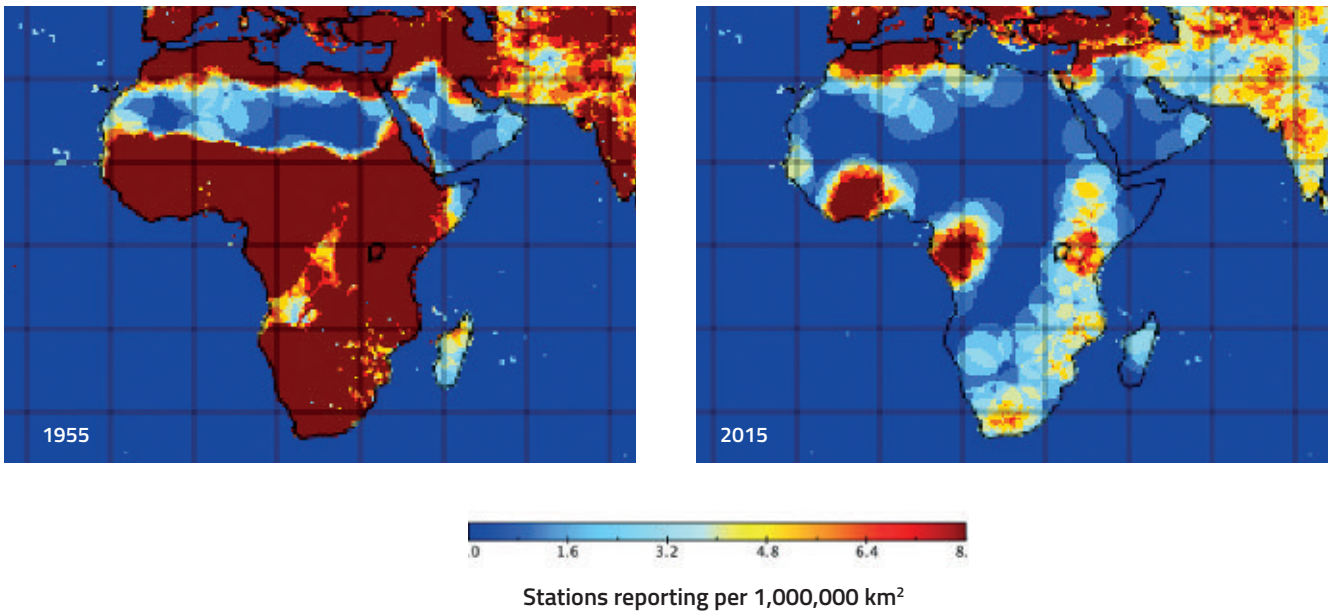


Figure 1: The development of the observational crisis of Africa (data from the Climate Research Unit of the University of East Anglia, 2017) showing the decline in reporting stations for precipitation in Africa between 1955 and 2015. While in 1955 there were generally over 8 stations reporting, the current conditions in Africa have no stations reporting in many regions of 1,000,000 km^2.

mate resilient development. Through its activities, TAHMO identified that both donors and recipient meteorological agencies found the current framework to be unsustainable, despite the considerable human and financial investments made. Thus, in April 2016, TAHMO submitted a proposal to the Rockefeller Foundation to organize a conference with the goal to develop a framework for sustainable private public partnerships business models to improve climate observation in Africa and least developed countries. The proposal was accepted and the conference held from 7-11 March 2017 at the Bellagio conference centre in Italy.

1.2 Conference Participants

The participants were drawn from various organisations including TAHMO, the African Development Bank (AfDB), World Meteorological Organisation (WMO), Secretariat of Water & Climate Services in the Netherlands, Food and Agriculture Organisation (FAO), Kenya Meteorological Department (KMD), Cameroon Meteorological Service, Meteorological Service Benin (Meteo Benin), South Africa Weather Service (SAWS), Ghana Agriculture Insurance Pool (GAIP), International Business Machines Corporation (IBM), Human Network International (HNI) and Vodafone; representing funding agencies, private consultants, NMHS, Academia, private sector companies and Non-Governmental Organisations (NGOs) having an interest in climate observation systems. Their two co-directors Drs. John Selker and Nick van de Giesen as well as the TAHMO CEO Frank Annor and Operations Manager Rebecca Hochreutener represented TAHMO. The list of participants can be found in *Annex 1*.

PPPs have worked in other sectors of the African economy so why not weather and climate?

1.3 Approach

The conference was attended by some of the world's most experienced individuals and organizations with a goal of leveraging these insights to develop guidelines for the establishment of *practicable* PPPs to advance meteorological observations as well as development and delivery of meteorological products in Africa. There were short presentations followed by frank and productive group discussions (see Plate 1 – 3 brainstorming by groups) and plenary sessions. Three teams were formed with five members each and the TAHMO Reps made rapporteurs of these teams. Their tasks were to draft sustainable Weather and Climate Public Private Partnerships (WCPPP) to sustainably deliver essential and currently unavailable climate products and services. PPPs have worked in other sectors of the African economy so why not weather and climate? What are the unique challenges of NMHS in Africa? What are the key features needed for PPP success in this specific domain? Are donor funds currently helping or hurting, and can we develop advice to improve the success of such investments? These were some of the guiding questions for the development of the framework. By bringing the best "minds" in meteorological systems, African governance, business uses of climate data, development partners, and academia, could we develop a framework for sustainable WCPPPs for meteorological observation for Africa, least developed countries, and other countries lacking adequate weather and climate observation? The ambitious goal was to envision operational models that would lead to highly accurate, reliable and accessible data streams for purposes of governance, business, agricultural productivity, and knowledge building of the climate trajectory.

2. Key components of a functioning PPP in meteorological observation

2.1 What should meteorological services deliver and what partnerships are required?

NMHS need to focus on "Impact based forecasting:" information from which people can take action. The utility of the information - the value it has for users - is the key metric of success for any meteorological observation system. This implies that the entire "ecosystem" spanning observation, quality control, incorporation into products, and dissemination of those products must be included for efforts to improve services to be successful.

While excellent observation is the foundation of accurate forecasting, the short-term emphasis should be on actionable weather *information* (as opposed to weather data), with these activities supporting the long-term understanding of climate change. Ultimately, some end users of meteorological observation systems (e.g. farmers) require both immediate weather forecasts for operations and long-term trends for strategic planning. Long-term climate observations are more demanding, requiring absolute calibration of sensors; long-term site metadata; and sites, which will be suitable for decades of operation. Success in meteorological observation demands a clear plan and continuous attention, and can be disrupted by short-term projects and programs promoted by donors.

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The societal value arising from meteorological observation systems is dependent on the function of the total value chain – single weak links can obviate efficacy. Four main links were identified: observations, transmission, processing/interpretation and service delivery. Brittleness in the meteorological value chain in the African context is common, a key issue that PPP can address. Beyond basic functions, the spectrum of end users is diverse, both regionally and in the nature of concerns. This is again an area with engagement of the private sector can expand the reach of the work of the NMHS to address the many niches of activities requiring meteorological information.

Farmers, often taken as a monolithic example of an end user group, are in fact diverse, ranging from subsistence to multinational, and need information relevant to timescales that span daily to seasonal. Many farmers need specific guidance on which variety to plant, and when to plant, apply fertilizer, and harvest. Crop-specific information can be vital, e.g., wind forecasts for bananas. It was believed by the participants that the even smallholder farmers in Africa are experienced enough to translate weather predictions for seasonal and daily decision-making, but they need very basic data, which may be presented symbolically. Expression of uncertainty in the seasonal forecast is an important challenge.

Modes of delivery are evolving rapidly. While radios are less depended on as the main channel of communication in urban areas, they are still very common and highly relied on in rural areas, so identifying locally appropriate means of transmitting weather information is critical. While most urban end users have smartphones, their **rural counterparts have basic feature phones.** This has stiff implications for the platform for communication of climate and weather information. In Kenya, for example, there is a model to link dissemination of weather information to Agriculture Extension Services where the Meteorological Agency will pay particular attention to translating the information into common "languages" and infographics best understood by extension agents and farmers they work with in local dialects.

The proper role of the private sector in generating and sending weather-based alerts was seen as unresolved. In most countries participating in the WMO, the NMHS is regarded as the only body with this authority, to retain social order in times of crisis. It was agreed that governments must manage the outcome of messaging, so they must have the ability to control emergency communications at a high-level. This does not mean they must be the

only source of these communications. Just as private radio stations have historically assisted governments in dissemination of alerts, which in most times have been mandated per their licensing conditions. However, in current time the modalities of reaching the public with urgent messages cannot be limited to purely official governmental channels (e.g., private cellular telephone networks are now a critical mode of communication in Africa). Given the interwoven data sources (from satellites to on-the-ground weather stations), sources of warning data (from human to model-generated alerts), it is clear that private sector engagement in African observation systems and extreme weather alerts will require a paradigm shift: **while retaining fundamental governmental authority over the content of the messages, they could be issued by diverse entities under negotiated agreements**. Weather Apps communicating forecasts in passive modality (i.e., not pushing-out emergency alerts) need not be restricted, however these must be distinguished from government approved forecasts/alerts/data that can be seen to be official communication.

A participant cited Genesis 41 in the Bible as an example of how changes are required to move African observations in the right direction. There is the need for a "Joseph" in every Meteorological Agency to discern changing times, climate and technology and gradually prepare them and their citizenry for these changes through policy changes. Many previous African Early Warning Systems (EWS) have not worked satisfactorily due to the lack of proper engagement of all relevant stakeholders including the private sector and citizenry, as well as other deficiencies in the weather services "value chain." Key areas NMHS need support from the private sector include improvement in sensor technologies and capacity development in data assimilation and Numerical Weather Predictions. Improving these systems may require the reform of laws and regulations. This is not expected to be easy or immediate, but we feel should be addressed in the next 5 years through issuance of guidelines by the WMO and NMHS.

African meteorological observation has failed not for lack of short-term investments, but rather a nearly universal lack of long-term sustainable models required for maintenance of equipment and servicing of social needs.

WCPPPs should always seek to provide added value, thus strengthen the climate services received by the public, while retaining the critical core social and governmental functions provided by NMHS. The communication and dissemination of information, however packaged, should carry the label of the NMHS to reinforce their role and authorization of the services. In this way, the NMHS will not shy away from engaging the private sector.

2.2 Funding and revenue generation

There has been a deeply problematic history of funding institutions providing resources for isolated technology packages and short-term projects that have become white elephants, or non-functional systems due to the **lack of long-term support**. This may be broadly seen as "project" support rather than "enterprise development," pointing to the fact that meteorological observation is intrinsically a long-term proposition, whereas projects are short-term. An enterprise, be it a government agency or a PPP, is designed and managed for sustainability. It is

clear that African meteorological observation has failed not for lack of short-term investments, but rather a nearly universal lack of long-term sustainable models required for maintenance of equipment and servicing of social needs. Commitment to a long-term vision that fits all the elements required for sustainable climate observation must now be demanded. Across the African continent, government funding to meteorological services is far below that required to keep networks at operational levels. The most critical issues are funds to provide sustained observation and delivery of essential information. Donors and funding agencies must be **internally** and externally vigilant in confirming that investment is made within credible sustainable models of operation. Short-term investments of all kinds (repair of dysfunctional equipment, one-time training of staff, adding vehicles, etc.) will generally not resolve the critical lack of long-term observation of African meteorology. Moreover, what is less often appreciated is that short-term investments and projects actually undermine the viability of national meteorological agencies. By setting an example of meteorological activities as being an area of donor interest, governments then often, back away from their own investment expecting that donor income will cover operational costs. As one example of a potential long-term approach, a **performance-based endowment** for climate observation would be hugely influential, and the cost would be no greater than currently envisioned expenditures by donors. If resources were delivered with oversight that confirmed proper use and performance, this could be the foundation of permanent solutions to observation and dissemination of climate information in these countries. While the donor community sees such a long-term role as developing dependencies, the facts on the ground suggest that this will be needed to provide access to sustainable meteorological data/information, which will be essential for **global** food security and stability, thus providing benefits far beyond the borders of the countries carrying out the measurements, and thus are appropriate areas for sustained external support.

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It has been suggested that it is morally unacceptable to sell weather and climate data, while others see that precisely such revenue will be essential to sustainable weather and climate observations. It was strongly argued by some participants that both commercial and citizen users should be asked to pay for specialized meteorological data and services. Free services are often seen as valueless. "Skin in the game makes a system work." A Dutch experiment in Ghana showed that people were willing to pay for actionable information and service delivery (small farmers willingly paid $6/season). The meeting participants indicated that current official perspective on

"open data" is that it may be obtained by all, but it may not be FREE to all users for all purposes. This distinction was seen by the participants to be critical to sustainability and consistent with WMO resolution 40, but also as being widely misunderstood by donors and meteorological services.

This issue reflects the debate surrounding resolution 60 at the 2015 congress of WMO, where Africans did not feel data could be sustainably shared without some being charged – seeing the need for support of observations - Europeans disagreed. African countries want to retain the ability to generate revenue from weather data. This makes them resistant to let these data out as it may compromise future earnings. It must be recognized that regardless of the desired income, sale of meteorological data as a source of revenue has been largely unsuccessful, compounded recently as the NMHS are being overtaken by increasingly available and accurate private sources of weather data and products. A **continental (rather than national) marketing strategy** through a private enterprise marketing sharing the benefits with the NHMS and other partners appears feasible, a source of superior value-added weather data, much more likely to generate revenue.

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2.3 Data recovery and management

There is an urgent need to translate data currently in paper files to digital systems (i.e. data rescue). These records are required for hydrological prediction, crop and general insurance products, and to understand climatic trends. Financial support is somehow selectively being provided by donors to achieve this outcome, however, there is considerable concern that these efforts may not be successful. Countries feel the involvement of data-hungry partners in the data rescue mission will make them more prone to the loss of income through data sales. Currently the data archives in Cameroon, for example, fill half a building, going back to 1900. The situation is similar in many African countries. In

Cameroon, for an example, data rescue is planned to start in 2018 conducted by a private business. However, the contracting processes are not necessarily focused on data quality; hence, it is quite possible that the companies carrying out this process may not be properly qualified, and that the data will not be closely checked for errors which commonly occur when interpreting hand-written archives. Greater engagement of the WMO or other international review of these efforts may be essential to obtain high quality outcomes. Donors would be well to consider providing free oversight services to assure high quality data rescue. How the private sector can be engaged in a more constructive way that leads to a win-win situation for all stakeholders involved with the climate observation systems remains an open question, and must be considered carefully on a case-by-case basis, representing another critical role for NHMS.

3. Business cases developed

3.1 Business Model Canvas

The business model canvas approach was adopted as a template for the development of three business models that were to be actionable and feasible to be implemented shortly after the conference. The role of this activity was twofold: first, we sought to assure the ideas and conclusions of the meeting would be based on actual examples of WCPPPs; and secondly, we saw an opportunity to generate novel and interesting WCPPP opportunities that might expand the concept of activities suitable for such an approach.

WCPPPs can add value and leverage national investments, making the NHMS more visible and attractive to the citizenry and government for appropriate budgetary allocation.

The three business models were developed over the course of three 2-hr sessions, with the final session undertaken by re-mixed teams, so people had a vision for how the conversations went in parallel conversations. The Cameroon business model sought to develop a strategic approach to bringing weather data to regional clients, such as hydropower and mining interests. For Kenya, we developed a model wherein a commercial climate prediction service paired with the Kenyan Meteorological Department to deliver a Famine Early Warning System and tailored weather data to farmers and citizens. The third model was a continent-scale climate business incubator, where a small team would launch a company supported by the member weather services to help countries build business cases for weather and climate opportunities that private investors could address. Opportunities were developed as examples that could be scaled up. In all models, national governments continue to play a pivotal role in WCPPP arrangements.

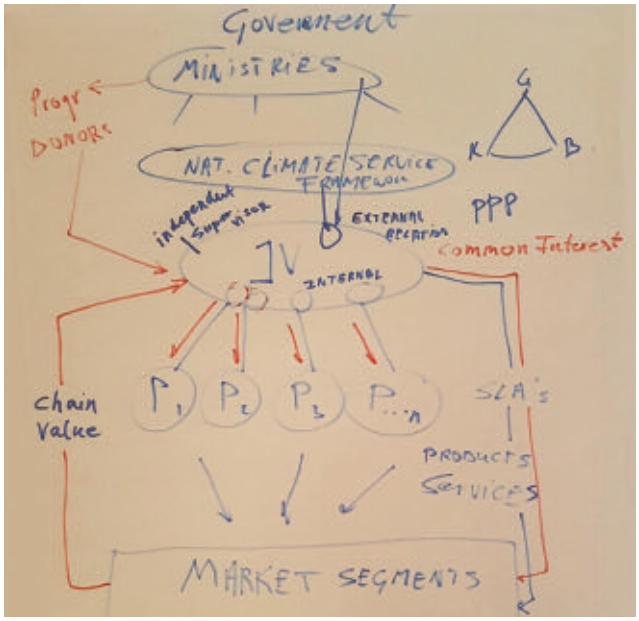

Figure 2: Framework for cooperation in the Cameroon business case.

A fourth currently active WCPPP was presented by the South African Weather Service (SAWS), but not worked out into a business canvas. SAWS have collaborated with a water-information firm, HydroLogic, to build a complete value chain for weather services. The chain consists of four parts: data gathering, data platform, application development, and market portal. The links along the chain consist of standard micro-contracts, ensuring that money collected in the market portal finds its way back up the chain to sustain data collection and curation. This is an existing functional WCPPP that, as such, deserves wider attention.

It was noted that no meteorological agency in the world is fully autonomous (financially), relying on only internally generated funds for their operational activities including staff salaries. African governments generally support NMAs staff salaries; however, funds for operational activities are continuing to dwindle due to budget constraints, and perhaps the lack of interest in the sector vis-à-vis other national priorities, resulting in a downward spiral of fewer resources and lesser outcomes. WCPPPs can add value and leverage national investments, making the NHMS more visible and attractive to the citizenry and government for appropriate budgetary allocation. One sure way to enhance the stature of NHMS is to deliver localized, accurate, reliable and accessible weather and climate services to the populace with the support of the private sector. Under current conditions this is a "chicken and egg"

puzzle - the NHMS require more funds to improve their services, but they need to improve their services to attract more funds. This is the dilemma, but at the same time, it could be seen as an entry point for WCPPPs. The three business canvases that seek to address these issues, are presented in the following sections.

3.2 The Cameroon Business Model on hydropower

The Cameroon model adopted a framework where the Government, knowledge institutions and businesses (often referred to as the Golden Triangle) play critical roles in the Public Private Partnership arrangement drafted (see Figure 1). The focus for Cameroon was the energy sector, which was saddled with low energy generation because of reduced stream flow, low capacity and low efficiencies in power generation and distribution, which has led to long periods of power rationing. Coupled to this problem is the need for trade-offs between Agriculture upstream and hydropower generation downstream that provides 90% of its energy generated to an aluminium company in the country. The area of interest for this exercise was the Sanaga catchment where the hydropower company has installed rain gauges along the river - one every 100 km. The main stakeholders in the catchment are the Power Company, Government (for planning), farmers and CAMWATER (for domestic water supplier). A coupled water balance and water allocation model that is fed by high-resolution hydro-meteorological data is needed. The business model canvas is presented in Figure 3.

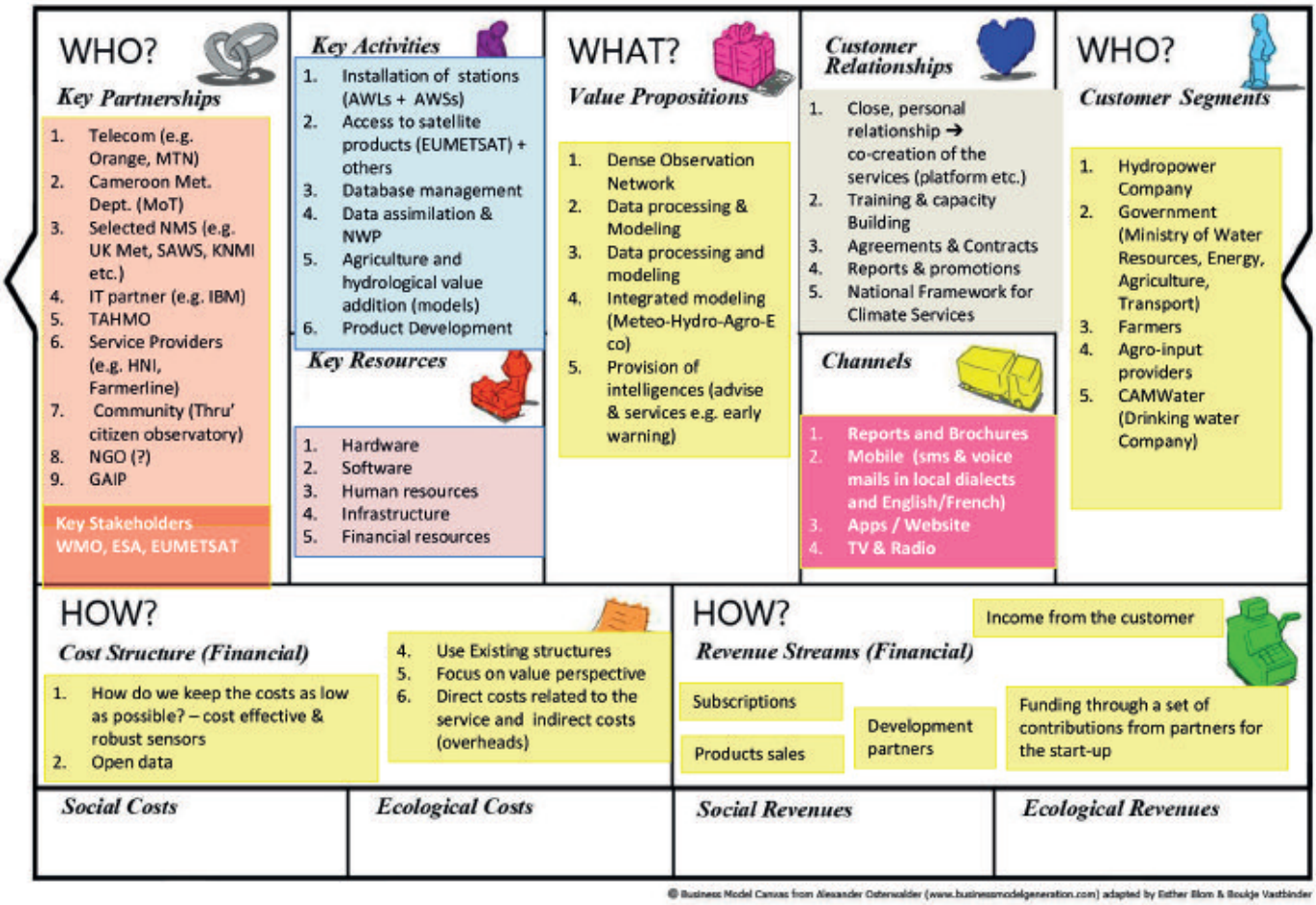

Figure 3: The business model canvas on climate observation for Cameroon.

3.3 The African Weather Opportunity

The African Weather Opportunity (AWO) was proposed as a collaborative effort of weather services from across the continent to enable businesses to efficiently engage with multiple NHMS to seek private partnerships to produce valuable (needed) meteorological products. Responding to the perception that the private sector invests its' resources only where there is a high return on investment, and that important opportunities for profit might be hidden to many businesses, this model sets out to present high-value business opportunities which would serve the goals of the meteorological services, to the private sector. The opportunity will be identified in detail, specifying the nature and quality of the products and services required, and might include pre-packaged financial packages to incentivize the private engagement. The AWO would retain a small interest in the deals, which would ultimately be the source of its financial support. It will at the same time offer the private companies the opportunity to engage several countries (governments) in just one secretariat ("one-stop shop") thereby reducing their overall costs in negotiating business deals with individual NMAs which can block advancement due to cost and un-predictable time to reach an accord. For example, TAHMO has found that developing memorandum of understandings with countries has frequently taken over two years of negotiation, presenting an unpredictable obstacle most businesses cannot afford to take on.

farmers do not only need insurance products, but also famine early warning systems that will guide them on what to grow, when to grow and when to undertake certain farming activities.

This approach will provide the donor community with an opportunity to replace aid with trade for a high return on their investment, which is currently not always the case. The business model will also ensure that critical needs of end users (e.g. farmers) are addressed since they will only pay for valued services and products. In so doing, the NMAs will gain visibility and revenue streams to make them more relevant to their populace while the private sectors get some returns on their investment in an enabling environment.

Structurally, the AWO will set up an AWO Board of Governors that will consist of participating NMAs, private companies, Donor Agencies, Government Officials, and International NGOs. This board will develop the climate opportunities, which will be issued as Request for Proposals (RFPs) for climate Observation systems. Each RFP will precisely define the opportunity and the expected benefits and returns from a successful response to the opportunity. The board will then evaluate the responses to the RFP, award the contract and supervise these contracts, such as fulfillment of partnership agreements with the NMAs; poverty-alleviation benchmarks; evaluate dissemination to the target groups; and evaluate sustainability and profitability. The proposed business model canvas is presented in Figure 4.

3.4 Farming decision support through weather predictions in Kenya

Some fieldwork on this model had already been carried out prior to the conference; hence, this undertaking was much more hands-on and based on detailed background from existing conditions and partnerships. It was realized that existing projects on weather for agriculture have not always delivered to the expectations of end users and donors due to duplication of activities and non-localized information shared. Dissemination of information to farmers has always been an issue, which was once again highlighted after Kenya was hit recently with drought that has brought international attention to the limitations of early warning and drought preparations . Agricultural insurance is not deep rooted in Kenya, although there are several organizations and projects including PREPARED, ACRE-Africa and Jubilee Insurance that are providing these services. The Kenya Meteorological Department and TAHMO are partners to some of these organizations and represented on the PREPARED project. Smallholder farmers have not fully bought into the idea yet. Nevertheless, it remains an area of high

potential with significant business opportunities. The Kenyan Government has promised to subsidize the payment of premiums for some farmers who cannot afford them so the market potential is huge. This market potential is highly dependent on the subsidy required, private and public sector support and interests and how these could be sustained. The question is, therefore, do we have the climate products and services to satisfy these needs? In this context, we point out that farmers do not only need insurance products, but also famine early warning systems that will guide them on what to grow, when to grow and when to undertake certain farming activities. Their willingness to pay for these services is uncertain, and depends greatly on the reliability of the information. A high-quality pilot project will likely be needed to determine which information is most useful, develop confidence in the products, and determine the willingness to pay among the diverse scales of farms in Kenya. Projects like PREPARED and WISER and initiatives like TAHMO have provided some foundation on which this business model can be built. With respect to the Kenya model, data ingestion into models from ground stations (KMD and TAHMO) is already on going, end-user surveys have been carried out, and partnership agreements are already in place. The key addition to the Public Private Partnership is IBM, which will support the team with data assimilation (ground data and satellites), analytics and localized predictions for farmers. IBM is "testing" the market and therefore has not much interest in the local market hence will provide their services

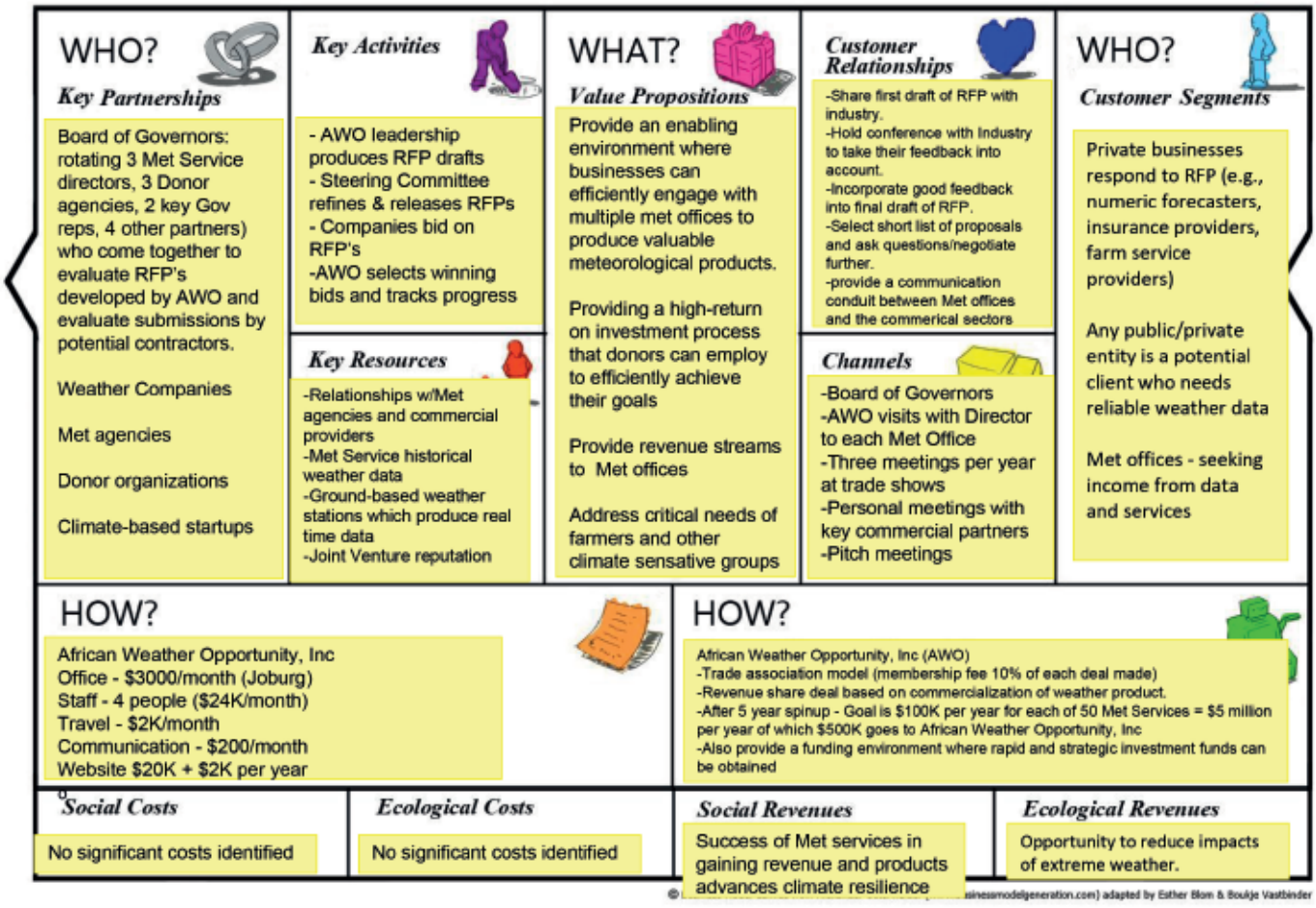

Figure 4: The African Weather Opportunity Business Model Canvas

on a voluntary basis for a start while building confidence and trust with the other partners involved to define a sustainable business model for them. TAHMO will support the team with ground observations, data integration and quality control and quality assurance mechanisms. The Kenya Meteorological Department will translate the weather predictions into useful information that would be sent to farmers in local dialects via SMS and voicemails. An application would be developed and made accessible for end-users on smartphones and (basic) feature phones to provide, for a small fee, forecasts with scopes spanning daily to seasonal scales targeting their local activities.

It is envisioned that general weather information will be free of charge. What is critical to note is that farmers not only need weather information but a bundle of services including agro-advisory services, farm input and market price tips, loans, insurance etc. which will be provided through the partnerships developed. The concept is that this product will ultimately be a one-stop shop with all value addition players having significant roles to play as well as receiving some of the benefits from the revenues generated. It is planned that accurate point (smaller than 2km x 2km resolution) weather forecasts will be generated and disseminated. Seasonal forecasts that translate probabilities into rainfall amounts (or quanti-

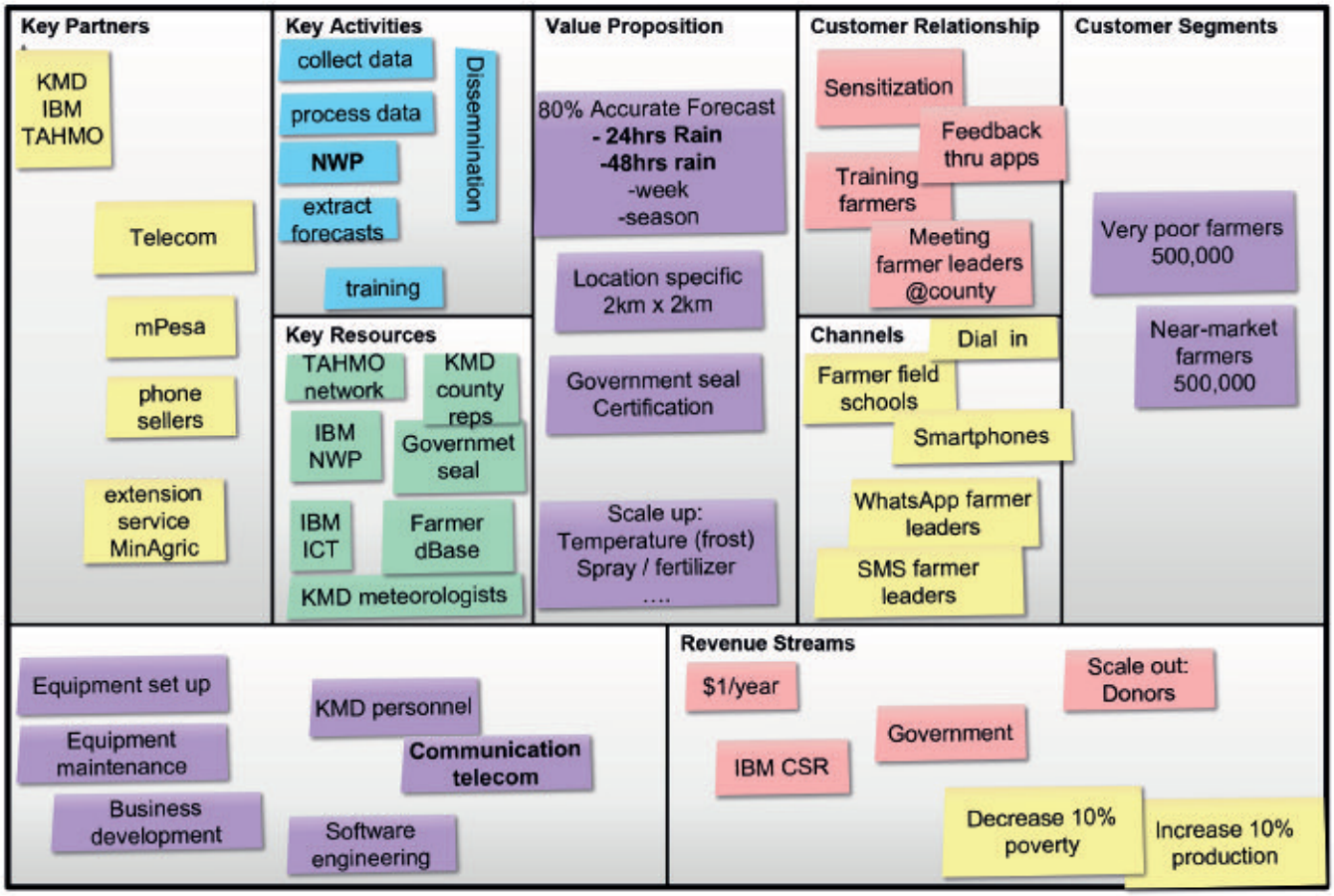

Figure 5: Famine Early Warning System for Kenya Business Model Canvas

ties) will be provided. Information will be tailored for crop farmers, pastoralists and dairy farmers. The model will start with crop farmers to address any developmental issues. The goal of this business model (pilot) is to significantly address food security and poverty reduction among crop farmers in Kenya. An initial target of 1 Million farmers is planned within 2 years of rolling out the model. It would be made affordable to both commercial and peasant farmers. It is planned that farmers will be charged US$1/farmer/year to access the full service. The service will be promoted via peer-to-peer promotion, advertisement in the mass and print media, through farmer associations and cooperatives, farmer training schools, projects such as PREPARED, Global Resilience Partnership (GRP) and WISER, organization of Extension Agents and farmer workshops, schools (student-ambassadors) through TAHMO and GLOBE with the support of the Ministry of Education and Agriculture, through KMD, Strathmore University, TAHMO, IBM and other partners social media platforms etc. It is worth noting that for such models (the Kenya model) to work, a significant degree of coordination within government and local authorities is needed which happens to exist in Kenya but may not be available in other African countries. It required some amount of effort, private investments and time to get these partnerships working which is often not very much appreciated by projects with very short durations.

The model would be developed to create a cycle of increasing dissemination due to positive product-public awareness, support and utilization - revenue generation and improved (and new) products and services. The business model will be sustained through revenue generation from delivery of products and government support and likely to be started with seed money from the Donor Agencies (such as the Global Resilience Partnership, the Green Climate Fund, USAID, the Dutch government, Kenya Government, African Development Bank, the World Bank) and private parties such as IBM. The donor support will be based on what is termed here as the regulated model (i.e. money paid on attainment of milestone (results-based payment, procurement plan and logical framework). The idea is not to focus on business - revenue generation but rather top-notch sustainable product and service delivery. Partners include:

- KMD (interpretation of forecast and making it more localized + Data Integration Station installation & Maintenance);
- TAHMO (Data integration, Station installation & Maintenance and Quality control & Quality Assurance);
- IBM (Data analytics, data assimilation and predictions);
- PREPARED (end-user engagement and maintenance of web platform for the dissemination of project results);
- WISER (Data support and integration);
- FAO (Advisory service - use of crop models e.g. Mosaic model);
- Donor community (provide seed money and ensure sustainability of the model for poverty alleviation);
- Safaricom (SMS and voice messaging platform maintenance);
- Agro-input providers (provide farmer database and market the products and services);
- Kenya Seed (provide farmer database and market the products and services);
- Red Cross (provide farmer database and market the products and services); and
- Government Agencies and Ministries (seed money and an enabling environment).

The business model canvas is presented in Figure 5.

4. Conclusions

The conference offered the participants the opportunity to understand the concept of public private partnership in the climate sector and to discuss partnerships. Case studies and business concept development pointed out strategies that have worked and failed. The key observation was that climate observation in Africa has failed due to **a lack of emphasis on achieving sustainable long-term strategies**. Participants offered the example of countries that have sought to privatize their weather services even though there are **no examples globally of success in this (fully private or autonomous in terms of budget allocation) concept.** Similarly, donor agencies have focused on **provision of hardware and capacity building** without necessarily addressing the fact that most of the institutions receiving these investments do not have sustainable frameworks to maintain and build on these investments. Finally, while Public-Private Partnerships (PPP's) have been highly touted, in most cases they have been proposed in frameworks, which have also not addressed **underlying unsustainable frameworks**. Simply having a private company provide a hardware or software solution which can **only be continued if donor funds are forthcoming** is not sustainable unless and until donors are willing to commit to permanent funding of African meteorological organizations. The bottom line was that simply "more of the same" would not change the downward trajectory of climate observation in Africa. Until the right investments are done and weather and climate support provided a bit differently, we should not expect the Africa climate and weather observations to change that much from its downward trajectory. There is the need to test new models that demonstrate the potential for self-sufficiency and sustainability. It will come at a cost because there will be the need for a paradigm shift from all key stakeholders.

The meeting set out to challenge these failed models and introduce the tools participants and the African Climate Community could employ to develop sustainable, high-impact PPP's. This included the introduction of business canvass methods of framing an entrepreneurial opportunity. Three potential PPP's were developed, and are presented in this report, to concretely demonstrate the possibility of developing novel and viable PPP's, validated by the diverse and experienced meeting participants. So as not to work only in the hypothetical domain, the concrete example of TAHMO's new model for continental-scale climate observation was presented. TAHMO's business model based on the commercial value of continental-scale observation of the African Climate was shown to be viable, and to provide essential support to national meteorological offices. Sustainability was illustrated with the over $1,000,000 in private contracts held by TAHMO. The data obtained from these contracts are then fed directly to the Meteorological offices in the countries which host TAHMO stations AT NO COST to the local government. TAHMO then also supports local Meteorological offices by paying their staff to install and maintain the stations. With 500 stations to be operating in 20 countries by the end of 2017, this shows the potential to develop deep PPP relationships that completely re-write the framework for African climate observation.

Through the development of the three new PPP concepts to address specific needs, meeting participants found that business models developed for African climate observation countries have much in common, but significant distinctions reflecting climatic regime, cultural and legal contexts. From the plenary discussions engaging representatives of companies, governments, and donors it became clear that donor support was not evaluated for sustainability as closely as are investments from private parties. Specifically, private companies must verify that investment will result in clear and commensurate sustainable outcomes. It was seen that applying these same criteria in the case of donor-supported undertakings would be beneficial, while funneling funds in without such analysis actually causes long-term damage to African climate observation, despite the positive intentions. Over-reliance on

donor short-term support has crippled most African institutions from doing things differently, rather building dependency on there being new projects rather than addressing long-term social needs. Seeing that resources are only available for special projects, governments conclude that their meteorological services should be able to live on these significant project funds, whereas these funds are generally not designated for the on-going un-funded operational needs. At the same time, many private players in the meteorology domain are primarily interested in short-term consulting and provision of profitable hardware sales, rather than investing in long-term relationships that will result in sustainable climate observation. There is natural resentment among meteorological services in engaging with the private sector in developing a market for climate products and services which may ultimately fail.

TAHMO's business model based on the commercial value of continental-scale observation of the African Climate was shown to be viable, and to provide essential support to national meteorological offices.

It was notable that many donors, NGO's and UN agencies propose that climate observation services should be delivered without charge, considering climate services as social/public goods. This approach may be feasible with well-funded government service in industrialized countries. African meteorological agencies will find it difficult to meet the expectations among their populace and governments by proposing that free data access for all is possible in the funding environment found in Africa. The weather and climate services and products are needed to promote food security and to eradicate poverty in Africa and must obtain on-going support generated from the entire commercial and citizen stakeholders. These services are not necessarily expensive, for example supported almost entirely by advertisers in the case of the global climate services provided by EarthNetworks, The Weather Company, Accuweather, and others. This might seem very simple but could be complex if the business arrangement is only based on revenue sharing.

The international context within which the provision of weather and climate observations and services are made is important. This relies on the successful operation of a global observing system (GOS) which is a real achievement that benefits everyone either directly or indirectly. There is therefore the need to consider the interdependence the international community has on the continued operation of the GOS and the essential principles agreed under WMO resolution 40 while ensuring that African observations are improved and maintained through supplementary networks such as those from TAHMO and others while maintaining standards agreed on.

The engagement of a multi-disciplinary team made up of donor agencies (e.g., the African Development Bank, WMO, and FAO), NGOs, international companies (e.g., Vodafone and IBM), private consultants and national institutions (GAIP, and the Meteorological Agencies) provided a unique crucible for the development of new ideas for sustainable climate observation by partnering public and private interests. The meeting ended with optimism that truly sustainable climate observation was possible specifically based on PPP's. The test of sustainability must be rigorous, and it was seen that current models for donor intervention often fail to address this simple, but demanding, criterion. At the same time, many private parties satisfy themselves with short-term gains, rather than investing in the creation of systems that are viable for the long-term. The meteorological agencies should also not expect private investments to have low returns on them.

The TAHMO team and all participants were deeply grateful to the Rockefeller Foundation Bellagio Committee for the opportunity given to have this conference.

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Annex 2: Discussions on WMO Resolution 40

It is a very good idea to directly address WMO resolution 40, as this is often an area of concern and confusion. Just to make sure everyone is on the same page here, the WMO resolution 40's contents, which in terms of adopted aspects, are exactly these (as published by the WMO at http://www.wmo.int/pages/prog/www/ois/Operational_Information/Publications/Congress/Cg_XII/res40_en.html#1):

1. **Adopts** the following policy on the international exchange of meteorological and related data and products: As a fundamental principle of the World Meteorological Organization (WMO), and in consonance with the expanding requirements for its scientific and technical expertise, WMO commits itself to broadening and enhancing the free and unrestricted international exchange of meteorological and related data and products;

2. **Adopts** the following practice on the international exchange of meteorological and related data and products:

   (1) Members shall provide on a free and unrestricted basis essential data and products which are necessary for the provision of services in support of the protection of life and property and the well-being of all nations, particularly those basic data and products, as, at a minimum, described in Annex 1 to this resolution, required to describe and forecast accurately weather and climate, and support WMO Programmes;

   (2) Members should also provide the additional data and products which are required to sustain WMO Programmes at the global, regional, and national levels and, further, as agreed, to assist other Members in the provision of meteorological services in their countries. While increasing the volume of data and products available to all Members by providing these additional data and products, it is understood that WMO Members may be justified in placing conditions on their re-export for commercial purposes outside of the receiving country or group of countries forming a single economic group, for reasons such as national laws or costs of production;

   (3) Members should provide to the research and education communities, for their non-commercial activities, free and unrestricted access to all data and products exchanged under the auspices of WMO with the understanding that their commercial activities are subject to the same conditions identified in Adopts (2) above;"

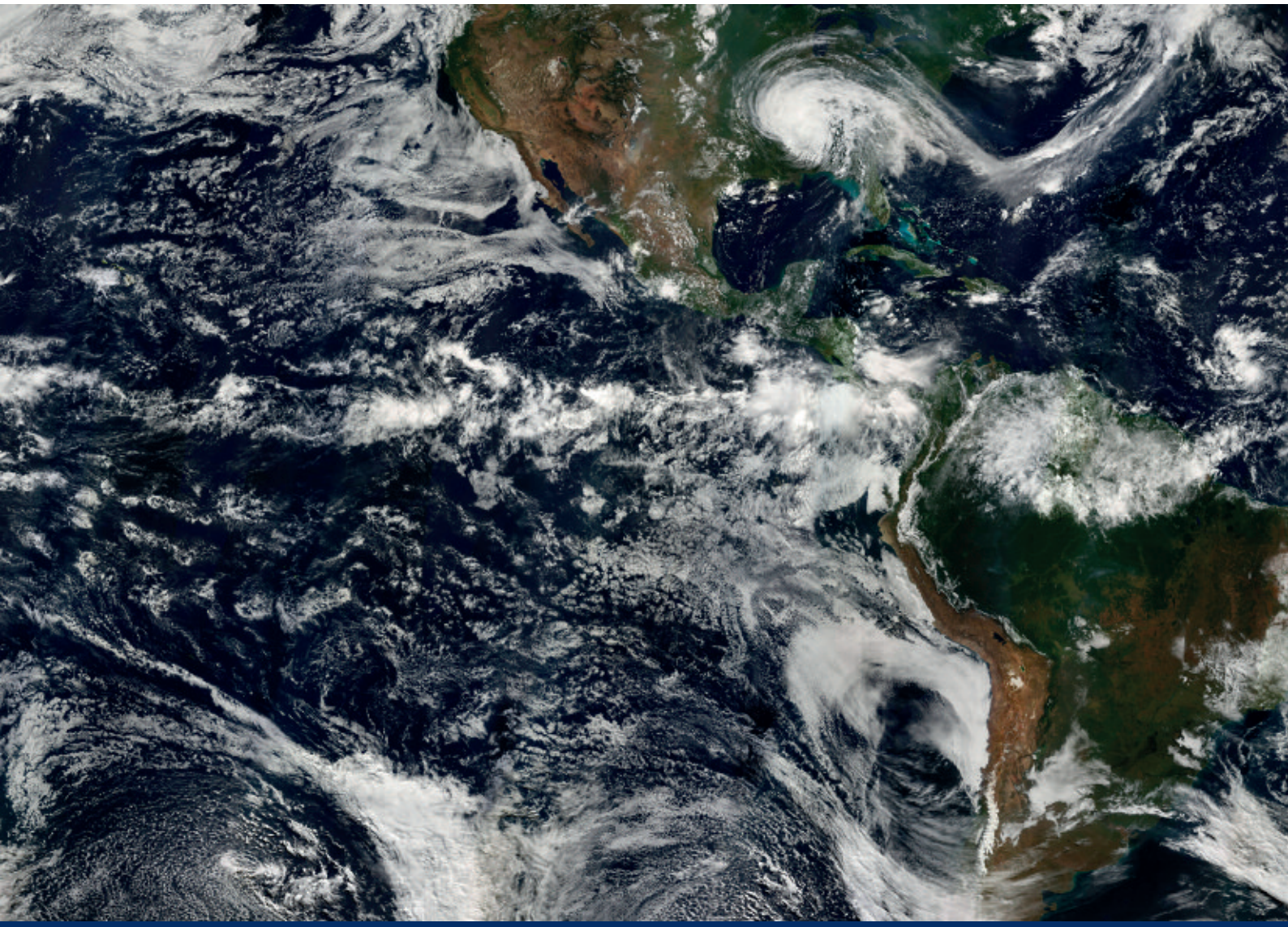
We see that the first adopted outcome relates only to the WMO itself, so is not material to the Bellagio discussion.

In the second adopted component, there are three sub-elements:

(1) First we see that this element considers only "basis essential data and products," focused on synoptic observations made by governments as part of their fundamental mission in climate observation. This is rightly addressed to WMO members and their data collection. Private entities, as addressed in the PPP framework, are not able to be members of the WMO, and so are not covered by this provision. The other interesting aspect is that "free" here means above and beyond the cost of producing these data (as described in annex 1, and the phrase "for reasons of … cost of production"). Since the Met agencies are not-for-profit, as are many of the collaborating partners (e.g., TAHMO), then this is automatically satisfied even if the data are made available with an associated cost.

(2) It is not clear what data are required to sustain WMO, but should WMO need data for its critical functions, thus for internal use and not distribution per se, I think that this could be accommodated by most PPP's, since it does not threaten commercial uses of the data.

(3) This is very much in keeping with the some PPP models (e.g. TAHMO model) of free distribution to research and education. It is fair to point that some PPP's are respecting this WMO goal in their fundamental operational framework. This however does not provide for these recipients to freely further distribute these data.



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