Scoping, Options Analysis and Design of a 'Climate Information and Services Programme' for Africa (CIASA): Final report

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CIASA has been renamed WISER - Weather and Climate Information Services for Africa

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Executive Summary

There have been many initiatives to strengthen weather and climate information and services across Africa in the last decade or so, with numerous valuable outcomes. However, it is commonly observed that availability and uptake of information and services is still relatively low and that this represents a threat to social and economic development.

The "mainstreaming" of weather and climate information into decision making is recognised to be a multi-disciplinary process involving components that include, inter alia, climate science and information services, translational science (developing appropriate communication approaches and delivery channels) as well as issues of governance to incentivise service delivery and use (as, for example, exists for weather services to the aviation sector). Considerable research has been conducted to improve capabilities in some aspects of these individual components, including pilot projects, generally of sub-national scale, to improve interaction and mutual understanding between climate information providers and users. The UN-led Global Framework for Climate Services (GFCS) is now providing important guidance for new programmes and fostering and promoting government recognition of the benefits of climate services. However, there has as yet been no major large scale Africa-focussed initiative to comprehensively address the various barriers to progress in an integrated way and to consider also their interactions and dependencies. There is a growing consensus that this lack of a holistic approach lies behind currently limited progress in uptake of weather and climate services.

The need for an innovative, holistic approach forms the central motivation behind DFID's consideration of a new intervention – Climate Information and Services for Africa (CIASA[1]). CIASA aims to achieve a step change in use of weather and climate information in Africa by addressing, at scale and in an integrated and coordinated way, the very diverse barriers to uptake and use of weather and climate services. Current planning is for a 4-year programme (as Phase 1 and including inception) disbursing £35 million to operational and research investments. It is anticipated that further phases of CIASA may follow. In November 2014 DFID procured a Met Office-led team to scope, analyse options and support design of the CIASA programme. The team comprised weather and climate experts from the UK and Africa as well as representatives from the World Meteorological Organisation (WMO), and experts in the fields of climate communication and development. This report presents the results of the scoping study and summarises DFID's selection of preferred intervention options for Phase 1.

The CIASA scoping comprised three main phases. Firstly, the Met Office-led Scoping Team developed a set of evidenced-based options for intervention themes and activities, working from DFID guidance in the scoping Terms of Reference and from the Inception meeting. Secondly, the Scoping Team worked together with DFID and other partners to refine the intervention options identified, develop a programme outline, raise options for a regional focus and to consider appropriate mechanisms of delivery and governance for the programme. In the third phase DFID conducted a formal appraisal, independent of the Scoping Team, to select preferred options for region, delivery and governance. Working on DFID selections, the Scoping Team then developed a draft framework for programme monitoring and evaluation.

[1] The potential scope for CIASA includes both weather and climate services. In this report, for reasons of brevity, where the term "climate" is used alone "weather and climate" is generally implied.

Evidence gathering, analysis and identification of intervention themes and activities

The development of evidenced-based options for intervention was based on a broad literature review and wide consultation with experts both within Africa and internationally and including users and providers of climate information in Africa. A large number of existing and planned climate-related initiatives covering underpinning climate science and applications as well as social/behavioural issues associated with the communication of science and early warnings were also referenced.

The broad line of enquiry for the evidence gathering was based on the following areas:

- the sensitivities of socio-economic activities to weather and climate;
- the status of weather and climate services and their uptake in Africa, with a focus on the main gaps and bearing in mind current and planned activities;
- barriers to the uptake and use of weather and climate services;
- expert opinion on priority needs for intervention activities.

Consultations were conducted using workshops, written submissions, questionnaires and semi-structured interviews. To gain a broad-ranging review of literature covering the production, delivery and use of climate information and services the literature review was structured on the 5 functional components (pillars) of the GFCS. In consultations and the literature review a focus was placed on the following sectors: agriculture and food security, health, disaster risk reduction (DRR), water, and urban environment (including long-lived infrastructure) and energy.

In analysis of results, responses from the consultations were collected into general coherent groupings or "barrier categories" which were expanded and modified as consultation progressed. The literature review was used to cross-check expert perceptions and to provide a broader perspective based on peer-review. This process gave rise to 5 thematic areas for intervention. In the second phase of the scoping the themes were further developed and refined in a joint analysis involving the Scoping Team and DFID with additional input from a WMO panel of experts and a workshop with users and climate service providers in Kenya. The resulting 5 thematic intervention areas are summarised below with a (non-exhaustive) list of proposed outputs.

1. **Improved governance and enabling environment:**
   - increased demand for climate services from government resulting in new, sustained funding and support for human and technical resources in National Meteorological and Hydrological Services (NMHSs), user and intermediary organisations;
   - national climate service planning included as part of national development agendas, with regional coordination;
   - new incentives for increased sharing of climate data and relevant climate impact data held by non-meteorological agencies e.g. crop yield and malaria statistics; and
   - improved coordination of donor investments and enhanced private sector engagement.

2. **Developing multi-disciplinary research programmes and African leadership in climate science:**
   - new climate services on monitoring and prediction and user-led delivery formats co-developed and trialled with users and intermediaries;
   - improved understanding and modelling of the African climate system – including applications modelling and improved means of conveying prediction uncertainties and making decisions under uncertainty;
   - comprehensive assessment of weather and climate model performance – including relative benefits of statistical and dynamical seasonal forecasting systems;

- development of translational science ("last mile" research) around social and behavioural issues to bridge gaps between climate science and decision making; and
- a step-change in strengthened climate science leadership in Africa and parallel initiatives for skills retention and career development.

3. **Strengthening national and regional climate and climate-related institutions:**
   - secure power sources, upgraded IT hardware and access to high-speed internet;
   - strengthened observational networks, data rescue, climate datasets and data management;
   - upgraded toolkits for climate monitoring and for processing national, regional and global prediction information; data-sharing architecture including both climate and sectoral impact data; and
   - increased numbers of trained personnel at NMHSs, Regional Climate Centres (RCCs), user and intermediary organisations.

4. **Strengthening global-regional-national networks and partnerships:**
   - strengthened links and data sharing between national, regional and international climate organisations – supported by service agreements;
   - strengthened regional service dissemination through RCOF and RCC activities – including more continuous services (updates), more seamless forecast provision, dissemination of more sector-focused and cross-sector (e.g. water-food-energy) products (co-developed in themes 2 and 3) serving regional and national resilience planning;
   - improved integration of national climate services and information exchange for trans-boundary units such as major river basins, groundwater units and agricultural zones.

5. **Strengthening national climate frameworks, user engagement and service delivery:**
   - strengthened NMHSs, better integrated within national infrastructure and conducting robust, reliable delivery of user-led climate services through a range of dissemination channels (including National Climate Outlook Forums (NCOFs) and intermediaries);
   - increased focus on services for sector and cross-sector (water-food-energy) impact; and
   - Frameworks for improved "last-mile" communication of climate information to local communities, both rural and urban, and improved social inclusiveness particularly with regard to women.

Regional, sector and timescale focus

The scoping noted that while underpinning progress can be made through pan-African investments in all 5 CIASA themes, it is reasonable to assume that a step change in the uptake of climate services will require a regional focus. This is because it is likely that thresholds in built capacity in each theme will need to be reached to trigger the level of interaction between themes needed to drive a step change, and such interaction will be more readily achieved in a regional (rather than pan-African) context. To illustrate, sharing examples of improved delivery, uptake and socio-economic benefit among regional partners with similar climate risk issues should inspire greater national/regional governance support for increased data sharing and technical capacity, leading in turn to further enhancement in uptake and thus setting up a "positive feedback" cycle that can drive a step change in practice. Additionally, the scoping found evidence of improved Benefit-Cost ratios when countries within a region collaborate on weather and climate services. . For these reasons a two-part programme is proposed for Phase 1 of CIASA. In outline, the two programmes have the following aims.

Regional Programme (provisional budget £25m): a regionally focused programme with activities across all 5 CIASA themes and with regional coordination designed to trigger the positive feedbacks referred to above and drive a step change in uptake of climate services.

*Pan-African Programme (provisional budget £10m)***:** a pan-African programme with activities centred on governance and enabling themes as well as research and science leadership. Activities in the Pan-Africa Programme will also be focussed on enhanced uptake of services and can be used to prepare regions for subsequent more focused investment through a Regional Programme.

Timescale and sector focus

The scoping study made the following recommendations on timescale and sector focus, noting that further consideration would need to be given during scoping/pilot projects or during project inception phases, taking full account of regional priorities in the Regional Programmes.

Timescale focus: Given the overriding CIASA objective of increased uptake of climate services, a possible approach is to split priorities across 1) research into use activities and 2) underpinning climate science. Thus activities to directly increase uptake can be focused on timescales for which there is already some capacity, i.e. climate monitoring, days ahead (severe weather), seasons ahead (climate variability - droughts/floods) and the 5-40 year timescale (climate change risks). Supported underpinning climate science could focus research towards filling gaps in timescales: i.e. understanding past climate variability and change and prediction at the sub-seasonal and multi-annual timescales.

Sector focus: Similarly, for sector focus, a possible approach is to focus on improving governance, data sharing and wider use of existing tools for translating climate information to impact across the GFCS priority areas of agriculture/food security, water, health and DRR. A continuing focus on the first two may be appropriate, since there is still much to be done in terms of uptake, particularly at national and sub-national levels. In parallel, research activities to better understand sector impacts could be focused in currently under represented sectors – e.g. health, urban environment, coastal zones and transport.

Programme outline: the "Four Component Approach"

Based on practical considerations of types of strengthening work that are logically grouped together, 4 programme components were defined to deliver activities across the 5 CIASA themes. These components, articulated for the regional programme, are listed below and in the accompanying figures.

CIASA components:

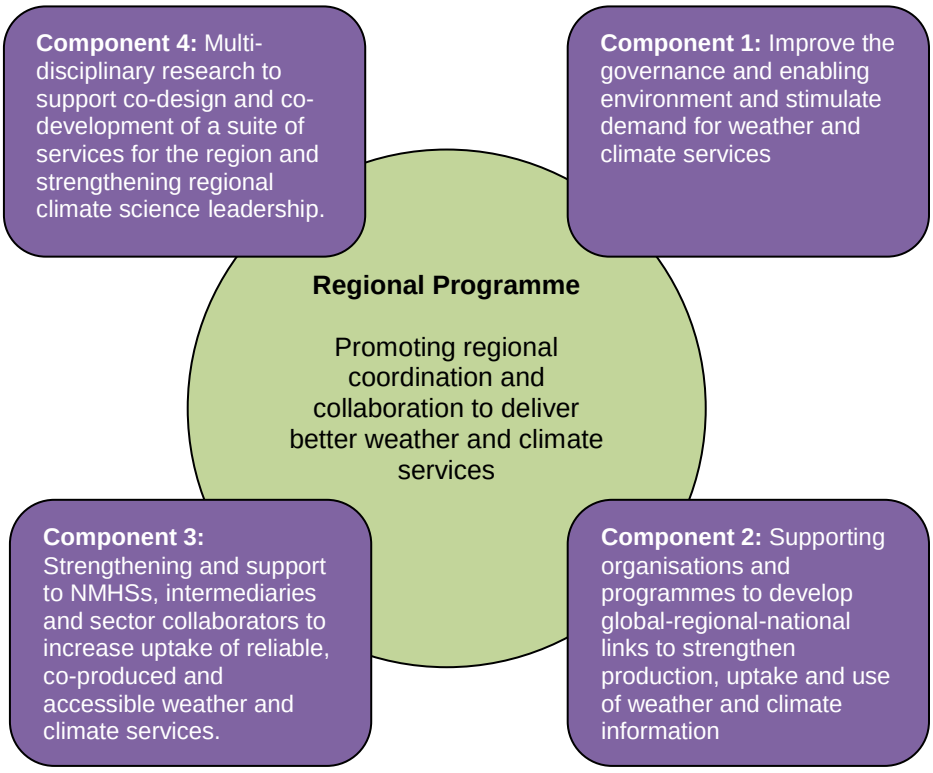
1) Improving the governance and enabling environment and stimulating demand for weather and climate services.
2) Supporting organisations and programmes to develop global-regional-national links to strengthen production, uptake and use of weather and climate information.
3) Strengthening and support to NMHSs, intermediaries and sector collaborators to increase uptake of reliable, co-produced and accessible weather and climate services.
4) Multi-disciplinary research to support co-design and co-development of weather and climate services for the region and strengthening regional climate science leadership.

The parallel pan-African programme will essentially use the same components with a focus on improving the wider enabling environment across Africa, multi-disciplinary research work and continental aspects of science leadership and supporting preparation of other

subsequent CIASA regional initiatives. It is proposed that the Regional and Pan-African programmes share common elements of governance to facilitate coordination.

Component 1: Improve the governance and enabling environment and stimulate demand for weather and climate services	• Engage regional and national bodies and policy makers to raise profile of climate services. • Understand and coordinate donor activity in the region and incentives for private sector engagement. • Understand user needs and preferences to develop a prioritised outline suite of co-produced services for the region. • Promote open data principles within the region (for climate and sector data). • Benchmark NMHS performance and share best practice within region. • Modernise meteorological training in the region.
Component 2: Supporting organisations and programmes to develop global-regional-national links to strengthen production, uptake and use of weather and climate information	• Strengthen the regional centre to enhance and widen the development and delivery of a suite of co-produced services for region. • Expand the Climate Outlook Forum process in the region (by sector and timescales). • Support to existing regional networks which promote and use weather and climate services. • Strengthened links between global centres (e.g. prediction centres) and the regional centre and the regional centre and NMHSs – supported by service agreements • Strengthen information exchange for trans-boundary units e.g. river basins and agricultural zones
Component 3: Strengthening and support to NMHSs, intermediaries and sector collaborators to increase uptake of reliable, co-produced and accessible weather and climate services.	• Provide technical assistance for development of service delivery plans showing how NMHSs will support national priority sectors, including consideration of cross-sectoral interests. • Provide funding to support implementation of plans – including for strengthening human and technical capacity and infrastructure. • Provide technical assistance and financial support for intermediaries and sector collaborators to upscale use of weather and climate services. • Incorporate climate information and services into planning for existing development projects.
Component 4: Multi-disciplinary research to support co-design and co-development of a suite of services for the region and strengthening regional climate science leadership.	• Support social science research proposals which enhance understanding of user engagement, behaviour change and 'last mile' delivery of services. • Improve understanding and modelling of weather and climate process in the region (e.g. LVB-HyNEWS, FCFA, CR4D). • Fill gaps in understanding to advance seamless prediction (e.g. WWRP/THORPEX-WCRP S2S) • Support model validation and forecast verification activities. • With the Pan-African programme, support regional scientific leadership in weather and climate science. Climate service curriculum development at participating universities.

Regional Programme: summary of programme components and associated activities



Schematic diagram of the Regional and Pan-African programmes, the 4 programme components and the 5 collective programme outputs.

Output 1: Strengthened governance and enabling environment for the generation, uptake and use of weather and climate services to support development.

Output 2: Innovative interdisciplinary research programme (a) supports the generation, uptake and use of weather and climate services and (b) builds sustained intellectual leadership in climate science in Africa.

Output 3: Improved data at historical, present and future timescales and better production systems support the generation of improved weather and climate information and services.

Output 4: Strengthened global-regional-national networks and partnerships support the improved generation, uptake and use of climate information.

Output 5: A step change in the uptake and use of weather and climate information at national, sub-national and community levels through strengthened capacity of and integration between NMHS's, collaborators and users that promotes improved service development and delivery.

DFID preferred options for Phase 1 of CIASA

Following a formal appraisal of options identified during the scoping DFID selected the following as the preferred options for regional focus and for the delivery and governance of the Phase 1 programme.

Regional focus: The Lake Victoria Basin (LVB) and surrounding area including Kenya, Uganda, Tanzania, Rwanda and Burundi (the 5 member states of the East African Community (EAC)) is the preferred option for the Regional Programme in Phase 1 of CIASA. It is anticipated that further phases, with focus on other regions, may follow dependent on the success of Phase 1 and available funding.

DFID selection of the Lake Victoria Basin and surrounding region was based on a number of factors including DFID strategic objectives and the potential for CIASA to add value to existing DFID-funded initiatives. Other key factors included: 1) the existing capacity in the region, which is considered at sufficient level such that a focused initiative can achieve a step-change in uptake of services – this is witnessed by, for example, the 5 EAC NMHSs already engaging in programmes such as the WMO Severe Weather Forecast Demonstration Project (SWFDP) as well as the Greater Horn of Africa Climate Outlook Forums coordinated by a well established IGAD Climate Prediction and Applications Centre (ICPAC); 2) the large populations dependent on the Lake ecosystem that have potential to benefit and 3) the potential to mobilise several widely endorsed but unfunded regional frameworks and initiatives. In particular the Lake Victoria Basin –- HydroClimate to Nowcasting for Early Warning Systems (LVB-HyNEWS) consortium of partners that has come together under the auspices of the WMO. This consortium has strong buy-in within Africa. Its formation was recommended by heads of East African National Meteorological Agencies in May 2014 and it has been proposed as a demonstration project by the African Ministerial Conference on Meteorology (AMCOMET[2]). The objectives of LVB-HyNEWS cover research to improve weather and climate information and services over a range of timescales, including: mapping historical climate to understand baseline risk; real-time monitoring and prediction/early warning on timescales from hours to decades ahead.

Harmonised with the proposed 5 CIASA themes and with links to other ongoing and emerging projects these initiatives provide a strong groundswell for enhancing uptake of weather and climate services in the region.

Programme delivery and governance: In the DFID appraisal, different delivery mechanisms, with common elements of governance, were selected as preferred options for the Phase 1 Regional and Pan-African programmes (see figure below). For the Regional Programme (Lake Victoria Basin and surrounding region) the preferred option is for funds to be channelled through a coordination lead partner in a Regional Programme Consortium. Associated governance teams may include representatives from DFID, the African Climate Policy Centre (ACPC), AMCOMET, EAC, the Lake Victoria Basin Commission (LVBC) and WMO. For the Pan-African Programme it is recommended that work is coordinated and governed by ACPC, AMCOMET and WMO. It is proposed that direct funding is provided to ACPC. In this framework ACPC would manage funds for delivery of the programme's activities and also channel funds to WMO and AMCOMET to support joint activities and initiatives, including the AMCOMET Integrated Strategy for Meteorology.

[2] http://www.wmo.int/amcomet/

Regional Programme delivery through: **Consortium Coordinating Lead**	**Funds for the regional programme channelled through a consortium lead or coordinating organisation which would manage disbursement to consortium partners and other related initiatives.** **Governance includes high-level regional partners with DFID, ACPC, AMCOMET and WMO (common with Pan-African Programme).**
Pan-African Programme delivery through: **African Climate Policy Centre (ACPC)**	**Direct funding to ACPC as an extension to DFID's existing ClimDev-Africa programme. ACPC would manage funds for the delivery of activities and channel funds to WMO and AMCOMET to support joint activities and initiatives being undertaken by these organisations.** **Governance includes DFID, ACPC, AMCOMET, WMO**

Summary of preferred delivery mechanisms and governance for the CIASA Regional and Pan-African Programmes

CIASA Impact, Outcome and Outputs

Working from DFID's preferred options the Scoping Team developed a proposed framework for programme evaluation. The Regional and Pan-African programmes will work together to deliver on the Impact, Outcome and 5 Outputs listed below with recommended finance levels and performance indicators.

Targets for the performance indicators apply to the sum over both the Regional programme (Lake Victoria Basin and surrounding region) and the Pan-Africa programme, but are based primarily on estimates for the regional programme – to introduce a degree of conservatism. Thus, for example, the target of 5 countries and 5 NMHSs benefiting is based on the 5 countries of the East Africa Community, although others will also benefit through the Pan-Africa programme. Numbers of people and households impacted are based on a Lake Victoria Basin (LVB) population of 30 million (a conservative estimate) and an average household of 5 persons. Additionally it is assumed that the project impact will result in 60% of the population with improved access to weather and climate services, and that 25% of this subset will use the information in decision making that affects their livelihoods. At impact level targets have been lifted to allow a contribution to benefit from the influence of CIASA on other programmes – for example improved governance and data sharing accomplished through CIASA activities should enhance the impact of other climate initiatives not directly linked to CIASA.

It is assumed that further development of performance indicators as well as design of monitoring and evaluation procedures for tracking the impact of CIASA investments will be designed during the inception stage of the programme and each sub project.

Impact: Increased use of weather and climate information and mainstreaming into development and sector policies, plans and programmes supports sustainable development in Africa.

- Value of socio-economic benefits and reduced losses (e.g. number of lives saved, improved agricultural productivity and property value protected)
- Number of people with improved resilience (International Climate Fund Key Performance Indicator 4)

Outcome: Increased use of reliable, co-produced and accessible weather and climate services based on better data, information, knowledge and tools informs regional, national, sub-national and community level policy, planning and decision-making in Africa.

- At least 3 projects and programmes adopt an integrated regional approach for development of climate services
- At least 50 organisations and institutions reporting improved or considerably improved use of weather and climate information to inform their decision making
- At least 20 government departments/ministries/institutions reporting improved or considerably improved understanding of weather and climate issues and links to development related to their sectors
- At least 875,000 households reporting use of improved climate services for decision making that improves their livelihoods

Output 1: Strengthened enabling environment for the generation, uptake and use of weather and climate services to support development. (£6.5 million)

- At least £100m of government and donor funding coordinated around agreed plans for development of climate services
- At least 5 initiatives supporting a better enabling environment rated (by identified decision makers) as useful or very useful
- At least 5 countries using their influence to generate regular dialogue on weather and climate services across government
- At least 50 new interagency agreements to strengthen climate services (e.g. MoUs or service level agreements between NMHSs and line ministries)

Output 2: Innovative interdisciplinary research programme (a) supports the generation, uptake and use of weather and climate services and (b) builds sustained intellectual leadership in climate science in Africa. (£10 million)

- At least 10 research outputs directly contributing to the development, uptake or understanding of new climate services
- At least 50 peer-reviewed climate and social science articles authored by African scientists and available in an open access format (disaggregated by gender and primary and secondary authorship)
- At least 100 African scientists and researchers (disaggregated by gender) working in African institutes that have built expertise in the development of user-led weather and climate services

Output 3: Improved data at historical, present and future timescales and better production systems support the generation of improved weather and climate information and services. (£5 million)

- At least 5 countries with revised freer data sharing policy and coordinated national plans for data rescue and digitisation
- At least 5 NMHSs using and sharing new/improved datasets supporting design and production of new/improved national and regional climate services
- At least 5 NMHSs with improved technology/hardware and related capacity for production of climate services
- At least 5 countries with an improved observations network and credible long-term plans for operation and maintenance

Output 4: Strengthened global-regional-national networks and partnerships support the improved generation, uptake and use of climate information (£3.5 million)

- At least 6 Regional and National Climate Outlook Forum processes initiated and/or strengthened
- At least 3 partnership networks with programmes to promote uptake and use of weather and climate information rated by identified stakeholders as useful or very useful
- At least 8 service agreements/MoUs in place between global and regional centres, and regional and national centres
- At least 10 RCCs and NMHSs using in house processing of data from global centres to generate new and/or improved climate services

Output 5: Improved access to weather and climate information at national, sub-national and community levels through strengthened capacity of and integration between NMHS's, collaborators and users that promotes improved service development and delivery (£10 million)

- At least 5 NMHSs with modernised plans focussing on improved service delivery
- At least 3,500,000 households able to access new and/or improved climate services through a range of intermediaries and communications channels
- At least 50 organisations and institutions reporting improved access to new and improved climate services through a range of channels
- At least 20 new or improved co-produced climate service products being delivered on time and in full to organisations and institutions in various sectors and being reported as effective.

Links to other framework initiatives and programmes

The CIASA programme has an opportunity to make a fundamental contribution in a changing landscape of climate services initiatives in Africa, as well in the global context. Important new framework initiatives include 1) the Global Framework for Climate Services (GFCS) which provides a strategy for investments and a platform for the coordination of activities; 2) the AMCOMET Integrated Strategy for Meteorology, which presents guiding principles and key programme components for strengthening weather and climate services in Africa; 3) a joint ACPC/World Climate Research Programme (WCRP) initiative to advance climate research for Africa that is focused on needs for development (CR4D[3] – Climate Research for Development); and 4) the developing ClimDev-Africa Phase 2 programme. In addition, CIASA is well-timed to play an important role in support of evolving climate policy and decision making for Africa that emerges from the imminent (2015) rollover of 3 United Nations (UN) policy cycles: new UN Sustainable Development Goals; a successor to the Hyogo Framework for Action for building the resilience of nations and communities to

[3] http://africa-climate.org/

disasters; and the UN Framework Convention on Climate Change (UNFCCC) objective to reach agreement on climate emissions targets at its 21st Conference of Parties (COP21).

Specific projects important for the CIASA Regional and Pan-African programmes to engage with will need to be identified at individual sub-project inception stage, and will include both climate science and translational science initiatives. For weather and climate aspects (in addition to the LVB-HyNEWS consortium) these include, for climate monitoring: the Enhancing National Climate Services (ENACTS) and Rainwatch-AfClix (RWX) programmes; for short-range forecasting, the WMO Severe Weather Forecast Demonstration Project (SWFDP) and World Weather Research Programme (WWRP) High Impact Weather project; for sub-seasonal timescales the WCRP/WWRP sub-seasonal to seasonal research programme – which has an African subproject; for seasonal timescales the WMO infrastructure for global provision and synthesis of climate model-based seasonal forecasts and the DFID Science for Humanitarian Emergencies and Resilience (SHEAR) programme; and for multi-decadal timescales the WCRP Climate Model Inter-comparison Project (CMIP5) and Coordinated Regional Downscaling Experiment (CORDEX) archives as well as the DFID Future Climate for Africa (FCFA) research programmes.

For translational science there are many initiatives across Africa that CIASA can engage with and learn from. Some examples include: weather and climate warning communications projects focused at community level conducted by the Humanitarian Futures Programme, Red Cross, the Climate Change Agriculture and Food Security (CCAFS) programme, CARE International and Christian Aid as well as aspects of DFID's Strengthening Adaptation and Resilience to Climate Change in Kenya (StARCK+) and Building Resilience to Climate Extremes and Disasters (BRACED) programmes. In addition the Red Cross Climate Centre has developed game-based approaches designed to rehearse and confront issues around communication.

SECTION 1

Introduction

Project background

It is widely recognised that there is generally low uptake of climate information to support resilience to climate variability and change. For example, in a White Paper prepared for World Climate Conference-3, Goddard et al (2010) write:

"*Much has been learned in the interpretation and use of climate information since the 1997/1998 El Niño event that garnered so much attention. Seasonal-to-interannual forecasts are now produced around the world. However, mismatches in their scales, specificity or communication (of forecast content and uncertainties) with decision-maker needs still hinder their use"*.

For Africa, recent studies and reviews (e.g. Dinku et al.2014; Jones et al. 2015) conclude that this unsatisfactory situation still prevails and that, in addition to the mismatches referred to above, inadequate governance and policy frameworks regulating use of climate data and information also hinders uptake and use. Jones et al. (2015) notes particularly low use of climate change scenarios to inform to long-term decision-making. At the other end of the scale use of short-range forecasts for early warning of severe weather events is still very limited in Africa – a WMO survey (WMO 2008) noting "....hazard warning capacities are uneven, even non-existent in some countries", a conclusion supported in a recent study by Lumbroso et al (2014). Lack of capacity for and/or use of weather and climate services hinders accruement of potentially large benefits – a review by Watkiss and Savage (2015) notes example Benefit-Cost ratios of between 4 and 36.

Low levels of uptake and use of climate information persist despite increasing research activity in African climate and its impacts. Wilby (2014) lists over 90 current and recent projects covering a wide range of foci, with many including specific elements aimed at enhancing information use – e.g. cross-disciplinary research designed to better communicate climate impacts; and development of tools and adaptive strategies to build resilience (see Wilby 2014, topics K and N in Annex 5). Nevertheless, perhaps because of lack of "programmatic" coordination towards a common goal between the climate science, communications, societal receptiveness, and governance dimensions of the task, the desired step-change in use of climate information across all levels of society has not yet been observed. This represents a threat to social and economic development in Africa.

There is now consensus that a new approach is needed and this is evidenced by the emergence of new framework initiatives aimed at facilitating the "mainstreaming" of climate services into decision making. The most prominent of these framework initiatives are introduced below. Such frameworks provide a valuable basis and rationale for donor investments. However, while they provide guiding principles on interventions needed, they tend to lack strong mechanisms for coordination between projects, acting instead as "programmes of opportunity" – platforms that bring together climate projects with broadly related aims but that are conceived, designed and funded largely independently and without a common management structure.

It may therefore be timely to ramp up a new, large programmatic approach to work together with the new framework initiatives. Such an approach would comprise co-designed and strongly-coordinated project components working under common management structures to address at scale the various barriers to uptake and use of weather climate services. Exploration of this programmatic approach forms the central motivation behind DFID's consideration of a new intervention – Climate Information and Services for Africa (CIASA) – that will form the basis of its next climate investment for the continent. To this effect, DFID procured (in November 2014) a Met Office-led team (Annex 1) to scope, analyse options and support design of a Business Case for CIASA. The primary focus for CIASA is to advance the co-development and uptake of needs-based, user-led weather and climate services – with the aim of delivering a step change in the use of climate information to support poverty reduction and promote socio-economic development. As such, potential activities cover a broad spectrum from institutional strengthening, technical assistance, hardware investment, and climate service delivery issues in addition to climate research and research associated with communication of climate information. The envelope of activities thus complements other current DFID programmes for Africa such as Future Climate For Africa (FCFA) and Science for Humanitarian Emergencies And Resilience (SHEAR) which are primarily research focused, while also bringing opportunities to strengthen the harnessing of outputs from these programmes for the benefit of users.

The context of new framework initiatives

Briefly, the key framework initiatives and programmes that can inform the design of CIASA and benefit from its outputs include: 1) the Global Framework for Climate Services (GFCS) a UN-led initiative in partnership with governments and other stakeholders and spear-headed by the World Meteorological Organisation (WMO) aimed at "mainstreaming" climate services into decision making at all socio-economic levels; 2) the AMCOMET[4] (African Ministerial Conference on Meteorology) Integrated Strategy for Meteorology, which presents guiding principles and key programme components for strengthening weather and climate services in Africa; 3) a joint ClimDev-Africa/World Climate Research Programme (WCRP) initiative to advance climate research for Africa that is focused on needs for development (CR4D[5] – Climate Research for Development) and 4) the developing ClimDev-Africa Phase 2 programme.

In terms of upcoming initiatives, CIASA has the opportunity to play an important role in support of evolving climate policy and decision making for Africa that emerges from the imminent (2015) rollover of 3 United Nations (UN) policy cycles:

- new UN Sustainable Development Goals;
- a successor to the Hyogo Framework for Action for building the resilience of nations and communities to disasters; and
- the UN Framework Convention on Climate Change (UNFCCC) objective to reach agreement on climate emissions targets at its 21st Conference of Parties (COP21).

This report describes the methodology used by the Scoping Team to develop evidence-based intervention options (Section 2) and presents a synthesis of the evidence gathered (Section 3). The results of a refinement of options and development of a programme outline, conducted jointly by the Scoping Team, DFID and other partners is presented in Section 4 and 5. The outcome of a formal DFID appraisal and selection of options for the programmes regional focus, and mechanisms for delivery and governance is outlined in Section 6.

[4] http://www.wmo.int/amcomet/
[5] http://africa-climate.org/

Section 7 lays out a draft framework for programme monitoring and evaluation. Brief conclusions are presented in Section 8.

SECTION 2

Methodology for the evidence gathering and synthesis

The CIASA scoping comprised three main phases. Firstly, the Met Office-led Scoping Team developed a set of evidenced-based options for intervention themes and activities, working from DFID guidance in the scoping Terms of Reference and from the Inception meeting. Secondly, the Scoping Team worked together with DFID and other partners to refine the intervention options, including through a series of workshops (rows 2-7, Table 1), and to raise options for a regional focus. In the third phase DFID conducted a formal appraisal, independent of the Scoping Team, to select the region for focus, the delivery mechanisms and project governance structure that are best fitted to DFID objectives and that add most value to existing DFID-funded initiatives. Further details on the three main phases of the work are provided below and summarised in Fig. 1.

Development of evidenced-based options for intervention – led by the Scoping Team (ref Section 3)
This phase was conducted independently by the scoping team with initial DFID guidance from the scoping Terms of Reference and Inception meeting. The evidence gathering phase comprised consultation with experts and a literature review. The broad line of enquiry was based on gathering evidence on the following:

- the sensitivities of socio-economic activities to weather and climate;
- the status of weather and climate services and their uptake in Africa, with a focus on the main gaps and bearing in mind current and planned activities;
- barriers to the uptake and use of weather and climate services;
- expert opinion on priority needs for intervention activities.

Consultations were conducted using workshops, written submissions, questionnaires and semi-structured interviews and extended to a wide range of experts with interests over a range of socio-economic sectors including both users and providers of climate information in Africa. To gain a broad-ranging review of literature covering the production, delivery and use of climate information and services the literature review was structured on the 5 pillars of the Global Framework for Climate Services (GFCS)[6]. In consultations and the literature review a focus was placed on the following sectors: agriculture and food security, health, disaster risk reduction (DRR), water, and urban environment (including long-lived infrastructure) and energy.

Three groups of organisations were consulted: users of climate information in Africa across a range of sectors; providers of climate information in Africa, including National Meteorological

[6] The GFCS is a UN-led initiative in partnership with governments and other stakeholders and spear-headed by the World Meteorological Organisation (WMO) aimed at “mainstreaming” climate services into decision making at all socio-economic levels.

and Hydrological Services (NMHSs) and Regional Climate Centres (RCCs) and other prominent international organisations, including the WMO, ACPC and the AMCOMET secretariat. A summary of the organisations consulted, the method of consultation and an outline of their activities is provided in Table 2 (a full list of experts consulted is provided in Annex 5).

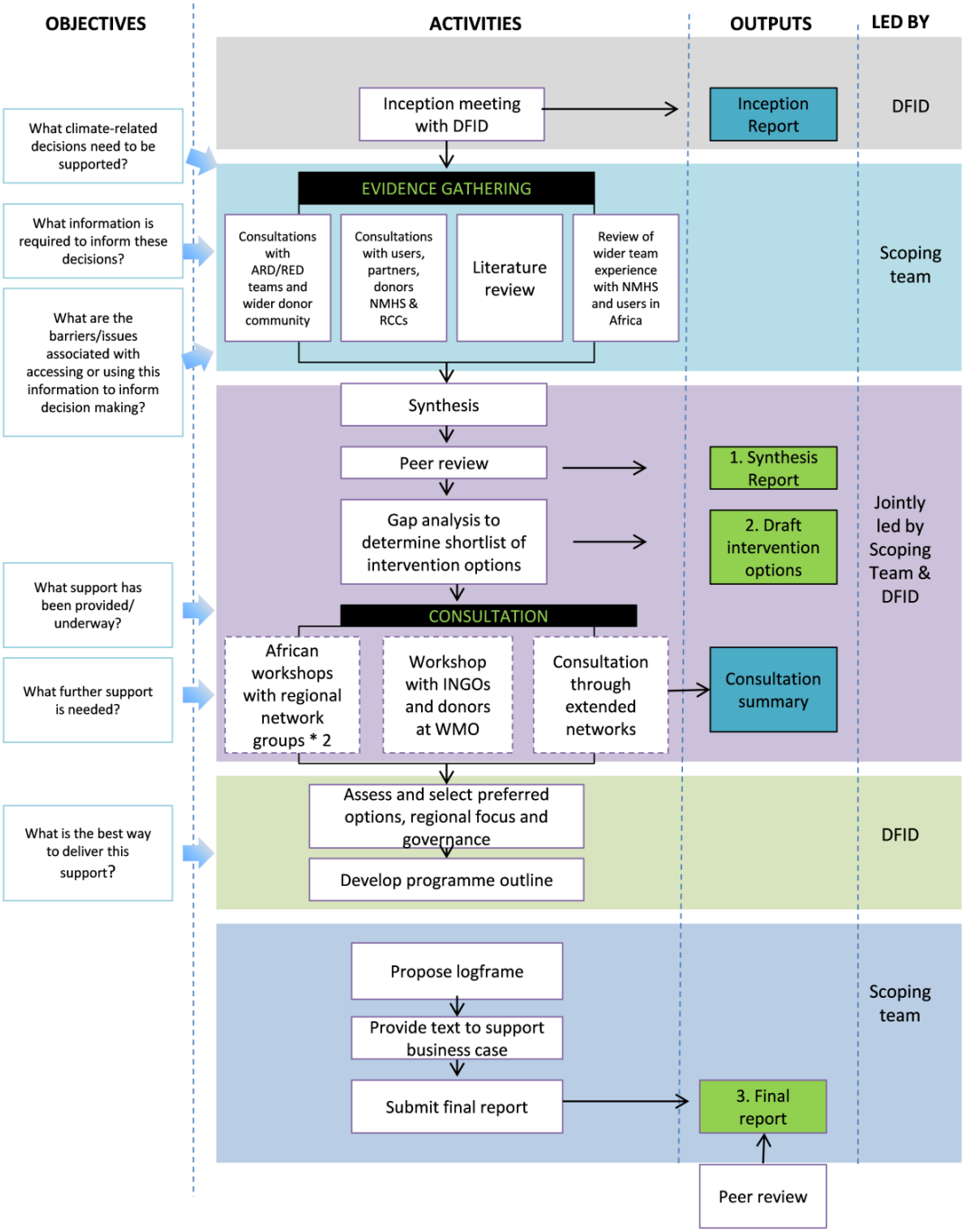


Figure 1: Scoping process flow chart

Results from the consultations were then ordered into general coherent groupings or "barrier categories" which were expanded and modified as consultation progressed, with the

literature review used to cross-check expert perceptions and to provide a broader perspective based on peer-review. This process gave rise to 5 proposed thematic areas for intervention each with a range of associated outputs.

Refinement of the proposed interventions – joint work: Scoping Team and DFID (ref. Sections 4 and 5)
The options for intervention and associated outputs were next reviewed and refined and options for a programme outline developed, including regional focus, delivery mechanisms and suitable governance structure. This process was jointly led by the Scoping Team and DFID and took place across 6 workshops (rows 2-7 Table 1).

DFID decisions on programme structure, delivery mechanisms, regional focus and governance bodies (ref. Section 6)
Based on the identification and discussion of options as described above, DFID independently took decisions on specifics of the programme structure, regional focus, delivery mechanisms and appropriate governance bodies. These DFID selected options, with associated reasoning, are presented in Sections 5, 6 and 7.

Following this procedure and DFID selection of options the Scoping Team developed, with DFID guidance, a draft framework for programme monitoring and evaluation (Section 7).

	Date	Participants	Aim	Venue
1	26 Nov 2014	Scoping Team Leaders and Met Office experts	Identify sector sensitivities, barriers to uptake and ideas for intervention activities for each of 5 sectors	Exeter
2	10 Dec 2014	Scoping Team Leaders and DFID advisors	Review/refine first formulation of options on intervention themes and activities	Reading
3	17 Dec 2014	Rep. from Scoping Team and climate users and providers in Kenya	Gain feedback on options for themes and activities	Nairobi
4	7 Jan 2015	Cross section of Scoping Team and DFID advisors	Further refinement of intervention themes and activities, need for regional focus	London
5	9 Jan 2015	Scoping Team Leaders and WMO experts	Gain feedback and further input to intervention themes and regional focus.	Geneva
6	23 Jan 2015	Scoping Team Leaders and DFID advisors	Review first formulation of the programme outline, formulation of options on delivery mechanisms and governance	Swindon
7	9-12 Feb 2015	Scoping Team Leaders (including leaders on Africa consultations), DFID advisors, various partners attending AMCOMET-3	Obtain broad feedback on proposed programme outline, regional focus and options for delivery mechanisms and governance.	Side meetings at AMCOMET-3 Praia, Cape Verde

Table 1: Main meetings/workshops held during the CIASA scoping

SECTION 3

Consultations, Literature Review and Synthesis

Consultations in Africa

Consultations in Africa were designed with and conducted by three members of the project team based in, or regularly working in East Africa, West Africa and southern Africa. A total of 23, face-to-face and telephone interviews of order 45 minutes duration were conducted, 11 with climate information users (henceforth “climate users” or “users”) and 12 with climate information providers (henceforth “climate providers” or “providers”). The sample is limited, and results were therefore used in conjunction with other consultations and the literature review and to amplify the analysis with “on the ground” examples.

Users interviewed had activities covering all sub-Saharan regions: East, West, Central and Southern Africa with interests in the following sectors: agriculture and food security (including livestock and pastoralism), health, water (including sanitation and hygiene), energy, disaster risk reduction and long-lived infrastructure (Table 2 and Annexes 2&3). Climate service providers interviewed included National Meteorological and Hydrological Services (NMHSs) in West, East and Southern Africa and 3 Regional Climate Centres (RCCs): the African Centre for Meteorological Applications for Development (ACMAD) - with pan-African remit; the IGAD Climate Prediction and Applications Centre (ICPAC) – with remit for the Greater Horn of Africa and the Southern African Development Community Climate Services Centre (SADC-CSC) – with remit for southern Africa. Together the climate providers have responsibilities for services to a wide range of users including regional, national and local governments, UN agencies, NGOs, water and river basin authorities, farmer’s groups, fishers, media and extension workers. Other entities with regional remit - e.g. the West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL) were also consulted.

Interviews for both users and providers were guided by a questionnaire (attached at Annex 4) which explored experience with successful aspects of enterprises to bring climate information into decision making, and also with barriers encountered. Opinions on the priority investments and activities needed were also canvassed. In addition, users were asked to rank the importance of improving the following aspects of weather and climate services for their operations: understanding of the benefits; availability of information; timeliness of delivery; relevance of content; quality; communication; training on interpretation. Similarly, climate providers were asked to rank the importance of improving the following: observation networks; in-house research and analysis tools; capacity to interact with users to develop climate services; capacity to maintain operations; capacity for effective communication and delivery. These sets of categories were selected on the basis of expert judgement; they were not drawn from any previously researched/established set.

Group	Method	Organisations, remit and outline activities
African users of climate services	Questionnaires and semi-structured interviews	*West and Central Africa:* **Kandadji dam programme** (Niger: environment/water/infrastructure/energy/health/DRR); **HUBRURAL** (Central and West Africa: agriculture/livestock/pastoralism/food security); **Ecology Monitoring Centre** (CSE, Senegal: agriculture/livestock/food security/health/disaster risk reduction (DRR)/water); **International Federation of Red Cross and Red Crescent** (IFRC, Senegal: Humanitarian/DRR); *Eastern Africa:* **Uganda Water and Sanitation NGO network** (Uganda: water/sanitation); **Kenya WASH Alliance** (Kenya: water/sanitation/hygiene) *Southern Africa:* **Gobabeb Research and Training Centre** (Namibia: environment); **Lower Usuthu Small Irrigation Project** (Swaziland: agriculture, water, energy) **Ministry of Agriculture, Swaziland** (livestock section) **Ministry of Natural Resources and Energy, Swaziland** (energy) **Famine Early Warning Systems Network** (FEWS-NET, Botswana: food security);
African providers of climate services (plus intermediary organisations)	Questionnaires and semi-structured interviews	*West Africa:* **African Centre of Meteorological Applications for Development** (ACMAD, Niger, pan-Africa remit: services for agriculture/water/health/DRR, national & regional governments and authorities, UN agencies, NGOs, Basin commissions); **West African Science Service Centre on Climate Change and Adapted Land Use** (WASCAL, regional/national remit: services to extension intermediaries, farmers groups, water providers and universities) **Agence National de l'Aviation Civile et de la Meteorologie** (Senegal, national remit: services to farmers groups, fishers, media) *East Africa:* **IGAD Climate Prediction and Applications Centre** (Kenya, regional remit: services for agriculture/food security/water/health/DRR/national & regional governments and authorities, UN agencies, NGOs, Basin commissions); **Burundi HydroMet Department** (national remit: services for agriculture/water/extension activities); **Kenya Rainwater Association** (national remit: services to local government/farmers); **African Centre for Lightning and Electromagnetics** (ACLE, Uganda: DRR services to government and other agencies/education); *Southern Africa:* **Southern Africa Development Community Climate Services Centre** (regional remit, climate risk assessment and early warning) **Swaziland Meteorological Service** (national remit: services to extension workers/farmers/water/construction/insurance/DRR/local government/media) **Lesotho Meteorological Services** (LMS, national remit: services to DRR, health, agriculture, water food security) **Botswana Meteorological Service** (national remit: services to public/energy/ water/ health/ insurance/construction) **Mauritius Meteorological Services** (national remit: services to local government/farmers groups/water providers)
Other international experts	Workshops, semi-structured interviews, written submissions	Project Team; World Meteorological Organisation (WMO); AMCOMET; World Health Organisations (WHO); African Climate Policy Centre (ACPC); International Research Institute for Climate and Society (IRI); SouthSouthNorth (SSN); Red Cross/Red Crescent Climate Centre; University of Southern Queensland; CARE International; Climate Data Knowledge Network (CDKN), Overseas Development Institute (ODI). A number of independent consultants were also interviewed.

Table 2: Categories of experts consulted, consultation methods used and corresponding organisations and their outline activities

Details of results from these questionnaire-based consultations can be found in Annexes 2&3. Some of the more frequent barriers and needs arising from the user and provider responses are listed below.

Users expressed needs for:

- Broad-based capacity building and training activities;
- Strengthened political support, governance and secure funding for NMHSs;
- Integration of climate service development into national planning processes– to give firm mandate;
- Open sharing of climate data and climate-related data (e.g. from user sectors);
- Climate information to be more easily accessible and accompanied by guidelines on interpretation and response;
- Support for strengthened user collaboration with NMHSs;
- New types of user-relevant information: e.g. timing of onset of rains;
- Improved skill for forecasts and early warning systems (EWS);
- More frequent information updates and seamless forecast provision across timescales (gaps at sub-seasonal and multi-annual ranges were noted)
- Simply expressed, community-friendly formats for climate information;
- More direct communication channels e.g. SMS;
- Better observation collection, quality control and archiving;
- Public awareness campaigns on benefits of climate services;
- Multi-disciplinary research: e.g. identifying rain/temperature thresholds important for triggering certain diseases.

Providers expressed needs for:

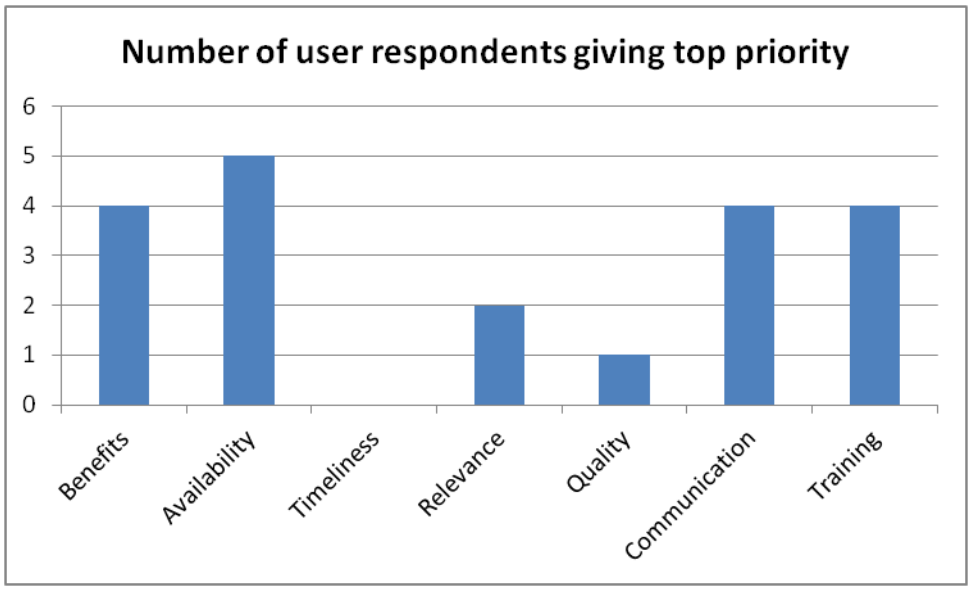
- Fostering government support for and user receptiveness to climate services;
- More and better trained personnel in research, operations and project management roles;
- Strengthened capacity to maintain and install equipment in support of operational services;
- Computer hardware upgrades, faster web connectivity, unrestricted software licenses, open source utilities, assistance with website development;
- Strengthened climate observation/monitoring networks across Africa;
- Strengthened climate data analysis tools;
- Support to strengthen engagement with users across all sectors – including forums and participatory approaches at community level;
- Support to facilitate better weather/climate service communication mechanisms – e.g. SMS messaging can be a cost overhead;
- Training for users and decision-makers, media and intermediaries.

Results of the ranking of the specific set of needs are shown for users and providers in Figs. 2a and 2b. Although the sample is small, results are broadly consistent with expert opinion on the perceptions of the groups consulted – which did not extend explicitly to community level. The users consulted most often rank improving the availability of climate information as the highest priority, followed by establishing the benefits of climate information to their sector, clear communication and training in its interpretation (Fig. 2a). This user group were less commonly concerned with relevance, quality and timeliness – though with low general availability and inadequate user-friendly communication users may find it difficult to judge performance on these latter aspects.

The provider group most frequently voted increased capacity to do the necessary climate research and analysis that underpins a climate service (including staff levels, equipment and training) as the highest priority requirement. This, together with relatively low votes for

improving interaction with users and communications and delivery may partly reflect a supply-driven culture – but also likely reflects a sense that capacity is not yet at sufficient levels for optimum interaction with users. Improvement of observation networks was also considered a high priority – reflecting the well know scarcity (and recent decline – see Fig. 6) of stations reporting weather and climate records.

a)



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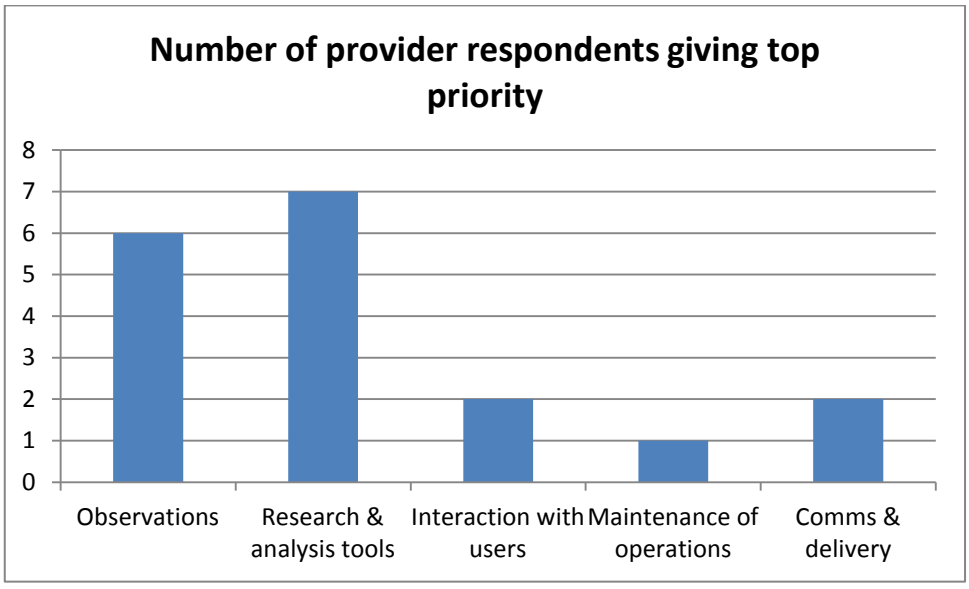


Figure 2: Number of questionnaire respondents giving top priority to pre-specified needs categories, a) climate information users (total of 11 respondents); b) climate information providers (total of 12 respondents). For a fuller explanation of the categories see the text and Annexes 2 and 3.

The needs expressed above may be grouped as follows into initial categories covering governance, research and a range of capacity strengthening needs as illustrated below. This initial categorisation is expanded and modified in subsequent sections through analysis of other consultations and the literature review.

Governance: centring on political support and funding; integration of climate services into development planning; open data policies; public awareness campaigns (around benefits of climate information);

Research: centring on new types of user-relevant co-produced information products; improved prediction skill; more "seamless provision" over timescales; improved delivery, communication and translation methods.

Capacity (infrastructure): centring on observation networks; IT hardware; secure power sources, internet connectivity.

Capacity (technical): centring on software tools for climate data analysis and prediction.

Capacity (human): centring on more and better trained personnel (in both users and provider communities).

Capacity (service co-development and delivery): centring on strengthening user-provider engagement, improving accessibility of information; simpler formats/language; guidelines on user response (e.g. to early warnings); strengthening intermediary activities and organisations.

Wider Consultations with Other Experts

Wider consultations took place with international experts in a range of organisations (Table 2 and Annex 5) covering broad categories of policy (e.g. WMO, ACPC), climate service provision (e.g. WMO, IRI, Met Office, University of Southern Queensland), INGOs with intermediary remit (e.g. Red Cross Climate Centre, CARE International) and Knowledge Management (e.g. SSN, CDKN). The method of consultation was by semi-structured interview based around the discussion points below, with most emphasis on barriers and intervention options, and in some cases by written submission.

- Sector sensitivities to weather and climate;
- Barriers to the uptake of climate information;
- Ideas for intervention options which could improve uptake of climate information.

Inputs from these consultations are presented below in the form of quotes or transcripts, edited to give context and to reduce obvious duplications (though similar inputs with nuanced differences are retained). A subset of the written submissions is also provided in Annex 6. All inputs have been couched in terms of barriers – as many intervention ideas received were simple rephrasing of barriers to progress. The inputs are grouped under the same "needs categories" used in the previous section, with two additional categories added. Taken with that from the Africa consultations, the list provides a perspective on the broad range of activities perceived as in need of strengthening – many of which are likely to require simultaneous and coordinated interventions to secure a step change in uptake of climate services.

Barriers to uptake of weather and climate services from wider consultations

Governance

- Low level of NMHS funding (and lack of private sector engagement);

- Lack of legal or policy framework regulating use of climate data – there are few incentives to use it, particularly for decisions relating to longer (e.g. 50-year) time horizons for which use is very low;
- Poor understanding of the influence that political cycles and time horizons (i.e. the length of time politicians are in power), institutional structures within governments, and vested interests have on the uptake and sustained use of climate services;
- Lack of high-level political champions for climate services – most "championing" is done at lower level and lacks authority for sustained traction;
- Lack of well developed arguments on the benefit of climate information presented to ministries of finance, planning, environment;
- Limited development of (e.g. 5-year) business plans at NMHSs – thus lack of agreed mandate;
- Limited representation from NMHSs in the process of developing National Adaptation Plans (NAPS) and therefore limited integration of climate services;
- Over-dependence on limited-term project work – with benefits lost after the project closes;
- Lack of donor coordination of investments;
- Donor commitment to underwrite disaster risk reduction (with respect to timely response to anticipated emergencies) is still far below need, even if EWSs are effective;
- Lack of scale-up of weather climate initiatives driven from national government level (e.g. Africa Risk Capacity)[7].

Research

- Science gaps in understanding and modelling African climate systems;
- Lack of understanding of the relationship between thresholds in weather/climate data and socio-economic impact. For example given a quantitative forecast of extreme rainfall what level of flood can be expected and where?
- Related to above, there is a lack of knowledge in relating thresholds in climate variables with decision making on options and choices. For example links to decisions on when to plant crops and choices on suitable crop/livestock types and varieties/breeds);
- Insufficient work to include climate data and non-climate data in decision support tools (e.g. crop prices in modelling food security);
- Lack of attention to climate impacts in some sectors e.g. energy, small island states, coastal zones, forestry, transport, tourism;
- Low skill of forecasts (and/or lack of information on skill levels);
- Lack of social/behavioural science research to better understand the barriers involved in pulling climate services into use;
- Gaps in understanding users' decision-making processes, which can be very specific to individual users;
- Lack of understanding on how to incorporate probabilities into decision making;
- Lack of understanding of the economics of value in use of climate information in long-term decisions (e.g. the cost of climate proofing now versus the discounted cost of remedial action decades later);
- Lack of information on climate information relevant to the 1-10 year time horizon (e.g. for planning road networks). This timescale can be more aligned with government planning cycles than e.g. the 50-year horizon – and so may carry more incentive for uptake;

[7] http://www.africanriskcapacity.org/

- Lack of understanding of holistic approaches to climate services operating across communities of users, sectors and landscapes – e.g. recognising and managing allocation of water resource across agricultural, energy, domestic and urban uses;
- Lack of understanding, in the delivery/uptake process, of how to resolve cultural divides between science-based information and locally-trusted Indigenous Knowledge systems;

Capacity (infrastructure)

- Insufficiency of observation networks (meteorological and hydrological);
- Insufficient network for lightning detection: of key interest for public safety both in terms of lightning strikes and for severe storm tracking (5 or 6 stations across Africa would bring much improvement);
- Poor national integration of climate observations (meteorological and hydrological) into a single shared resource (many networks are outside the remit of, and unavailable to, NMHSs);
- Lack of computing capacity e.g. to run regional NWP prediction models.
- Lack of high internet bandwidth – which may be available in country, but not specifically to the NMHS or collaborators;
- Lack of secure accommodation for NMHSs (e.g. lease held buildings), leading to reluctance to modernise;

Capacity (technical)

- Lack of tools (at NMHSs/RCCs) to strengthen capacity for monitoring and forecasting of climate and its impacts;
- Need for climate data rescue, digitisation and software tools for data management;
- Lack of capacity for RCCs and NMHSs to develop products that are more useful (e.g. more detailed) and accessible than “off the peg” internet products from global centres (e.g. rainfall monitoring from NOAA) – leading to lack of engagement since users “go elsewhere”;
- Lack of provider capacity to generate climate information at geographical scales relevant to users;
- Lack of capacity to make best use of available climate datasets (e.g. from the WCRP Coordinated Regional Downscaling Experiment);
- Limited capacity to exploit satellite observations to fill spatial and temporal gaps in historical climate data and thereby strengthen real-time climate monitoring;
- Lack of access to or training on tools to analyse user-relevant aspects of climate such as growing days, consecutive dry days, heavy rain days – to help NMHSs serve user needs.

Capacity (human)

- Lack of human and institutional capacity for providers to conduct quality climate and climate impact analysis – this limits functionality of RCCs, NMHSs and RCOFs;
- Lack of international climate science training workshops with Africa focus;
- Lack of capacity/training workshops involving providers with users and accompanied by follow-up contacts;
  Limited use of “train the trainers” concept – using influential industry, village and community leaders, boundary workers, religious leaders.

Capacity (service co-development and delivery)

- Lack of engagement of users in co-development of climate information products. This is needed to develop products that users understand. Climate information presentation, packaging, translation/interpretation and communication in useful/useable forms for different users needs a multi-stakeholder approach;

- Limited frameworks for dialogue between users and providers such as National Climate Outlook Forums (NCOFs);
- Operational procedures in some user sectors are institutionalised and resistant to use of climate information – often, users are unaware of the potential benefits of climate information;
- Lack of user awareness raising and outreach to help decision makers understand and use climate data – lack of worked examples;
- Poor accessibility to credible and comprehensive climate information in suitable formats;
- User difficulties in understanding and interpreting climate information, including uncertainties associated with seasonal predictions and climate change scenarios;
- Limited use of intermediaries who can play key roles in translating and "downscaling" climate information on all time horizons to local communities – brokering links between users and providers;
- Limited efforts to ensure services reach vulnerable communities that are most impacted by adverse weather and climate (e.g. marginalised groups, children and women);
- Low availability and translation of climate information into forms useful for early warning;
- Difficulties in translating climate information into actionable guidance for decisions and policies;
- Lack of coordination between national and sub-national levels in communicating weather and climate information;
- Lack of climate provider participation in key user events (e.g. regional workshops for the water sector). There is lack of reciprocation, since users do attend RCOFs and NCOFs run by climate providers;
- Users want specific information (based on geographical location, crop and livestock types etc.) which is not readily available;
- Lack of regional/national intermediaries to assist in consistent interpretation and response to national/regional climate change scenarios (e.g. such as available in the UK through UKCP09);

Global-regional-national partnerships

- Limited exchange of climate data and information across international, regional and national centres – to pool resource and strengthen basis of climate services;
- Limited frameworks/service agreements (e.g. MoUs) for international cooperation in climate data generation, data exchange, data analysis, training and capacity building;
- Limited ability for climate providers to exploit latest advances in climate science and technology.

African climate science leadership;

- Lack of institutions (in most parts of the continent) with capacity to pursue a leadership position in climate science;
- Fragmented climate community in Africa - owing to various scientific, capacity, cultural, funding and political barriers;
- Disproportionately low number of peer-reviewed publications on African climate from African scientists working in African institutions;
- Lack of incentives for training African national climate scientists;
- Limited sustained research fellowship opportunities;
- Lack of collaboration between universities and NMHSs.

In general the statements collected from these wider consultations are consistent with those from consultations in Africa and fit well into the initial categories defined – though with

considerable expansion of issues. Two additional categories, somewhat distinct from the others, emerged, namely: 1) strengthening partnerships between global, regional and national climate organisations in order to harness global resource and latest technology for climate services and 2) developing sustainable climate science leadership in Africa, to foster ownership of and focus on key challenges in understanding and predicting the African climate system.

Consultations within the Project Team and with Met Office experts

Consultations within the project team were initiated with a workshop, early in the project, convened with other experts within the Met Office. The workshop was used to gather inputs on sector sensitivities, barriers to uptake of climate services and ideas for intervention activities for each of 5 sectors: Agriculture and Food Security, Energy, Water, Health, Urban Environment and Infrastructure and DRR. Weather/climate sensitivities were also stratified according to information types that may be of use in managing them, specifically monitoring data (past climate); short-range forecasts (nominally 1-10 days), medium term climate (nominally 10 days to 3 months) and long-term climate (nominally 1-50 years ahead). Team members who were unable to attend provided written input.

In general results show strong coherence with evidence from the other consultation approaches, and therefore we do not discuss in detail here. The matrix developed is provided as a reference in Annex 7. The main conclusions from the sector and timescale stratification on barriers to uptake are as follows:

- Most of the barriers to uptake discussed above are relevant to all sectors, notably lack of user/provider capacity, lack of access to services, lack of data sharing, lack of provider-user engagement, insufficient translation into useable formats ("last-mile" delivery);
- Although simple climate to sector impact relationships exist for some sectors and are often used – e.g. the total seasonal rainfall required to sustain pasture or certain crops; above normal rainfall implies more standing water for mosquito breeding implying enhanced malaria risk – more sophisticated understanding requires inclusion of multiple variables and varies with sector. For example many mechanistic models have been developed to represent climate influences on crop yield[8] and stream flow, while somewhat fewer have been developed for the health sector (largely around malaria);
- Consideration of individual sectors exposes the need for coordinated integration of climate services across various actors connected with a sector – with different modalities operating. For example for the agricultural sector seasonal forecasts need to reach seed and fertiliser suppliers as well as farmers – so that the seed and fertilizer types appropriate for anticipated growing conditions are available for purchase for timely planting and fertilizer application. Lack of such coordination will discourage use of the forecasts by farmers. Similar coordination could optimise use of climate services in the water sector where issues such as allocation between competing needs for hydropower, flood recession agriculture, irrigation, domestic and industrial use will be uppermost. Except in extreme years, variability of use upstream may dominate availability downstream – again discouraging use of forecasts by some users if there is no cross-sector coordination.
- Consideration of decision timescale reveals multiple and very diverse barriers to uptake. For example lack of capacity to respond to short-term warning of severe weather (e.g. find timely shelter for livestock) will reduce motivation to respond. In urban development planning lack of use of long-term climate scenarios may, in

[8] http://www.agmip.org/

contrast, be more associated with costs of climate proofing and the long pay-off timescale relative to political cycles.

Synopsis of Literature Review (LR)

The literature review (LR) has been stratified on the 5 functional components (pillars) of the GFCS. These 5 pillars are considered in the GFCS implementation planning to be “essential components...needed to make producing and delivering effective climate services possible”. A review of the status of each pillar in Africa will therefore facilitate identification of gaps in capacity, providing a deeper perspective on results from the consultations. The 5 pillars shown in Fig.3 and are referred to as: User Interface Platform (UIP), Climate Services Information System (CSIS), Observations and Monitoring, Research Modelling and Prediction and Capacity Development. In this section we give, for each pillar, a brief description, the “barrier areas” from the consultations that map on to it and a synopsis of LR findings on status and opportunities. For more details the reader is referred to the LR (the executive summary is provided in Annex 8). It was important in the scoping to address all five pillars, since effective climate services are considered to depend on functionality in all pillars and on good connectivity between them. Thus an early observation on CIASA programme design is that significant progress across all five pillars will be more readily achieved on a regional scale than on a pan-African scale (this further discussed in Section 5).

The GFCS has also identified four sectors for which strengthening of climate service is a priority, namely: food security, water, health and DRR. To inform a potential sector focus for CIASA the LR has surveyed progress in Africa in these sectors as well as the emerging priority sectors of energy and urban environment (including long-lived infrastructure). A bibliography of all material referenced in the LR is provided at Annex 9 – for brevity and to avoid duplication only additional material is referenced in this report.

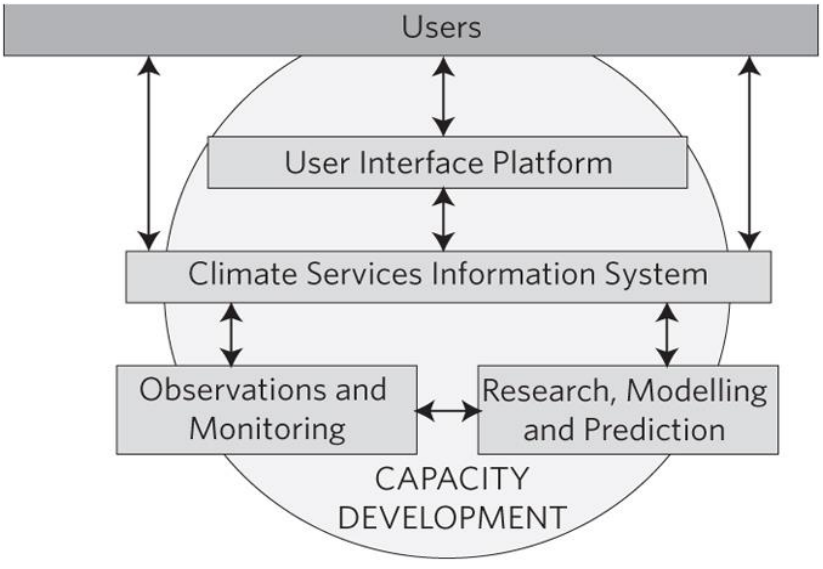


Figure 3: The Global Framework for Climate Services. The pillars are meant primarily as a conceptual model and in practice there is some overlapping of functions and responsibilities.

User Interface Platform (UIP)

(reference Sections 2 and 3 of the LR)
The UIP provides a structured means for climate users and providers as well as researchers to interact. Its aim is to promote effective decision making through co-design and delivery of user-relevant information that is well communicated, understood and used.

Gaps and barriers identified in the consultations that map onto this pillar are represented primarily by those listed under the **capacity (service co-development and delivery)** barrier (see above) and centre on lack of user-provider engagement and lack of mechanisms for this. The following points on status and opportunities regarding UIPs in Africa are drawn mainly from the LR.

Status and opportunities

Regional UIPs

Status: Established UIP activities include the Regional Climate Outlook Forums (RCOFs), initiated in the late 1990s and currently held in 5 regions of sub-Saharan Africa. RCOFs provide a platform for climate researchers, providers and users across key sectors to interact and increase mutual understanding. Activities are centred on communication of a regional forecast for the season ahead (typically next 3 months) and discussion of sector responses as well as user feedback on past forecasts. Some RCOFs include hydrological forecasts for river basins and other regional partnerships also include health outlook forums, notably Malaria Outlook Forums (MALOFs). In addition, there have been significant investments in creating parallel regional (and national) platforms for DRR.

Opportunities: There are opportunities to learn from regional demand for new RCOF activities and scale up successful initiatives. For example, in response to demand, ACMAD has recently implemented a new RCOF for the Guinea Coast region, where the seasonal timing differs from the Sahel (formerly the main focus of the West Africa RCOF). RCOFs that are better aligned to regional climate characteristics should enhance user uptake. Mid-season RCOFs could also be introduced (a mid-season RCOF was formerly held for the long November to March southern African season – but has been discontinued, presumably for resource reasons). RCOFs could also be supported to provide a channel for strengthened support to a wider range of sectors. The interdependencies across sectors, referred to in the consultation section, suggest there are opportunities to increase uptake through greater emphasis on cross-sector discussions. In addition to their role in forecast communication, the RCOF (and NCOF) activities represent valuable opportunities for trialling, refining and promoting new, more user-relevant forms of monitoring and forecast information not currently available (such as season onset and rainfall distribution through the season)[9]. There are also opportunities, again in liaison with research activities (e.g. FCFA and SHEAR), to extend the RCOF model to other time horizons, in particular engendering research/provider/user engagement around climate change scenarios and, equally, the sub-seasonal time horizon. There are governance benefits to circulating the task of hosting the RCOF around the countries of the region – as is done in the Greater Horn of Africa - and this could be further supported. Hosting the RCOF raises the profile of climate services to the hosting national government – emphasising that it is an activity with high levels of regional and international support. This impact can be further enhanced if an NCOF is held in tandem with the RCOF.

[9] This approach has been used for trialling season onset timing forecasts, see: Climate Science Research Partnership: Phase 1 (CSRP-1), 2014 - final report http://www.metoffice.gov.uk/csrp/csrp1-results

National UIPs
Status: At national level NMHS engagement with users is often limited and sometimes rudimentary. National Climate Outlook Forums (NCOFs), modelled on RCOFs have, in recent years, been implemented by NMHSs in some countries and facilitate provider-user interaction and forecast communication at national level. Many countries also have national mechanisms for integrating climate and health, including climate and health working groups, a forum established in Africa since 2008.

Opportunities: In addition to observations made above we also note that NCOFs are generally at a much earlier stage of formation than RCOFs. There are therefore good and timely opportunities to learn from the RCOF experience in shaping the evolving NCOFs and to scale up implementation in more countries. In particular there are opportunities to integrate NCOFs with existing networks and services, this may enable resources for UIPs to be channelled in ways which simultaneously boost key public services, enabling livelihood groups to benefit from the multiple benefits of more accessible agricultural, health, education, DRR and climate services.

Sub-national and community level UIPs
Status: There are some examples of enhanced NMHS engagement at sub-national level. For example the StARCK+ project is developing tailored forecasts for county levels in Kenya. While user engagement at community level is frequently led by intermediary organisations – for example the Participatory Scenario Planning (PSP) approach of CARE International, and other intermediary organisations such as CCAFS.

Opportunities: Developing sub-national and community level frameworks required to deliver user-driven climate services comprise, at present, largely pilot activities. Key opportunities lie in identifying how these approaches, where successful, may best be continued, supported and scaled up. To date most work has focussed on services to rural communities but there is also considerable scope to strengthen resilience of urban communities – e.g. by developing UIPs to serve the city-scale interest (comprising municipal leaders, service providers etc). CIASA synergies with the FCFA FRACTAL (Future Resilience for African Cities and Lands) project may present opportunities in this regard.

From regional down to community scales strengthening user-provider engagement and uptake of services will need to be driven by enhanced monitoring and evaluation frameworks to collate and assess learning about which approaches are most effective and to accumulate a body of evidence demonstrating the value of climate services for strengthening resilience among at risk groups.

Climate service intermediary organisations:
Status: Climate service intermediary organisations and activities are recognised as playing important facilitating roles in the UIP arena particularly at sub-national and community level – working through existing networks, including farmer group representatives, extension services, local radio, religious and faith leaders and non-governmental organizations. There is emerging learning that, at local levels, strengthening communication of climate information through support to existing, well-established and trusted networks (e.g. agricultural extension services, community leaders) – including “training of trainers” - may be more effective than introduction of new boundary organisations. The latter may even weaken incentive for engagement by placing more distance between user and provider. At other levels (for example in communicating risks of climate change to urban planners at national level), collaborative, cross-sectoral boundary activities to co-produce tailored data and information and support for its use may be more appropriate.

Opportunities: In strengthening boundary organisations and intermediary networks there are opportunities to bolster or customise existing facilities for government departments, sectors and communities (e.g. through new foci on river basins or agricultural zones) in preference to proliferating new networks/platforms.

Increasing interest in national, sub-national and community level forums as key instruments for uptake of climate services opens an opportunity for research to reach a better understanding of the roles of intermediary and boundary organisation, which methods work best for different classes of users and the organisational changes and capacity building required on the part of both providers and users to enable climate information to better support specific decision making contexts.

Short-range weather warnings:
Status: Physical forum-style UIP activities are not appropriate for short-range warnings because of the short timescales. Nevertheless, interfaces are still required to develop optimum services. Public service and customer advisory groups, public surveys etc that facilitate service development in developed countries are largely rudimentary in many African countries.

Opportunities: Projects in Senegal and Kenya to design and establish warning communication chains to community level and in Uganda to design storm warning services to fishers on Lake Victoria (delivered by SMS) and to establish impact risks associated with thresholds in forecasted variables are examples that future work can learn from and scale up. Consideration of the city scale will also be important for short range warning of potentially severe events and there are opportunities to strengthen engagement between NMHSs and municipal leaders.

Capacity implications: The above opportunities carry implications for strengthening the capacity of climate and user organisations and collaborators: RCCs, NMHSs and sector users for their role in coordinating and capacity to participate in RCOFs and NCOFs – as well as intermediary organisations to enable scale up of extension/translation activities.

Links to ClimDev-Africa: The proposed phase 2 of ClimDev-Africa includes a component on “Forums for dialogue”, which will invest in facilitating thematic forums to establish a community of practice to promote the uptake of climate information and services in decision making.

Climate Services Information System (CSIS) and Observations and Monitoring

(reference Section 4 of the LR)
Here we combine a summary of the LR on the status of the CSIS pillar in relation to Africa as well as on the observation and monitoring pillar - both are concerned with issues of infrastructure and technical capacity.

The mechanisms that routinely collate, store and process information about past, present and future climate – i.e. the operational facility catering to all the climate information needs of users, are collectively described as the Climate Services Information System (CSIS) in the GFCS Implementation Plan. The CSIS comprises a physical infrastructure of institutions, computer capabilities, tools and operational practices. Successful delivery and use of climate services at all levels down to local level is dependent on a well functioning CSIS making use of all available information from global, regional and national sources. The Observations and Monitoring pillar is concerned with ensuring that the climate observations necessary to meet the needs of users are made, managed and disseminated. High quality historical and real-

time observations and data are required not only across the entire climate system but also relevant biological, environmental and socio-economic variables so that impacts of climate variability and change on these sectors can be evaluated.

Gaps and barriers identified in the consultations that map onto these pillars are represented primarily by those listed under **capacity (infrastructure), capacity (technical)** and **global-regional-national partnerships** in the previous section. The **capacity (human)** category is also included as a cross-cutting factor. The following observations on the status and development needs of the CSIS as well as of Observation and Monitoring activities in regard to Africa are drawn from the LR.

Current status and opportunities

Capacity of NMHSs - general

Status: Based on expert assessment, more than 70% of countries in Africa have NMHSs that operate climate services at only basic levels or less. Thus most conduct some observation data gathering, management and climate monitoring, but have limited interaction with users and limited in-house capacity for forecasting or generating/serving climate change scenario information. The skew to low capacity is very pronounced compared to a world wide estimate (Fig. 4).

Opportunities: There is strong evidence that substantial and broad-based strengthening of NMHSs is a crucial factor in improving climate service development and uptake. On this basis the WB/GFDRR Hydromet Programme is one initiative contributing (with global remit) to NMHSs strengthening though there are opportunities to provide further focus on Africa.

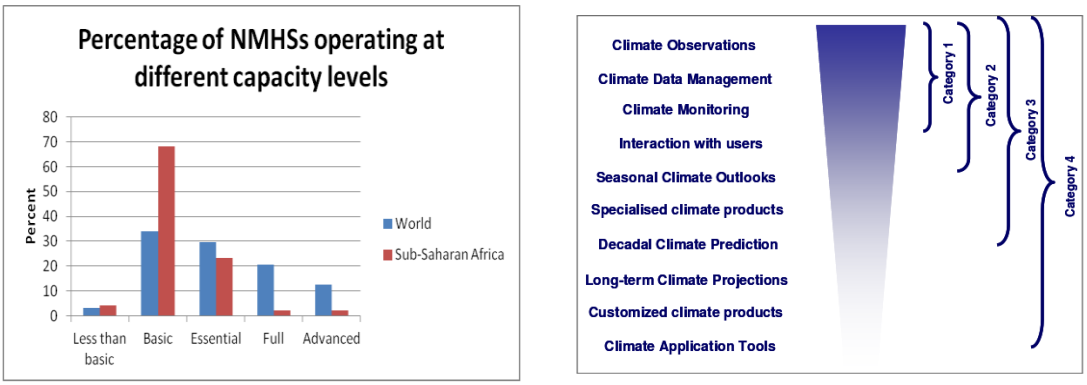


Figure 4: Left: estimated percentage of NMHSs as a function of capacity for climate services World (blue) and sub-Saharan Africa (red). Estimates are based on team expert assessment. Right: Hierarchy of climate service capabilities. Categories 1, 2, 3 and 4 correspond to basic, essential, full and advanced services. It should be emphasised that the categories are illustrative only, in reality there is a continuum of capability and variations will occur within any category.

Observation networks

Status: High quality observations of basic climate variables are fundamental to development of all climate services from monitoring and risk assessment to weather and climate predictions. Africa is the continent with lowest density of weather and climate observations (Fig. 5). Moreover, the density of observations has suffered a dramatic decrease in recent years in most parts of sub-Saharan Africa (Fig. 6).

Opportunities: There are opportunities to rehabilitate silent stations, implement new networks and also to explore use of non-traditional observations (e.g. using data from other sectors as well as mobile phone "call in" observations and mobile phone photography from the public[10]) which may bring particular benefit in areas where the conventional network is sparse. Automatic weather stations are being installed as integral components of climate projects in several countries. There is a need to coordinate implementation regionally and to ensure local capacity for sustained maintenance. The WMO Integrated Global Observing System (WIGOS) initiative is working to increase sharing of observation networks that are not operated by the country NMHS. There are opportunities to strengthen its Africa focus. Recent studies in Cote d'Ivoire found potential to significantly increase observation coverage when networks from the agriculture, hydrology, oceanography and aviation sectors complement those operated by the NMHS.

[10] See for example the Met Office Weather Observations Website (WOW) http://wow.metoffice.gov.uk/

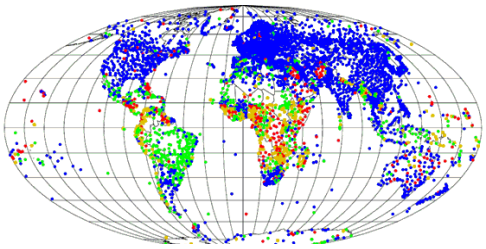


Figure 5: Showing global weather stations reporting to the World Meteorological Organisation. In blue are stations for which 90% of reports are received, in green 45 – 90%, in yellow less than 45% and in red are silent stations. Source: World Meteorological Organisation.

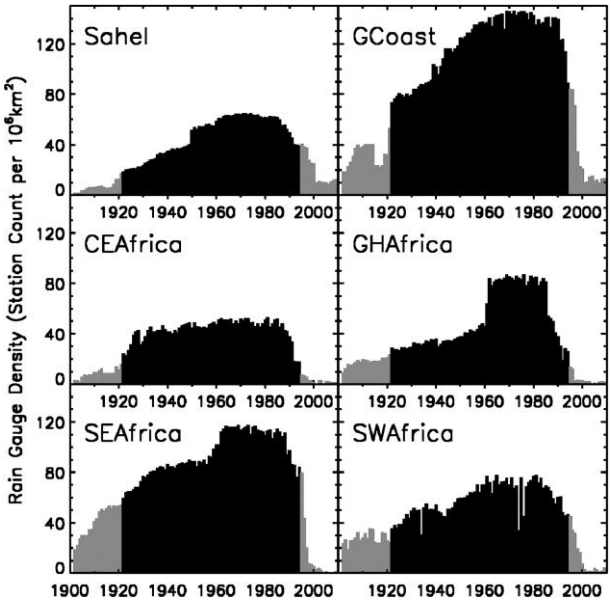


Figure 6: Time series of the density of rain gauges used by CRU TS3.1, for each of six rainfall regions. Units are station counts per 10^6 km^2, and black bars denote the period (1922–94) considered in one study to have adequate data for robust analysis. *Source = adapted from Rowell (2013)*

Climate data rescue and management:

Status: The maintenance of climate records in a useful form provides a major challenge for some NMHSs in Africa. It is only recently that observations have been recorded electronically in a systematic way in some countries, and a vast quantity of climate data is still held on paper records. Not only can this information not be easily shared with others or used in model analysis, there is a risk that this data could be lost altogether as many of these paper records can deteriorate in poor environmental conditions.

Opportunities: The ACRE (Atmospheric Circulation Reconstructions over the Earth) and IEDRO (International Environmental Data Rescue Organization) are two initiates facilitating – with global remit - data rescue and digitization projects. Opportunities can be sought to strengthen their African focus.

Climate monitoring:

Status: Few NMHSs have access to modern climate monitoring tools to analyse observations and generate information products flexible to user needs e.g. national/sub-

national maps or graphics showing climate characteristics and/or monitoring of evolving drought or flood conditions. Few countries have the capacity to generate gridded analyses (from irregularly spaced station data) to support versatile production of map products and risk assessments.

Opportunities: Some promising progress has been made in a few countries, including by the ENACTS (Enhancing National Climate Services) and the Rainwatch-AfClix (RWX) programmes. The former generating spatially complete and gridded rainfall and temperature analyses through blending station data with satellite and re-analysis data and serving through an online portal, the latter visualising, at specific stations, the current season-to-date rainfall evolution in the context of climatology and past extreme seasons. There are opportunities to scale up.

Short-range weather prediction:
Status: The vast majority of African countries do not have access to the state-of-the-art computer weather prediction output that has revolutionised public service weather warning out to a few days ahead (e.g. for heavy rain, strong winds, heatwaves) in developed countries. Other than South Africa, only a few of the more developed countries run in-house short-range prediction models. Ethiopia and Kenya, for example, run the NCAR Weather Research and Forecasting model (WRF) model driven by boundary data obtained routinely from global centres. In most countries services are, at best, based on interpretation of rendered images from global centre models obtained over dedicated channels or over the internet – leaving little opportunity for in-house tailoring.

Opportunities: Recent initiatives to make global centre forecast information available to regional centres and NMHSs, such as the WMO's Severe Weather Forecast Demonstration Project (SWFDP), and high resolution modelling over Lake Victoria have indicated large potential benefits to users. Using similar information from global centres, the pan-Africa centre ACMAD provides early warnings of severe weather across the continent – to serve as guidance to regional and national centres. All these efforts are in demonstration phase and there are opportunities to support consolidation and wider implementation, as well as full validation and further transfer of knowledge and forecasting expertise**.** Investment in 'in-house' NWP modelling capability is generally considered not cost effective, at least in the near future, given the large costs involved in operation and maintenance of state-of-the-art systems.

Seasonal-range outlooks:
Status: African rainfall has a strong seasonality – in some cases limited to a 3-month period in the year with an encompassing long dry season. In many regions inter-annual variations in seasonal rainfall have relatively good predictability. Tools for predicting prospects for the season ahead, crucial to planning in many key sectors, are not currently making use of available science and technology. Low-cost statistical prediction tools (largely run on desk-top computing or laptops) are in operational use at RCCs and also at many NMHSs and RCCs provide training and other support in these methods to NMHSs. There is low capacity to evaluate the performance of climate-model based predictions from global centres – and thus low capacity to exploit recent advances in these systems which consequently remain underused.

Opportunities: WMO is fostering international collaboration to increase the availability of climate-model based seasonal forecasts through designated Global Producing Centres (GPCs) and an associated Lead Centre[11]. There are opportunities to strengthen RCC and NMHS capabilities to access this information, evaluate it down to country/regional level and

[11] www.wmolc.org

use it to strengthen the information base for issued forecasts - potentially leading to more objective and reliable forecasts and greater incentive for user engagement and uptake.

Gaps in "seamless" forecast provision:
Status: African centres have little information on which to base advice to users on sub-seasonal time horizons (typically 10-50 day range). Similarly, there is little access to information on multi-annual to decadal timescales (1-10 years). Both these ranges are of high potential value in Africa: the former for in-season agriculture decisions, for example; the latter for e.g. long-term planning for food security – thus with availability, uptake may be readily incentivised.

Opportunities: Model-based sub-seasonal forecasts from global centres are in a relatively mature state of development. There are opportunities to link with research activities (see later) to instigate extensive validation over Africa and trial product development with users. Similarly, there is evidence of success with multi-annual prediction in parts of Africa that warrants more focused assessments and trials with users.

Climate change scenarios:
Status: Most Regional and National Centres and intermediary networks have not developed the capacity to serve communities and decision makers with best available information on climate change scenarios tailored to the region or country (as for example is available for the UK through UKCP09). Consequently, few countries have a national authoritative source for information on climate change providing consistent advice across government departments and sectors.

Opportunities: There are opportunities to link with the FCFA Regional activities to strengthen harnessing of research outputs for the 5-40 year time horizon for the benefit of user sectors.

Regional Climate Centres:
Status: By providing a framework for strengthening existing regional climate organisations in Africa WMO is fostering a network of WMO-designated Regional Climate Centres (RCCs) operating to specified capacity levels that can support NMHSs in the region, particularly those with lowest capacity. Specified mandatory roles and functions include generation and dissemination of regional climate monitoring products and seasonal forecasts, coordination of RCOFs and training for NMHS representatives. Provision of climate scenario information is a highly recommended function. Although all centres are providing valued services, to date these centres are not meeting the WMO specification and in some cases capacity remains very low. The Central African region is not yet served by a regional centre – with implementation still at planning stages.

Opportunities: By strengthening RCCs there is an opportunity to bring greater coordination to climate services across the region – assisting capabilities to inform trans-boundary issues such as water resource management. Developing RCC capacity can also strengthen their contributions to regional training, the RCOF process, enable greater levels of support to NMHSs and increased engagement with users having regional interests such as IFRC.

Global-regional-national networks:
Status: The GFCS defines a formal structure based on a cascade of climate information from global centres through regional to national centres – with increasing detail and refinement added by processing and specialised expertise at regional and national levels. The information from global centres is currently underused – partly because of lack of tools and expertise at RCCs and NMHSs to process the information and also because of less-than-optimum packaging of the data by global centres.

Opportunities: As already mentioned above, some progress is being made in fostering global-regional-national links. For example, the ENACTS programme, the SWFDP for short range forecasting and the WMO GPCs for seasonal forecasting. There are opportunities to scale up these activities, building on existing work – for example establishing formal cooperation agreements and improving data exchanges and training.

In summary, results from the LR are wholly consistent with those of the consultations in revealing an overall picture of very low capacity in most aspects of infrastructure and technical resource (observational networks, computing hardware, tools and expertise for analysis) as well as capacity to exploit resource from global centres. This applies both for NMHSs and RCCs.

The Research, Modelling and Prediction

(reference sections 6, 2 and 3 of the LR)
In brief, this pillar is concerned with addressing knowledge gaps associated with developing and using climate services. Research disciplines embraced include the earth system sciences, sector-related science (e.g. hydrology, health) and sciences of society, economics and human systems. To summarise the aims are:

- developing and improving practical science applications;
- enhancing cooperation in research communities and interaction between climate information providers and users;
- improving climate information products, and
- improving understanding of Earth's climate system.

Gaps/barriers identified in consultations that map onto this pillar are represented primarily by those listed under **Research** in the consultation section and centre on knowledge gaps around: understanding, modelling and prediction of the African climate and its drivers, the practical application of climate science, decision making under uncertainty, social, behavioural, cultural and gender-based issues surrounding the delivery and use of climate services. The gaps listed under **African Climate Science Leadership** also broadly map onto this pillar.

Status and opportunities:

African climate science leadership
Status: Despite investments to develop young emerging scientists within the climate related arena, few become recognized leaders in the international community whilst also staying within the Africa continent. There are severe limitations in resources, technical capacity, available staff and computational capacity, and a chronic lack of investment in postgraduate education and research infrastructure. This is manifest in the relatively low level of engagement of African scientists in major international activities like the IPCC. Other than in South Africa, there is no active climate model development. Of all the CMIP models developed by the international science community, none of the core development teams sit in African institutions. This is mirrored at weather timescales in that no operational models that are being used for weather forecasting by NMHSs in Africa are being developed in Africa. As noted in the CSIS section, very few countries other than South Africa are running numerical prediction models.

Opportunities: There is an emerging consensus that this area requires radical new approaches. Climate science fellowship schemes involving African scientists working in

collaboration with global model centres (see e.g. CSRP-1[12]) can play a useful part. In general a more sustained approach is considered necessary and there are opportunities to support new approaches developing as part of the CR4D initiative based on a framework of institutional pairing and mentoring.

More generally, the new CR4D framework, developed jointly by ClimDev-Africa and WCRP, is providing a holistic Africa-led approach and fostering a federation of research proposals designed to align a multi-disciplinary research agenda to development needs. There are opportunities to support activities across the 7 key challenge areas which have strong links to most aspects of the research and capacity needs discussed in this section, specifically: 1) inadequate and declining ground-based observational data sources; 2) insufficient understanding, knowledge and information on climate variability and change and their impacts on agriculture and food security, water and other natural resources management, sanitation and public health, environmental conservation, economic development, etc.; 3) high vulnerability to natural climate variations and anthropogenic climate change and associated extreme events such as droughts, floods, storms and heat waves; 4) lack of coordinated multidisciplinary platforms for the delivery of national climate services to inform sustainable development; 5) substantive gaps between the production of scientific information and the actual appropriateness, saliency and credibility of the information for the user community and for planning and decision making processes; 6) difficulties integrating contemporary scientific knowledge with local indigenous knowledge; and 7) lack of understanding of the complex interactions and feedbacks between climate and non-climatic stressors of political, social and economic origin.

International climate research and modelling:
Status: The Africa Climate Report (2004) noted that "...the scientific understanding of the African climate system as a whole is low…". While there has been some progress since that time, notably from the AMMA programme in West Africa – there are still many gaps in understanding. In as much as climate models represent the embodiment of understanding, this is supported by the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) which concluded that current climate models have only a modest ability to capture those phenomena that are most important in driving African climate. Others have noted that there has been little net improvement in some aspects of modelling African climate between the CMIP3 and CMIP5 experiments (i.e. in the last 5-10 years). The CSRP programme concluded that priority research areas needed to address these insufficiencies include:

- High resolution modelling (including regional convection resolving); improved representations of tropical convection (the principle rainfall mechanism in Africa); the atmospheric boundary layer and land-atmosphere interactions, mechanisms communicating remote influences (e.g. from El Niño) and aerosol impacts on longer-term variability and change (potentially important in both Sahel and East Africa). Improved understanding/modelling of these aspects is needed for improved forecasts at short, medium and seasonal range and beyond.
- Advancing expert judgement on climate model reliability and thus potentially reducing uncertainty in climate change scenarios. This requires improved understanding of the mechanisms that drive modelled change across a range of model configurations as well as improved understanding of the drivers of present day changes.

[12] Climate Science Research Partnership: Phase 1 (CSRP-1), 2014 - final report http://www.metoffice.gov.uk/csrp/csrp1-results. CSRP was a partnership between DFID and The Met Office on improving understanding and modelling of African climate, applications and capacity building.

- Improved observation networks and/or observation campaigns are important to provide the necessary “ground truth” to unlock model errors/biases.

Opportunities: In recent years the DFID CSRP programme has initiated a focus on improving understanding and modelling of African climate and its drivers. This focus is continuing with the FCFA programme which focuses in the 5-40 year time horizon and includes a model development consortium (IMPALA) with a pan-African focus as well as consortia with regional research focus. IMPALA includes regional model development at very high convection resolving resolution. There are opportunities for CIASA to link with FCFA research outputs to strengthen pull through of research into trial and use. Other programmes with synergies include CORDEX-Africa[13] and AMMA Phase 2[14], which also focus on enhancing understanding of climate variability and change in Africa, as well as research-driven capacity building. DFID’s SHEAR programme includes research, and applications to improve EWS for the “weeks to seasons” timescale.

Prediction

Status: Most African NMHSs rely, for short-range prediction, on expert extrapolation of current conditions and forecast map products from global centres (e.g. SWFDP) obtained via the internet[15] and other means. Some centres are also providing high resolution regional model output. For example, through the WMO Voluntary Contribution Programme (VCP) the Met Office is providing high resolution limited area model forecasts for the lake Victoria Basin out to 2 days ahead. For seasonal prediction many countries rely on low-cost statistical prediction methods, either developed in-house if capacity exists or with tools and data available ahead of season at pre-RCOF workshops held by RCCs. The IRI-developed Climate Predictability Tool (CPT)[16] – a custom designed windows-based software package is increasingly used to develop statistical models. Some of the more under-resourced countries rely mainly on statements from the RCOF consensus regional forecast for their sub-region without any further adjustments to account for possible national variations. Forecast maps from the WMO GPCs are also used - with some evidence of increasing use. As discussed under the CSIS pillar there are very few fully-validated tools, even from global centres, for predicting the sub-seasonal range (typically 10-50 days ahead) and the multi-annual to decadal range (1-10 years ahead) – and these remain key timescale gaps interrupting “seamless” provision. There are promising developments in the science (see below) but lack of understanding of its maturity to form the basis of useful predictions and services.

Opportunities: Given the current shortfalls, there is a need to strengthen the predictions and EWS available to users in Africa, make the forecast products more user-relevant and fill gaps in the time horizons predicted. This is likely to involve a mixture of strengthening “in-house” (NMHS/RCC) systems as well as strengthening forecast information “cascade” from global centres. For the short range there are opportunities to support and/or link with projects such as the well-tested SWFDP, new initiatives for the Lake Victoria Basin under the LVB-HyNEWS grouping[17], and the WWRP High Impact Weather[18] programme focused on impact-based forecasting. For seasonal range forecasting there is a need to fully validate and compare existing statistical and climate-model based methodology and opportunities to exploit the growing international collaboration in serving the climate-model based predictions. In terms of filling timescale gaps the WWRP-THORPEX/WCRP sub-seasonal to seasonal (S2S) research programme[19] seeks to increase capabilities for prediction on the

[13] Coordinated Regional Climate Downscaling Experiment in Africa. http://start.org/cordex-africa/
[14] African Monsoon Multidisciplinary Analysis. http://amma-international.org/index
[15] The Norwegian Met Services serving of ECMWF output is used by some: http://www.yr.no/place/Afrika/
[16] http://iri.columbia.edu/our-expertise/climate/tools/cpt/
[17] LVB-HyNEWS: Lake Victorial Basin Hydro Climate to Nowcasting for Early Warning Systems, http://africa-climate.org/wp-content/uploads/2014/08/HyVic_Concept.pdf
[18] http://www.wmo.int/pages/prog/arep/wwrp/new/high_impact_weather_project.html
[19] http://s2sprediction.net/static/about

10- to 50-day time horizon and has a specific sub-project for Africa with potential for a forecast demonstration phase following the example of SWFDP. Support to the S2S programme, to identify user requirements in Africa, evaluate the quality of sub-seasonal forecasts and where appropriate develop products for trial would make a significant step towards filling this key gap in service provision. Success shown by some decadal predictions systems in predicting multi-annual variability in North Atlantic ocean temperature (Hermanson et al. 2014) opens opportunities for exploring multi-annual rainfall predictions in parts of Africa where this variable is correlated with rainfall (e.g. Sahel).

Multi-disciplinary research – physical and biological sciences

Status: With regard to progress in developing services for specific sectors the LR shows that current progress in the development of climate services is variable. Unsurprisingly progress appears to be greatest in the Food Security and Agriculture sector, with many examples of successful small-scale projects and relatively well developed services generated and disseminated at Regional Climate Outlook Forums. The literature suggests less progress in developing services for the health sector and a significant demand but limited progress in areas like energy and urban infrastructure that were not original priority areas for the GFCS. There has been relatively little research to date to develop services to inform management of coastal zones, transport and tourism. Many of these applications correspond to subjective or semi-objective applications of rainfall and temperature forecasts. However, there is a growing body of research on direct integration of climate predictions with application modelling and this remains a priority to help optimise usefulness to users and therefore uptake. Key areas include: agriculture and food security (regional crop yields; crop pests and diseases); health (movement and onset of diseases); water resources/energy (river flows, irrigation systems, and hydro-electric systems): see Malherbe et al. (2014) for an example on African crop yield modelling. The EU EUPORIAS project is investigating use of climate-model predictions to strengthen Ethiopia's Livelihoods, Early Assessment and Protection (LEAP) system[20]. In the health arena, some progress has been made recently including by the EU QWECI project which aimed to understand the climate drivers of the vector-borne diseases of malaria, Rift valley fever and certain tick-borne diseases, which all have major human and livestock health and economic implications in Africa. The focus countries were Ghana, Malawi and Senegal. Statistical prediction systems for malaria have also been developed and used at Malaria Outlook Forums and in some cases at national level.

Opportunities: Although there has been progress, strengthening of capabilities to deliver climate information in terms of impact on crop yield, disease incidence, water availability etc remains a clear need in encouraging user uptake. There are opportunities to support and strengthen multi-disciplinary groups with existing pilot projects in this field.

Research – social, behavioural, communications science

Status: There is a growing body of research into diverse issues associated with effective communication of climate information. Key issues include co-development of approaches for communicating often complex science outputs, including concepts of uncertainty and probability, and supporting their appropriate application in decision making. There has been some research on the advantages and disadvantages of various delivery mechanisms (radio, mobile phones etc.) as well as in understanding the social/behavioural/cultural barriers to uptake. Commonly noted constraints include: physical disconnect between climate science providers and users and lack of appreciation of each others' ways of working, language barriers, gender issues related to communications chains and differing work roles, high levels of illiteracy, inadequate infrastructure, a lack of access to phones, radios or televisions, users who are either geographically remote, scattered or mobile (e.g.

[20] http://www.euporias.eu/prototype/leap-ethiopia

pastoralist communities in parts of Africa) and lack of trust in the forecast relative to long-standing practice of reliance on local and indigenous knowledge systems.

Opportunities: A number of projects are addressing the diverse issues associated with achieving successful communication and use of climate services and there are opportunities to support scale up of these activities. Included are CCAFS pilot projects with farmers in Senegal (also addressing gender-related issues), Mali, Kenya, Tanzania and Zimbabwe. Frameworks for knowledge exchange between climate providers and users to enhance effective co-production of user-relevant information have also been developed by the Human Futures Programme (HFP) and partners - and are being further developed. The Red Cross Climate Centre[21] has developed over 45 new games designed to rehearse and confront issues around communication, understanding and response to climate information in areas including disaster preparedness, gender, food security, climate information and health.

In brief the results from the LR confirm a need, also articulated in the CR4D agenda, for extensive climate and multi-disciplinary research to underpin improved uptake of climate services – and that, particularly in the communication area, such research will need to be guided by collation and assessment of emerging learning on "what works".

Capacity Development

(reference section 7 of the LR)
The capacity development pillar is concerned with requirements for enabling all activities underpinning climate services to occur sustainably. It includes capacity development requirements of providers and of users. Areas included are governance (recognising, for example, that some countries lack a strong mandate to interact with users), management, human resources development, education and training, leadership, partnership creation, science communication, service delivery, resource mobilisation and infrastructure. These issues cut across the other pillars and most have been already discussed. Here we focus on LR findings on **governance** and **capacity (human)** which are two categories that map onto this GFCS pillar.

Governance:
Status: The AMCOMET Integrated Strategy on Meteorology (the 5 pillars of the strategy are given in Annex 10) notes that ministers responsible for meteorology have a "hands off" approach to, and have little interaction with their NMHSs. The knock on effects include limited recognition by ministers and government in general of the potential socio-economic benefit of weather and climate services as well as exacerbation of several of the barriers to uptake already discussed. Specifically: long-term low funding of NMHSs from government and development partners leading to lack of infrastructure, observing systems, forecasting tools, trained personnel and resource for service delivery; lack of capacity for NMHSs to modernise and exploit advances in science and technology; lack of collaboration between NMHSs and other government sectors (e.g. agriculture, water, health) to share climate relevant data and create "joined up" climate services through partnership. In some cases RCCs also lack sufficient governance support from their governing Regional Economic Communities. Scoping work for the DFID FCFA programme also found that many of the biggest barriers to using climate information relate to institutional mandates, hierarchical structures and a lack of adequate incentives. Additionally a CCAFS pilot study noted that the success of a project providing weather and climate services for decision making by farmers in Mali was in part due to the national government taking over budgetary responsibility of the project from donors and turning the project from an externally driven enterprise to a nationally-appropriated priority. The successful Africa Risk Capacity (ARC) programme, in which national governments pay premiums for index-linked insurance to protect citizen

[21] http://www.climatecentre.org/site/games

livelihoods is another example of how high-level government buy-in can accelerate uptake of climate services.

Opportunities: There are a number of initiatives around governance of climate services that CIASA can learn from and build on including the CCAFS and ARC examples referred to above. Support for documenting success stories and developing promotional material relevant at government level is needed. There are also opportunities to link with FCFA work on governance that leads on from the scoping studies.

Human resource, education and training:

Status: The need for broad-based training in climate science in Africa is frequently stated. WMO workshops to identify needs of RCCs and NMHSs (including African representatives) note "a lack of guidance, training and technical manuals on the interpretation of climate output from global centres". Indeed a mandatory function of RCCs is to coordinate training for users of their services; however there are often insufficient funds, access to expertise and other resources to deliver the sustained training programmes required. In response the CR4D agenda includes capacity development initiatives that include NMHS engagement with partner universities, and ClimDev-Africa phase 2 includes a fellowship programme that will build a critical mass of human resource that is able to promote uptake of climate information and services in decision making across the region. Conclusions of the DFID CSRP programme noted that while fellowships, workshops and RCOF participation have proved useful in education and training more sustained interactions should also be developed: for example through long-term visiting scientist exchanges and/or establishment of joint research and applications centres between international partners and African regional centres. The FCFA scoping also concluded that workshops can have limited effectiveness for a range of reasons including issues of the financial remuneration provided which can negatively affect who and how many can attend. The LR also notes a need to modernise weather and climate forecaster training including in communicating probabilities and uncertainty and impact based advice, as well as in aspects of customer service and quality management. Sector users of climate information also need climate literacy training as demonstrated by training initiatives of the Global Water Partnership, the World Health Organisation and the World Food Programme.

Opportunities: Opportunities to strengthen capacity building activities include support for emerging ideas from the CR4D initiative around engagement of universities and the ClimDev-Africa fellowship programme. Engagement of universities could include development of a climate services curriculum. There are also opportunities to learn from existing visiting scientists programmes such as those operated by the NOAA NCEP Africa Training Desk[22] and to strengthen and modernise training programmes at Regional Training Centres in Africa. Creation of regional offices for transfer of climate knowledge and technology within African regional centres, including use of embedded experts, is a potentially powerful approach (and has been used as part of geospatial monitoring initiatives such as the EUMETSAT AMESD and MESA programmes). Initiatives to enhance climate data literacy such as that implemented by START in partnership with the University of Cape Town's Climate System Analysis Group (CSAG), under the CORDEX-Africa program[23] could be supported. Increased provider-user engagement can also be effective in increasing climate literacy as well as educating providers in user needs, e.g. through co-development of prototype climate services[24].

[22] http://www.cpc.ncep.noaa.gov/products/african_desk/cpc_intl/menus/intro.shtml#Introduction
[23] http://start.org/programs/cordex-af
[24] This approach has been used in the EU EUPORIAS project http://www.euporias.eu/prototypes

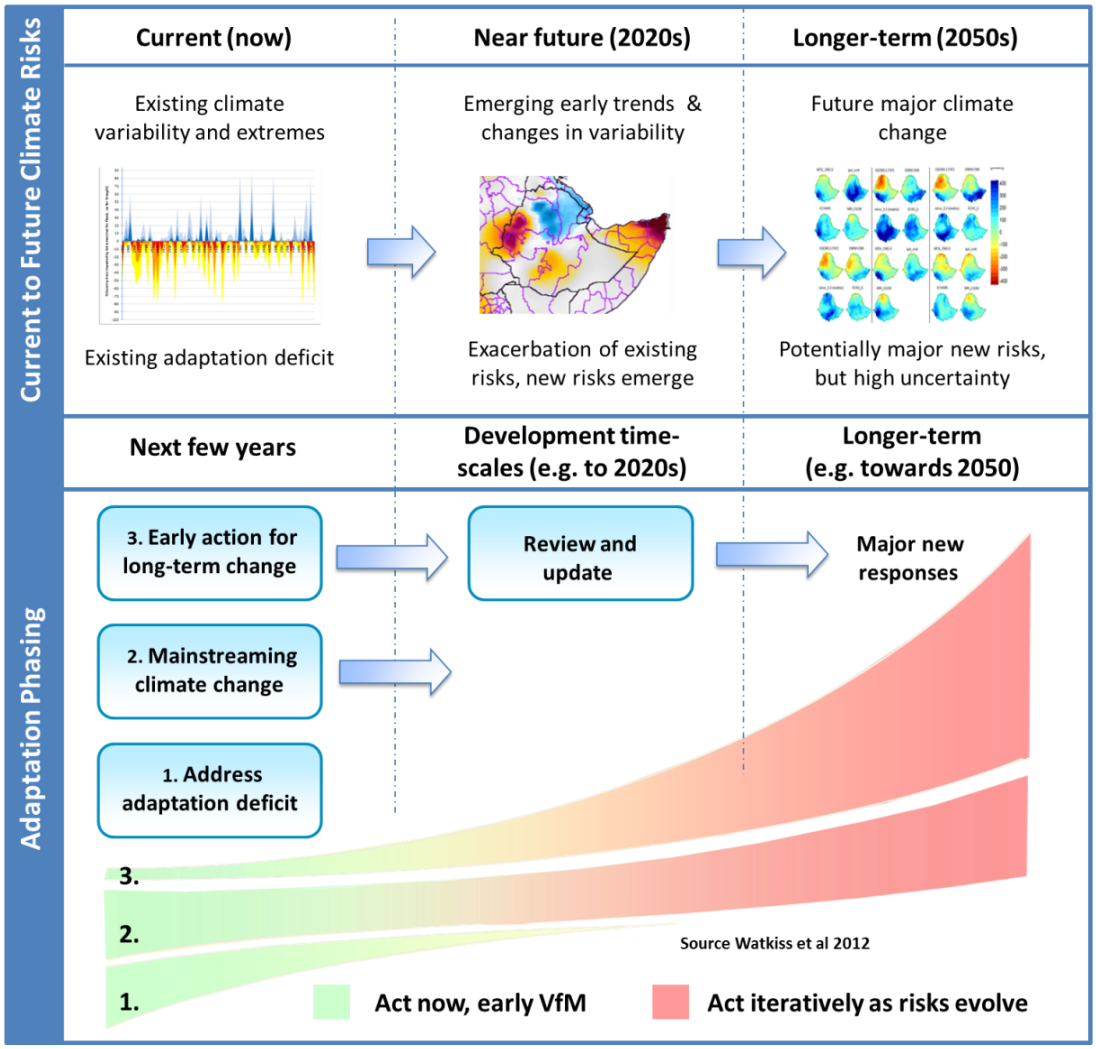
Value for money (VfM)

The LR also considered studies of the value-for-money (VfM) of weather and climate services, working largely from a work by Watkiss and Savage (2015). DFID's VfM framework for climate adaptation recommends an iterative climate risk management approach, following recommendations in the IPCC SREX report (IPCC, 2012) and the IPCC 5th Assessment Report (IPCC, 2014), to advance early value-for-money adaptation.

According to Watkiss and Savage (personal communication), these iterative frameworks can help maximise value-for-money adaptation. They consider three areas as outlined in Fig. 7 and below:

- Firstly target the current adaptation deficit, to reduce the impacts of climate variability while also building resilience for the future. This often includes interventions that are focused on no- or low-regret options, i.e. which are good to do anyway (even without climate change). These generate immediate economic benefits and also build resilience for the future.
- Secondly target the changes in risk over the medium-term, focusing on near-term decisions with long life-times, i.e. existing plans or investment that will be exposed to climate change in the future (e.g. infrastructure, development planning decisions). This can be implemented using risk screening and mainstreaming, with early priorities around low-cost robustness and flexibility that offer economic benefits through avoided future losses or enhanced opportunities.
- Finally address the long-term but more uncertain major risks of future climate change, building iterative response pathways. These identify early actions to allow learning (through the value of information, maximising option values and reducing lock-in).

Watkiss and Savage also prepared an inventory of benefit/cost studies of climate services. In general, high benefit/cost ratios (BCR) are found. One study estimated BCRs of between 4 and 36. They also find evidence for economies of scale that can boost BCRs if countries within a region collaborate in provision of weather and climate services, which supports a regional focus for CIASA. Importantly, the value of weather and climate services is lost if there is no uptake of the service – emphasising the need for a focus on achieving a step change in uptake.



Summary of the evidence gathering and synthesis

The status, needs and opportunities regarding development and uptake of climate services identified in the consultations have been elaborated in the previous section through wide consultation and a broad-ranging literature review. From the evidence gathered the following 5 thematic intervention areas have been proposed. Each theme collects sets of related activity options to address the issues of governance, research, capacity (infrastructure, technical, service delivery related and human), global-regional-national partnerships and African science leadership that have emerged as priorities.

The 5 CIASA thematic areas and associated "barrier categories" as discussed in the consultation sections, taken forward for joint discussion with DFID and other partners are listed below.

1. **Strengthening the national/regional governance and enabling environment for weather and climate services;**
    - Governance

2. **Implementing innovative multi-disciplinary research programmes and building the capacity of the African research community;**
    - Research; African climate science leadership

3. **Strengthening national and regional climate and climate-related institutions in capacity for improved climate-relevant data gathering and service production systems;**
    - Capacity (infrastructure, technical, human)

4. **Strengthening global-regional-national networks and exchanges of climate-relevant data and information;**
    - Global-regional-national partnerships, capacity (service co-development and delivery – RCOFs)

5. **Strengthening national climate frameworks, and capacity for user engagement and needs-based, user-led service development and delivery.**
    - Capacity (service co-development and delivery)

These 5 proposed thematic areas and potential activities within each were presented to DFID at the Reading meeting on 10 December 2014 (Table 1). The themes and activities were then defined in joint discussions between the scoping team and DFID as well as through input from workshops held with users and climate service providers in Kenya, and a selected panel of WMO experts (Table 1). In the following section we outline the resulting range of activities and expected outputs proposed for each thematic area.

SECTION 4

Summary of the consolidated intervention themes and outputs

General Overview

This section summarises the outcome of a joint Scoping Team/DFID analysis to shape the content and outputs of the 5 intervention themes. The analysis was based on the evidence gathering and synthesis conducted by the Scoping Team, as discussed in Section 3. Input from workshops with Kenyan users and providers of climate information and a panel of WMO experts also informed the analysis.

Theme 1: Strengthening the governance and enabling environment for weather and climate information and services

This theme is concerned with fostering greater support within national governments and Regional Economic Communities (RECs) to generate investment, political will and incentives for sustained improvement in climate information and services as well as engagement and free data sharing across government ministries and agencies. Success will likely require high-level political leadership (e.g. at the level of the Office of the Prime Minister/President). Other enabling factors such as institutional strengthening and improved technical, intellectual and intermediary resources are covered under other themes.

Successful engagement of government will require evidence of the value of climate information and services – both in terms of safety of people and property and economic benefit. Inclusion of planning for climate service development within national development agendas will aid sequencing of activities in a programmatic way, engagement of the private sector and coordination of donor support. Shaping of national climate services would benefit from regional coordination (e.g. standardised products and product formats agreed by countries). This would allow for more seamless provision for trans-boundary applications and integrated involvement of Regional Climate Centres, while retaining NMHS autonomy on detailed national and sub-national services.

Proposed key outputs include:

- increased demand for climate services from government resulting in new, sustained funding and support for human and technical resources in National Meteorological and Hydrological Services (NMHSs), user and intermediary organisations;
- national climate service planning as part of national development agendas, coordinated across RECs;
- increased status of National Meteorological and Hydrological Services (NMHS) within government and engagement across government – leading to greater trust in and uptake of climate services, and;
- incentives for increased sharing of climate data and relevant climate impact data held by non-meteorological agencies e.g. crop yield and malaria statistics.
- improved coordination of donor investments and enhanced private sector engagement.

Theme 2: Implementing innovative multi-disciplinary research programmes and building the capacity of the African research community

This theme incorporates research activities across three sub-themes, a) research to co-design, develop and trial new climate services, including “last-mile” research to get the right information to the right people in the right ways; b) underpinning climate research – filling gaps in understanding and modelling of the climate system needed to develop priority services in Africa (the ACPC/WCRP agenda for Climate Research for Development is a key framework); c) strengthening scientific leadership in Africa to take sustainable ownership of major challenges in African climate science.

Sub theme (a) could be coordinated across a region and incorporate multiple sectors and their interactions. Prototype services could be co-designed and developed with user and intermediary chains and trialled in real-time. Research would include both climate monitoring (e.g. building on RWX (Rainwatch-AfClix), ENACTS and geospatial monitoring activities such as MESA) and prediction applications. Prediction research will exploit emerging international collaborations and frameworks, including the CR4D agenda, WWRP High Impact Weather and the HyNEWS projects. Additionally some research should aim to fill gaps in seamless provision (e.g. through support to the WCRP/WWRP sub-seasonal to seasonal research programme). Co-development of services and “last-mile” research should involve multiple disciplines to bridge the gap between climate science and decision-making, including from uncertain/probabilistic information and draw on behavioural and psychology research and best practice from existing services and pilot initiatives. At local levels better understanding of the role of and reliance on indigenous prediction methods will be needed to facilitate inclusion of science-based services in decision making.

Sub-theme (b) would focus on developing improved understanding of remote and local drivers of the African climate system with the specific aim to improve climate model predictions for identified user priorities. Research activities could include data collection (including intensive observational campaigns), model evaluation and applications modelling research and would complement/augment the research agendas of, for example, SHEAR and FCFA. Development of systems and protocols for evaluation of models and information products will be fundamental to building confidence and demand for services.

Sub-theme (c) would consider, design principles and implement innovative approaches to building sustained intellectual climate science leadership in Africa. Current ideas include developing/strengthening partnerships between existing emerging centres of excellence on the continent with sustained support from recognised regional and international scientists and co-location of small groups of young scientists and experienced mentors (reflecting a perceived need for a “deep and narrow” approach rather than “superficial and broad”).

Proposed key outputs include:

- new climate services on monitoring and prediction and user-led delivery formats co-developed and trialled with users and intermediaries – filling gaps in seamless provision;
- improved understanding and modelling of the African climate system – including applications modelling and improved means of conveying prediction uncertainties and making decisions under uncertainty;
- comprehensive understanding of weather and climate model performance and relative benefits of statistical and dynamical seasonal forecasting systems;

- development of translational science ("last mile" research) around social and behavioural issues to bridge gaps between climate science and decision making; and
- a step-change in strengthened climate science leadership in Africa and parallel initiatives for skills retention and career development.

Theme 3: Strengthening national and regional climate and climate-related institutions including in capacity for improved data gathering and production systems

This theme is concerned with developing the technical infrastructure and intellectual resources required to maintain delivery of co-developed weather and climate monitoring and prediction products. It is largely concerned with institutional strengthening, predominantly at national and sub-national levels, but also at regional level (Regional Climate Centres), including capacity development and training. Many African NMHSs are currently able to provide only very basic climate services and support from Regional Climate Centres does not currently reach WMO-specified standards. Strengthening of user as well as intermediary or boundary organisations may be included where required. Activities in this theme (along with theme 5) would therefore be instrumental in realising national development plans – with regional coordination - prepared as part of theme 1. Activities would also link to research and development in theme 2. Activities would be driven by results of situational analyses[25] both of national and regional institutions and their interactions.

Proposed key outputs include:

- secure power sources, upgraded IT hardware and access to high-speed internet;
- strengthened observational networks (and assessments of the potential use of non-traditional observations), data rescue, climate datasets and data management;
- upgraded toolkits for climate monitoring and for processing national, regional and global prediction information; data-sharing architecture including both climate and sectoral impact data;
- increased numbers of trained personnel at NMHSs, RCCs, user and intermediary organisations.

Theme 4: Strengthening global-regional-national networks and sharing of climate-relevant data and information

Generation of climate services down to local levels in Africa will benefit from enhancing coordination, availability and use of monitoring and prediction data generated by national, regional and international organisations – this has been demonstrated to date by the Severe Weather Forecast Demonstration Project (SWFDP), which employs a "cascading forecast" methodology in which regional centres in Africa synthesise and add value to predictions from global centres and disseminate consolidated products on to NMHSs to facilitate early warnings. Similar progress has been made in coordinating climate-model based seasonal forecasts from international centres. This theme is concerned with strengthening and building the national/regional/global networks – filling gaps in seamless provision, improving accessibility and geographical inclusiveness of data sharing, and formulating clearly defined service agreements for data products and support (technical manuals, training, secondments).

[25] Loosely, an assessment of an organisation's capabilities in relation to its mandated or planned roles and responsibilities.

International coordination along the above lines has been developing for the seasonal forecasting activity in the form of Regional Climate Outlook Forums (RCOFs). This theme would include strengthening of RCOF activities (NCOF strengthening is under Theme 5), focussing on their role in regional level coordination and dissemination of monitoring and prediction products, increasing the capacity of NMHSs and sector organisations to attend and contribute to the RCOF process, and expanding the RCOF scope from seasonal to more seamless forecast provision and widening the sectoral scope (e.g. supporting regional power pools, urban resilience planning). Since RCOFs are infrequent activities (typically 1-3 times a year) the theme would also be concerned with developing ways of maintaining coordination and services on a continuous operational basis.

Proposed key outputs include:

- strengthened links and data sharing between national, regional and international climate organisations – supported by service agreements (refined from WMO generic requirements);
- strengthened regional service dissemination through RCOF and RCC activities – including more continuous services (updates), more seamless forecast provision, dissemination of more sector-focused and cross-sector (e.g. water-food-energy) products (co-developed in themes 2 and 3) serving regional and national resilience planning;
- improved integration of national climate services and information exchange for trans-boundary units such as major river basins, groundwater units and agricultural zones;
- a long-term aim would be integrated climate service hubs disseminating a range of co-developed services covering, for example, agricultural, health, energy advisories as well as hydro-meteorological outputs.

Theme 5: Strengthening national climate frameworks, capacity for user engagement and focused service development and delivery

This theme will be concerned with developing sustainable cultural change within NMHSs, promoting close links with sector partners and a service delivery ethos. There is a strong link with the enabling activities of theme 1 (through national development planning) and theme 3, and activities would include personnel recruitment, development and retention as well as formulating standard operating procedures for generating and disseminating services. Strengthening of and engagement with other national and sub-national partners, including intermediary partners, would also be addressed under this theme as well as development of National Climate Outlook Forums (NCOFs) to facilitate sector and cross-sector partnerships and dissemination of services. Development of sub-national/community forums to facilitate participatory downscaling[26] to local communities also forms a part of this theme.

Proposed key outputs include:

- strengthened NMHSs that are better integrated and respected within national infrastructure and conducting robust, reliable delivery of user-led climate services through a range of dissemination channels (including NCOFs, intermediaries, and local participatory downscaling);
- increased focus on services for sector and cross-sector (e.g. water-food-energy) impact;

[26] A process by which, through sharing of the different knowledge sets of climate service providers and local users, a consensus can be reached on the likely local risks associated with a climate prediction that is intrinsically made for non-local geographic scales.

- Frameworks for improved “last-mile” communication of climate information to local communities, both rural and urban, and improved social inclusiveness particularly with regard to women.

Considerations of regional, sector and timescale focus

The joint Scoping Team/DFID analysis also included assessment of the need for regional, sector and timescale foci for CIASA. The following conclusions were reached.

Regional focus
While underpinning progress can be made through pan-African investments in all 5 CIASA themes, it is reasonable to assume that a step change in the uptake of climate services will require a regional focus. This is because it is likely that thresholds in built capacity in each theme will need to be reached to trigger the level of interaction between themes needed to drive a step change, and such interaction will be more readily achieved in a regional (rather than pan-African) context. To illustrate, sharing examples of improved delivery, uptake and socio-economic benefit among regional partners with similar climate risk issues should inspire greater national/regional governance support for increased data sharing and technical capacity, leading in turn to further enhancement in uptake and thus setting up a “positive feedback” cycle that can drive a step change in practice. Additionally, there is evidence of improved Benefit-Cost ratios when countries within a region collaborate on weather and climate services (Watkiss and Savage, 2015).

For best chance of success, and thus to discover “what works”, focused activities to make significant advances across all themes should be made in regions where functionality in all themes already has a degree of development – such that the thresholds in built capacity referred to above are achievable. Lessons learnt can then inform follow-on focused initiatives in other regions. For these reasons a two-part programme is considered for CIASA. In outline, the 2 programmes would have the following aims.

Regional Programme: a regionally focused programme with activities across all 5 CIASA themes and with regional coordination designed to achieve close interaction across between the themes leading to a positive feedback cycle that drives increased uptake of climate services.

Pan-African Programme: a pan-African programme with activities centred on governance and enabling themes as well as research and science leadership. Activities in the Pan-Africa Programme can be used to prepare regions for subsequent more focused investment through a Regional Programme.

Timescale and sector focus
The scoping did not find strong evidence to favour a particular timescale focus for CIASA interventions. Vulnerability to severe weather in Africa is well documented (e.g. often fatal capsizing of fishing vessels on Lake Victoria exacerbated by lack of EWS). Focus on short-range public warning of severe weather must therefore be a candidate for focus. For the longer term, some authors favour a climate monitoring and seasonal timescale focus noting that climate risk management and resilience (rather than longer-term climate change risks and adaptation) is more appropriate for poverty reduction – and that activities that improve the management of weather and climate risks are regarded as ‘low regrets’ adaptations to future climate change as well as offering good value for money. On the other hand there is concern around “lock in” regarding rapid urban development and long-lived infrastructure which cannot easily be adapted “ad hoc” and therefore requires prudent forward estimation

of the changing envelope of climate and extremes over long (50-year) timescales. This reasoning lies behind the 5-40 year focus for FCFA.

Timescale focus: Given the strong requirement at all timescales and the top CIASA objective of increased uptake of climate services, one approach is to split priorities across 1) research into use and 2) underpinning climate science. Thus activities to directly increase uptake can be focused on timescales for which there is already some capacity, i.e. climate monitoring, days ahead (severe weather), seasons ahead (climate variability - droughts/floods) and the 5-40 year timescale (climate change risks). Supported underpinning climate science could focus research towards filling gaps in timescales: i.e. understanding past climate variability and change and prediction at the sub-seasonal and multi-annual timescales.

Sector focus: In terms of sector focus, the scoping found a predominance of applications in agriculture and food security and to a degree in water resource management (with implications for hydropower), with less progress in health and a significant demand but limited progress in areas like energy and urban environment. It is noted that the high dependence on rain-fed agriculture and seasonal water resources tends to obscure sight of the need to advance use of climate information in other sectors.

This information helps to identify where research gaps lie for developing an understanding of the sector impacts of climate variability. In terms of uptake, the situation is less clear. For example advisories issued by RCCs and NMHSs often include information for many sectors – a relatively well developed NMHS issues short advisories for agriculture and food security (including livestock), DRR, energy, transport, water resources, and health. However, for all sectors, these advisories appear to be largely subjective inferences based on the rainfall forecast (e.g. where below-normal rains are expected, seek advice on crop types; where above-normal rains are expected, be vigilant for malaria). Thus there is little evidence that methods for using climate data in crop modelling (as, for example, the RCOF forecasts are used in FEWS-NET food security products) or malaria modelling (as input to MALOFs) is filtering down to NMHSs or national sector level. These issues likely relate back to the identified barrier areas of governance and lack of data sharing. There are often conflicts of mandate e.g. in general only the Ministry of Agriculture has mandate to advise on crop planting times – thus without cross-ministry engagement and data sharing, little progress can be made. This issue is not restricted to Africa – witness the relatively recent (2009) creation of the UK Flood Forecasting Centre – a joint Environment Agency/Met Office enterprise aimed to improve flood forecasting in response to the UK floods of 2007. CIASA can learn from this and similar examples in the developed world.

Thus for CIASA a possible approach is to focus on improving governance and data sharing across the GFCS priority areas (agriculture and food security, water, health and DRR) – perhaps with a continuing focus on the first two, as there is still much to be done in terms of uptake. Promulgating objective or semi-objective techniques for using climate data in risk assessments for crops, water and health, already available and used by some RCOFs, down to NMHSs level should also be a priority. In parallel, research activities to better understand the sector impacts could be focused where gaps exist – e.g. health, urban environment, coastal zones, transport.

For the Regional Programme, the region chosen should provide some helpful context on selecting priority timescales and sectors. With the above points in mind it is recommended that timescale and sector priorities are given further consideration in scoping/pilot projects or during project inception phases.

SECTION 5

Draft programme outline

The programme components, outputs, outcome and impact

In this section we describe the draft programme outline for CIASA that developed out of the joint Scoping Team/DFID analysis of evidence presented in the previous section.

Components

In scoping the programme outline, the activities under the 5 CIASA themes (Section 4) were re-examined with a view to grouping together work areas that, in a practical sense, would be best addressed together. This exercise resulted in 4 programme components. The main change was to group national and sub-national elements of theme 3 (dealing with infrastructural, technical, and human capacity) with theme 5 (dealing with service delivery/user engagement), since in practice these aspects are best addressed in a closely coordinated way. Capacity strengthening at regional level (e.g. for RCCs, RCOFs) was paired with the theme on strengthening global-regional-national partnerships.

The 4 CIASA components, articulated for the Regional Programme, are as follows.

CIASA components:

1) Improving the governance and enabling environment and stimulating demand for weather and climate services.
2) Supporting organisations and programmes to develop global-regional-national links to strengthen production, uptake and use of weather and climate information.
3) Strengthening and support to NMHSs, intermediaries and sector collaborators to increase uptake of reliable, co-produced and accessible weather and climate services.
4) Multi-disciplinary research to support co-design and co-development of weather and climate services for the region and strengthening regional climate science leadership.

The parallel pan-African programme will essentially use the same components with a focus on improving the wider enabling environment across Africa, research and continental aspects of science leadership and supporting preparation of other regional initiatives. It is proposed that the Regional and Pan-African programmes share common elements of governance (see Section 6) to facilitate coordination.

Together, the two programmes are directed to the following outputs (see also Fig. 8).

CIASA Outputs:

1) Strengthened enabling environment for the generation, uptake and use of weather and climate services to support development.

2) Innovative interdisciplinary research programme (a) supports the generation, uptake and use of weather and climate services and (b) builds sustained intellectual leadership in weather and climate science in Africa.
3) Improved data at historical, present and future timescales and better production systems support the generation of improved weather and climate information and services.
4) Strengthened global-regional-national networks and partnerships support the improved generation, uptake and use of climate information.
5) Improved access to weather and climate information at national, sub-national and community levels through strengthened capacity of and integration between NMHS's, collaborators and users that promotes improved service development and delivery.

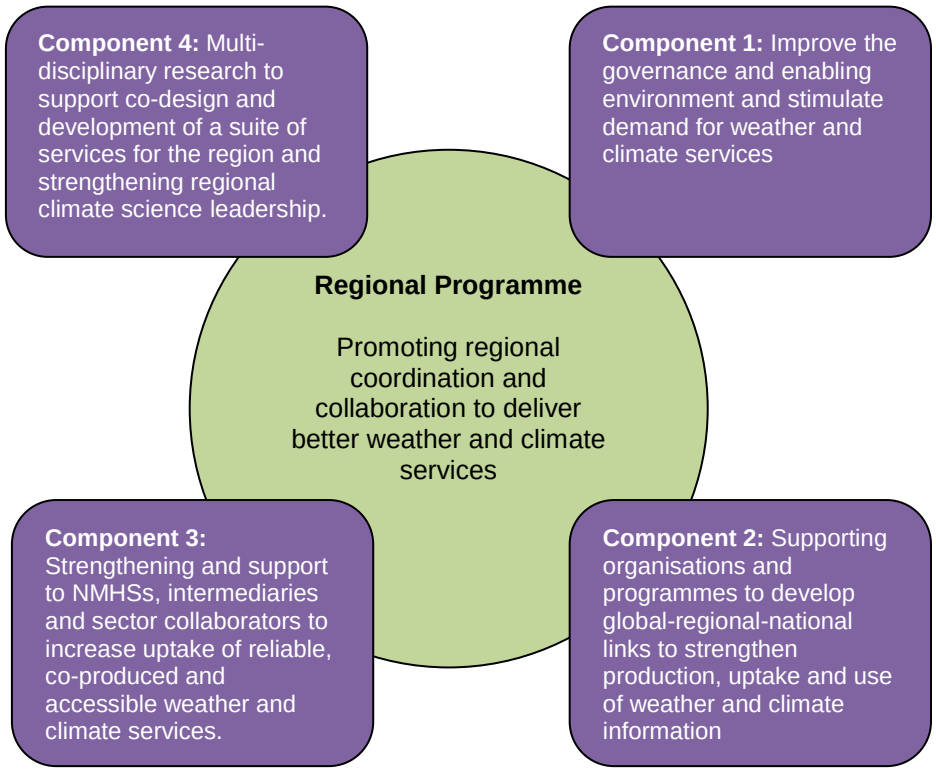
Activities conducted by the Regional and Pan-African programmes would be based on those discussed under the 5 intervention themes of Section 4. A summary of activities is provided in Fig. 9 and Fig. 10 for the Regional and Pan-African programmes respectively, they should be read together with the themes description and the considerations of regional, timescale and sector focus outlined in Section 4.

Formal articulations of the CIASA programme outcome, impact and hypothesis of change are as below.

Outcome: Increased use of reliable, co-produced and accessible weather and climate services based on better data, information, knowledge and tools informs regional, national, sub-national and community level policy, planning and decision-making in Africa.

Impact: Increased use of weather and climate information and mainstreaming into development and sector policies, plans and programmes supports sustainable development in Africa.

Hypothesis of Change: Improved governance and enabling environment combined with co-production of climate information leads to the development of more reliable, tailored and accessible services. This leads to greater uptake and use to inform decision making at all levels, demonstrating value and increasing resilience of Africa populations.



Regional Programme (Phase 1- Lake Victoria Basin region, Phase 2 -other eligible regions)

Pan-African Programme

Output 1: Strengthened governance and enabling environment for the generation, uptake and use of weather and climate services to support development.

Output 2: Innovative interdisciplinary research programme (a) supports the generation, uptake and use of weather and climate services and (b) builds sustained intellectual leadership in climate science in Africa.

Output 3: Improved data at historical, present and future timescales and better production systems support the generation of improved weather and climate information and services.

Output 4: Strengthened global-regional-national networks and partnerships support the improved generation, uptake and use of climate information.

Output 5: A step change in the uptake and use of weather and climate information at national, sub-national and community levels through strengthened capacity of and integration between NMHS's, collaborators and users that promotes improved service development and delivery.

Figure 8: Schematic diagram of the Regional and Pan-African programmes, the 4 programme components and the 5 collective programme outputs.

Component 1: Improve the governance and enabling environment and stimulate demand for weather and climate services	• Engage regional and national bodies and policy makers to raise profile of climate services. • Understand and coordinate donor activity in the region and incentives for private sector engagement. • Understand user needs and preferences to develop a prioritised outline suite of co-produced services for the region. • Promote open data principles within the region (for climate and sector data). • Benchmark NMHS performance and share best practice within region. • Modernise meteorological training in the region.
Component 2: Supporting organisations and programmes to develop global-regional-national links to strengthen production, uptake and use of weather and climate information	• Strengthen the regional centre to enhance and widen the development and delivery of a suite of co-produced services for region. • Expand the Climate Outlook Forum process in the region (by sector and timescales). • Support to existing regional networks which promote and use weather and climate services. • Strengthened links between global centres (e.g. prediction centres) and the regional centre and the regional centre and NMHSs – supported by service agreements • Strengthen information exchange for trans-boundary units e.g. river basins and agricultural zones
Component 3: Strengthening and support to NMHSs, intermediaries and sector collaborators to increase uptake of reliable, co-produced and accessible weather and climate services.	• Provide technical assistance for development of service delivery plans showing how NMHSs will support national priority sectors, including consideration of cross-sectoral interests. • Provide funding to support implementation of plans – including for strengthening human and technical capacity and infrastructure. • Provide technical assistance and financial support for intermediaries and sector collaborators to upscale use of weather and climate services. • Incorporate climate information and services into planning for existing development projects.
Component 4: Multi-disciplinary research to support co-design and co-development of a suite of services for the region and strengthening regional climate science leadership.	• Support social science research proposals which enhance understanding of user engagement, behaviour change and 'last mile' delivery of services. • Improve understanding and modelling of weather and climate process in the region (e.g. LVB-HyNEWS, FCFA, CR4D). • Fill gaps in understanding to advance seamless prediction (e.g. WWRP/THORPEX-WCRP S2S) • Support model validation and forecast verification activities. • With the Pan-African programme, support regional scientific leadership in weather and climate science. Climate service curriculum development at participating universities.

Figure 9: Regional Programme: summary of programme components and associated activities

A programme of work across Africa focusing on improving the governance and enabling environment, multi-disciplinary research, building climate science leadership and preparing for regional focus

- **Develop and implement a joint programme of work around key policy themes and to stimulate demand, including Strategic Pillars 1 and 5 (political support and partnerships respectively) of the AMCOMET Integrated Strategy.**
- **Facilitate donor coordination.**
- **Develop an approach for modernisation of training.**
- **Build capacity and intellectual leadership in Africa on weather and climate.**
- **Develop a framework to effectively coordinate the collection and use of, and access to data (including non-traditional observations).**
- **Coordinate/support preparatory work/pilots to prepare subsequent regional programmes in Phase 2.**
- **Support for implementation of CR4D.**
- **Provide, with others, governance for work programme 2.**

Figure 10: Regional Programme: summary of programme components and associated activities

SECTION 6

Summary of DFID's preferred options: regional focus, governance and delivery mechanisms

Following the joint Scoping Team/DFID analysis of evidence for effective intervention options DFID conducted an independent appraisal to select preferred options for the regional focus and the programme delivery and governance mechanisms.

Regional focus

From options considered during workshop discussions, DFID selected the Lake Victoria Basin (LVB) and surrounding area including Kenya, Uganda, Tanzania, Rwanda and Burundi (the 5 member states of EAC) as the preferred option for the Regional Programme in Phase 1 of CIASA. It is anticipated that further phases, with focus on other regions, may follow dependent on the success of Phase 1 and available funding. The rationale for the selection includes the considerations listed below as well as considerations of value added to existing DFID programmes and policy.

1. **Existing capacity:** the region is well set up for work aimed at a step change in climate service uptake, for example:
   - The Regional Climate Centre, ICPAC is one of the most experienced and well established, though still in need of strengthened user engagement. For a single Africa region, ICPAC operates the most RCOFs annually (3) – thus there are pre-existing platforms for provider-user engagement;
   - Two countries in the region have relatively well developed NMHSs (Kenya and Tanzania) – though strengthened capacity and service delivery is still needed;
   - There is an SWFDP currently active in the East Africa region. With strong engagement from the NMHSs of all 5 EAC countries in interactions with global centres to provide warnings of severe weather up to a few days ahead.

2. **Existing unfunded frameworks and initiatives:** there are a number of regional initiatives with strong endorsement in the science community for which planning and international scientific and user consortiums are already at a mature stage. Key among these is the Lake Victoria Basin –- HydroClimate to Nowcasting for Early Warning Systems (LVB-HyNEWS) initiative. LVB-HyNEWS is a consortium of partners that have come together under the auspices of the WMO. The consortium has strong buy-in within Africa. Its formation was recommended by heads of East African National Meteorological Agencies in May 2014. Further, it has been proposed as an AMCOMET demonstration project. It has a coordinating Task Force comprising PIs appointed by the directors of the 5 EAC NMHSs. The aims of the 3 sub-projects comprising LVB-HyNEWS are briefly described below. With further shaping inline with the 5 CIASA themes the projects provide a strong basis for enhancing uptake of weather and climate services in the region:

   HyVic: The Hydrology of Lake Victoria (HyVic) project has been adopted as a WCRP/GEWEX Regional Hydroclimate Project. Planned aims include:
   - Mapping of current climate for decision making by leading socio-economic sectors. Online delivery with state-of-the-art visualisation;

- Understanding, modelling and prediction of past and future climate variability and change, focusing on regional water balance and lake levels;
- Impacts on crops and food security, hydroelectric and wind energy resources, and across the EAC countries and adaptation pilots for urban environment, livelihoods of lakeside communities, lakeside road infrastructure and fisheries.
- Strengthened regional observation network to support the above as well as enhanced observing periods.

EAC NEWS: The Navigation Early Warning System (NEWS) project responds to an EAC feasibility study on marine navigational safety and exploitation of natural resources in Lake Victoria and its basin. Its planned objectives include:

- Improving capacity of and interaction between NMHSs of the region to generate and disseminate warnings of severe weather on Lake Victoria.
- Understanding the regional climatology of severe weather and developing and communicating a severe weather "hotspots" atlas;
- Enhanced observation network for severe weather, including weather radar.

SWNDP: The Severe Weather Nowcasting Demonstration Project for Lake Victoria is a WWRP initiative with links to the WWRP SWFDP and High Impact Weather Projects. Its planned aims include:

- A field programme to increase understanding of weather drivers in the region – contributing to improved prediction of severe weather as well as climate variability and change;
- Development of a severe weather nowcasting system to deliver warnings (hours ahead) for shipping, aviation, agriculture, public health and related DRR. This activity would be nested within the current SWFDP project which provides earlier, preliminary warnings up to days ahead;
- Capacity building and development of a regional research capability.

3. **Potential to improve resilience and benefit development:** There is a very substantial opportunity to work towards a seamless weather and climate service for the region – increasing day-to-day safety as well as resilience to climate variability and change that serves socio-economic activities across large populations. On a day-to day-basis, there is low capacity to provide weather warnings in the region, notably to the 200,000 fishers employed on the Lake: an estimated 5000 deaths occur each year on the Lake, largely due to capsizing of fishing vessels in high winds and waves due to violent storms[27]. This leaves a large legacy of poverty for dependent family members. On seasonal timescales, recurrent droughts in the wider Greater Horn of Africa region have been devastating. The severe drought during 2010/11 affected more than 13 million people, placed hundreds of thousands at risk of starvation and caused an estimated 50,000 - 100,000 deaths[28]. On longer, multi-decadal timescales climate change impacts on the Lake and its ecosystems will affect large populations. Lake Victoria is Africa's largest freshwater lake supporting over 30 million people and is one of the two water sources for the Nile river, and thus also impacts several hundreds of millions who live in the Nile River Basin. Rapid urbanization is placing an enormous burden on towns around the lake and its associated catchments in Burundi, Kenya, Rwanda, Tanzania and Uganda; and this has become a critical issue as all countries strive to achieve the Millennium Development Goals (MDGs) for water and sanitation[29]. Thus improved climate knowledge for decision-making - both in terms of mapping of current climate, real-time monitoring and projection

[27] 3rd Lake Victoria Basin Donors' Conference, 17-18 June 2013, http://www.icafrica.org/fileadmin/documents/LBV/Project%20Concepts%20Notes.pdf
[28] Hillier, D. and Dempsey, B. 2012: A dangerous delay: the cost of late response to early warnings in the 2011 drought in the Horn of Africa. Oxfam and Save the Children joint agency briefing paper.
[29] 3rd Lake Victoria Basin Donors' Conference, 17-18 June 2013, http://www.icafrica.org/fileadmin/documents/LBV/Project%20Concepts%20Notes.pdf

of future climate - is becoming increasingly important for, in particular: water resources, energy, food security and urban planning.

Timescale and sector focus
For the Lake Victoria basin there is clear motivation (within the LVB-HyNEWS consortium) for climate monitoring, short-range prediction and the 5-40 year timescale. It is recommended that seasonal timescale work is also addressed – to take advantage of the enhanced provider-user interactions that will develop and to build on existing capabilities within ICPAC and the 5 NMHSs as well as existing engagement with users via the Greater Horn of Africa Climate Outlook Forum. Research activities towards filling the gap in provision at sub-seasonal scales (WWRP-THORPEX/WCRP S2S programme) are also recommended. For sector focus the motivation within LVB-HyNEWS points to priorities within the water resource and sanitation, DRR, urban development and energy sectors as well as to agriculture and food security.

Finance, governance and delivery

Finance and phasing for CIASA Phase 1
Phase 1 of CIASA, including a Regional Programme for the Lake Victoria Basin and surrounding region and a Pan-African Programme is anticipated to run for 4 years, including an Inception Stage. It is anticipated that further Phases may follow, dependent on the success of Phase 1 and available funding.

A funding envelope for the Inception Phase and Phase 1 of £35 million is anticipated, provisionally split into £25 million for the Regional Programme and £10 million for the Pan-African programme.

Governance and delivery
From options discussed at workshops and meetings, DFID selected different delivery mechanisms, with common elements of governance, for the Regional and Pan-African programmes – as outlined below. Rationale for the selections included the relevance, experience and standing in Africa of the organisations involved and the desire for a “mixed portfolio” approach which will allow assessment of strengths and weaknesses of the chosen mechanisms at the close of Phase 1 with possible re-assessment for Phase 2. Additionally, as there is a proposed early start to Phase 1, there is a need for chosen mechanisms to have capacity for rapid disbursement of funds.

For the Regional Programme (Lake Victoria Basin and surrounding region) DFID’s preferred option is to channel funds through a coordination lead partner in a Regional Programme Consortium. Associated governance bodies may include representatives from DFID, ACPC, AMCOMET, EAC, LVBC and WMO). A possible governance framework for the Phase 1 Regional Programme is reproduced in Fig. 11.

For the Pan-African Programme DFID’s preferred option is that direct funding is provided to ACPC in an extension of procedures operated in DFID’s previous contributions to ClimDev-Africa. In this framework ACPC would manage funds for delivery of the programme’s activities and also channel funds to WMO and AMCOMET to support joint activities and initiatives.

A summary of governance and delivery proposals for the Regional and Pan-African Programmes is provided in Fig. 12.

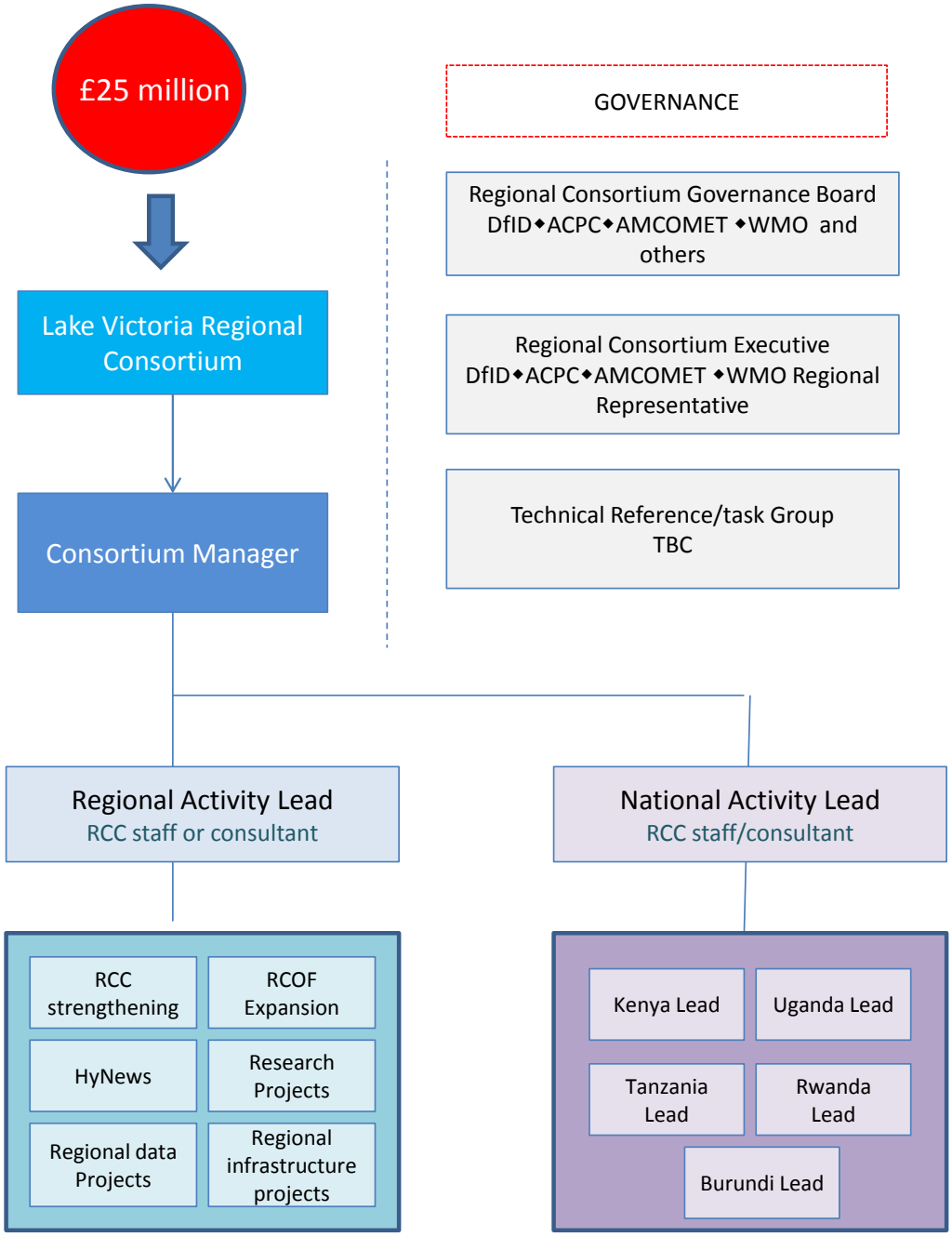


Figure 11: A possible governance and delivery structure for the Phase 1 Regional Programme (Lake Victoria Basin and surrounding region).

Regional Programme delivery through: **Consortium Coordinating Lead**	**Funds for the regional programme channelled through a consortium lead or coordinating organisation which would manage disbursement to consortium partners and other related initiatives.** **Governance includes high-level regional partners with DFID, ACPC, AMCOMET and WMO (common with Pan-African Programme).**
Pan-African Programme delivery through: **African Climate Policy Centre (ACPC)**	**Direct funding to ACPC as an extension to DFID's existing ClimDev-Africa programme. ACPC would manage funds for the delivery of activities and channel funds to WMO and AMCOMET to support joint activities and initiatives being undertaken by these organisations.** **Governance includes DFID, ACPC, AMCOMET, WMO**

Figure 12: Summary of possible delivery mechanisms and governance for the CIASA Regional and Pan-African Programmes

SECTION 7

Draft framework for programme evaluation

Working from DFID's preferred options the Scoping Team developed a proposed framework for programme evaluation. A draft logframe with performance indicators is provided in Annex 11. A summary is provided below organised around the Impact, Outcome and Outputs discussed in Section 5. Targets for the performance indicators apply to the sum over both the Regional programme (Lake Victoria Basin and surrounding region) and the Pan-Africa programme, but are based primarily on estimates for the regional programme – to introduce a degree of conservatism.

Thus, for example, the target of 5 countries and 5 NMHSs benefiting is based on the 5 countries of the East Africa Community, although others outside the region may be expected to benefit through the Pan-Africa programme. Numbers of people and households impacted are based on a Lake Victoria Basin (LVB) population of 30 million (a conservative estimate) and an average household of 5 persons. Additionally it is assumed that the project impact will result in 60% of the population with improved access to weather and climate services, and that 25% of this subset will use the information in decision making that affects their livelihoods. Thus at impact level the number of people with improved resilience is estimated as 30 million x 0.6 x 0.25 = 4.5 million. This is further lifted to 5 million to allow a contribution to benefit from the influence of CIASA on other programmes – for example improved governance and data sharing accomplished through CIASA activities should enhance the impact of other climate initiatives not directly linked to CIASA.

At the outcome level targets refer to CIASA activities only. Thus, based on the 30 million population estimate, the number of households with improved access to weather and climate services is 4.5 ÷ 5 ~ 3.5 million. A 25% uptake rate gives 875,000 households making use of the services to improve resilience.

It is assumed that further development of performance indicators as well as design of monitoring and evaluation procedures for tracking the impact of CIASA investments will be designed during the inception stage of the programme and each sub project. Provisional funding levels to each output, recommended by the scoping, are also provided.

Impact: Increased use of weather and climate information and mainstreaming into development and sector policies, plans and programmes supports sustainable development in Africa.

- Value of socio-economic benefits and reduced losses (e.g. number of lives saved, improved agricultural productivity and property value protected) – value to be confirmed at inception
- 5,000,000 people with improved resilience (International Climate Fund Key Performance Indicator 4)

Outcome: Increased use of reliable, co-produced and accessible weather and climate services based on better data, information, knowledge and tools informs regional,

national, sub-national and community level policy, planning and decision-making in Africa.

- At least 3 projects and programmes adopt an integrated regional approach for development of climate services
- At least 50 organisations and institutions reporting improved or considerably improved use of weather and climate information to inform their decision making
- At least 20 government departments/ministries/institutions reporting improved or considerably improved understanding of weather and climate issues and links to development related to their sectors
- At least 875,000 households reporting use of improved climate services for decision making that improves their livelihoods

Output 1: Strengthened enabling environment for the generation, uptake and use of weather and climate services to support development. (£6.5 million)

- At least £100m of government and donor funding coordinated around agreed plans for development of climate services
- At least 5 initiatives supporting a better enabling environment rated (by identified decision makers) as useful or very useful
- At least 5 countries using their influence to generate regular dialogue on weather and climate services across government
- At least 50 new interagency agreements to strengthen climate services (e.g. MoUs or service level agreements between NMHSs and line ministries)

Output 2: Innovative interdisciplinary research programme (a) supports the generation, uptake and use of weather and climate services and (b) builds sustained intellectual leadership in climate science in Africa. (£10 million)

- At least 10 research outputs directly contributing to the development, uptake or understanding of new climate services
- At least 50 peer-reviewed climate and social science articles authored by African scientists and available in an open access format (disaggregated by gender and primary and secondary authorship)
- At least 100 African scientists and researchers (disaggregated by gender) working in African institutes that have built expertise in the development of user-led weather and climate services

Output 3: Improved data at historical, present and future timescales and better production systems support the generation of improved weather and climate information and services. (£5 million)

- At least 5 countries with revised freer data sharing policy and coordinated national plans for data rescue and digitisation
- At least 5 NMHSs using and sharing new/improved datasets supporting design and production of new/improved national and regional climate services
- At least 5 NMHSs with improved technology/hardware and related capacity for production of climate services
- At least 5 countries with an improved observations network and credible long-term plans for operation and maintenance

Output 4: Strengthened global-regional-national networks and partnerships support the improved generation, uptake and use of climate information (£3.5 million)

- At least 6 Regional and National Climate Outlook Forum processes initiated and/or strengthened

- At least 3 partnership networks with programmes to promote uptake and use of weather and climate information rated by identified stakeholders as useful or very useful
- At least 8 service agreements/MoUs in place between global and regional centres, and regional and national centres
- At least 10 RCCs and NMHSs using in house processing of data from global centres to generate new and/or improved climate services

Output 5: Improved access to weather and climate information at national, sub-national and community levels through strengthened capacity of and integration between NMHS's, collaborators and users that promotes improved service development and delivery (£10 million)

- At least 5 NMHSs with modernised plans focussing on improved service delivery
- At least 3,500,000 households able to access new and/or improved climate services through a range of intermediaries and communications channels
- At least 50 organisations and institutions reporting improved access to new and improved climate services through a range of channels
- At least 20 new or improved co-produced climate service products being delivered on time and in full to organisations and institutions in various sectors and being reported as effective.

SECTION 8

Conclusions

The Department for International Development is considering a new programme on climate information and services for Africa (CIASA). The primary focus for CIASA is in advancing the co-development and uptake of needs-based, user-led weather and climate services – with the aim of delivering a step change in the use of climate information to support poverty reduction and promote socio-economic development.

In November 2014 DFID procured an Met Office-led team to scope, analyse options and support design of a Business Case for CIASA. In this report we have described 1) the methodology employed by the Scoping Team in gathering and synthesising evidence-based options for intervention, 2) the outcome of joint DFID/Scoping Team discussions to refine the options, 3) the preferred options selected by DFID – including regional focus, programme delivery and governance mechanisms, 4) a proposed framework for programme evaluation.

The scoping has drawn on a broad literature review and wide consultation with experts. African climate policy and science frameworks and organisations consulted include: ACPC, AMCOMET and its Integrated Strategy for Meteorology, the ACPC/WCRP priority research agenda for Climate Research For Development (CR4D) and the developing ClimDev-Africa Phase 2 programme. The overarching UN-led Global Framework for Climate Services initiative spearheaded by WMO has also been widely referenced. Users and providers of climate information in Africa were also consulted. A large number of existing and planned climate-related initiatives covering underpinning climate science and applications as well as social/behavioural issues associated with the communication of science and early warnings were noted.

Joint analysis of evidenced-based options for intervention by DFID and the Scoping Team led to recommendation of a two-part Phase 1 programme, implemented for a 4-year period including Inception that comprises a Regional Programme (£25 million) and a Pan-African Programme (£10m) running concurrently with close coordination through common governance.

A set of 4 programme components were defined to organise work on the intervention themes identified, with work across the Regional and Pan-African programmes collectively directed to and operating within the following 5 output areas and finance allocations:

1) Strengthened enabling environment for the generation, uptake and use of weather and climate services to support development. (£6.5 million)
2) Innovative interdisciplinary research programme (a) supports the generation, uptake and use of weather and climate services and (b) builds sustained intellectual leadership in weather and climate science in Africa. (£10 million)
3) Improved data at historical, present and future timescales and better production systems support the generation of improved weather and climate information and services. (£5 million)
4) Strengthened global-regional-national networks and partnerships support the improved generation, uptake and use of climate information. (£3.5 million)
5) Improved access to weather and climate information at national, sub-national and community levels through strengthened capacity of and integration between NMHS's,

collaborators and users that promotes improved service development and delivery. (£10 million)

It is considered that timescale and sector priorities are given further consideration in scoping/pilot projects or during project inception phases, taking full account of regional priorities in the Regional Programmes. However, the following points are noted.

Timescale focus: Given the overriding CIASA objective of increased uptake of climate services, one approach is to split priorities across 1) research into use activities and 2) underpinning prediction science. Thus activities to directly increase uptake can be focused on timescales for which there is already some capacity, i.e. climate monitoring, days ahead (severe weather), seasons ahead (climate variability - droughts/floods) and the 5-40 year timescale (climate change risks). While supported underpinning prediction science could focus on filling gaps in timescales: i.e. the sub-seasonal and multi-annual timescales.

Sector focus: Similarly, for sector focus, a possible approach is to focus on improving governance, data sharing and wider use of existing tools for translating climate information to impact across the GFCS priority areas of agriculture/food security, water, health and DRR. A continuing focus on the first two may be appropriate, since there is still much to be done in terms of uptake, particularly at national and sub-national levels. In parallel, research activities to better understand sector impacts could be focused in currently under represented sectors – e.g. health, urban environment, coastal zones and transport.

Formal articulations of the proposed CIASA programme outcome, impact and hypothesis of change are as below.

Outcome: Increased use of reliable, co-produced and accessible weather and climate services based on better data, information, knowledge and tools informs regional, national, sub-national and community level policy, planning and decision-making in Africa.

Impact: Increased use of weather and climate information and mainstreaming into development and sector policies, plans and programmes supports sustainable development in Africa.

Hypothesis of Change: Improved governance and enabling environment combined with co-production of climate information leads to the development of more reliable, tailored and accessible services; this leads to greater uptake and use to inform decision making at all levels, demonstrating value and increasing resilience of Africa populations.

From options presented by the scoping, a formal DFID appraisal selected the following options for regional focus, programme delivery and governance.

Regional focus: The region selected as the preferred Phase 1 regional programme is the Lake Victoria Basin and surrounding region. It is anticipated that further phases, with focus on other regions, may follow dependent on the success of Phase 1 and available funding.

Delivery and governance: DFID selected different delivery mechanisms, with common elements of governance, for the Phase 1 Regional and Pan-African programmes. For the Regional Programme (Lake Victoria Basin and surrounding region) an option in which funds are channelled through a coordination lead partner in a Regional Programme Consortium is preferred. Associated governance teams may include representatives from DFID, ACPC, AMCOMET, EAC, LVBC and WMO).

For the Pan-African Programme DFID's preferred option is that work is coordinated and governed by ACPC, AMCOMET and WMO, with funding provided directly to ACPC. In this

framework ACPC would manage funds for delivery of the programme's activities and also channel funds to WMO and AMCOMET to support joint activities and initiatives, including the AMCOMET Integrated Strategy for Meteorology.

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ANNEX 1

CIASA Scoping Project Team

Name	Role	Organisation
Richard Graham	Project Lead	Met Office
Bill Leathes	Business Case Lead	Met Office
Helen Ticehurst	Project Coordinator and Capacity Building Lead	Met Office
Caroline Bain	Research, Modelling and Prediction Lead	Met Office
Steven Wade	Literature Review (LR) Lead	Met Office
Tim Oakley	Observations and Monitoring Lead	Met Office
Emma Visman	User Interface Lead	VNG Consulting/Kings College London
Mxolisi Shongwe	Southern Africa Consultation Lead	South African Weather Service
Cheikh Kane	West Africa Consultation Lead	Institut de recherche pour le développement (IRD)
Timóteo Ferreira	East Africa Consultation Lead	Independent Consultant
Emily Boyd	Gender specialist	Reading University
Sumiko May	LR contributions	British Red Cross
Robert Powell	'Last Mile' communication specialist	Independent Consultant
Simon Bayley	Consultation specialist	Independent Consultant
Darren Lumbroso	LR contributions	HR Wallingford
Richard Ewbank	User engagement specialist	Christian Aid
Simon Anderson	Advisory Group	International Institute for Environment and Development
Rosalind Cornforth	Advisory Group	Reading University
Richard Washington	Advisory Group	Oxford University
Chris Hewitt	Advisory Group	Met Office
Wilfran Moufouma Okia	Advisory Group	ACPC
Maxx Dilley	Advisory Group	WMO
Richard Jones	Advisory Group	Met Office
Tammy Janes	User Engagement Advisor	Met Office
Rosanna Amato	Observations and Monitoring Advisor	Met Office

ANNEX 2

Summary of Consultations with Users of Climate Services in Africa

	User 1	User 2	User 3	User 4	User 5	User 6
Sector	- Agriculture - Livestock - Food security - DRR - Water	- Agriculture - Food security	Environment	Agriculture / DRR	Multi-sectoral	Health / DRR / Energy / Water / Infrastructure
Groups worked with	○ Extension services ○ Gvt services ○ Local gvt. ○ CBOs ○ Water suppliers ○ Agri suppliers ○ Private sector	○ EW services ○ National gvt.	○ Local gvt. ○ Scientists ○ Mines ○ Universities	○ National gvt. ○ Farmer groups ○ Regional economic commissions	○ Local gvt. ○ Farmer groups ○ CBOs	○ Extension services ○ Local gvt. ○ Farmer groups ○ Agricultural suppliers
Level	Local / National / Regional / Continental / Global	Regional	Community / National / Regional / Continental / International	National / Regional	Community / National / Regional	County / Community

	User 7	User 8	User 9	User 10	User 11
Sector	WASH	Agriculture / Water / Energy	Livestock	Energy	Water
Groups worked with	○ Extension services ○ Local gvt. ○ National gvt. ○ Water providers	○ Extension services ○ Local gvt. ○ Farmer groups	○ Farmer groups ○ NGOs ○ livestock product suppliers	○ Local gvt. ○ NGOs ○ Communities ○ Foresters ○ Energy industry	○ Local gvt. ○ National gvt. ○ Faith organisations ○ NGOs ○ Communities ○ Women's groups
Level	National / County / Community	District / National	National / Regional	National	Community / National / International

EVIDENCE ON DEMAND
CLIMATE & ENVIRONMENT
INFRASTRUCTURE | LIVELIHOODS

Question 1

Q1A: *Describe one or two projects you have been involved with that have made a real difference to your (or your organisation's) ability to provide climate information which was better able to support decision making? Give the project names if possible.*

Q1B: *What factors made these projects successful?*

	User 1	User 2	User 3	User 4	User 5	User 6
Q1A	**Quantifying Weather and Climate Impacts on Health in Developing Countries (EU QWeCI project)**	*Regularly use climate observations, reanalysis, remotely sensed data and forecast products to draw conclusions on advance food security outcomes.*	**Project A**: *FogNet* - A SASSCAL initiative investigating the effect of the warming of the Benguela on fog in the Namib Desert. **Project B:** *Gobabeb First Order Weather Station* - Collection of weather & climate data complements long-term ecological monitoring projects undertaken by Gobabeb & visiting researchers.	None given	*West Africa Early Warning Project*	**Project A**: *ECOPAS Regional Programme of Niger* *- Produced cartographic info using met and satellite info* **Project B**: *Long-term Ecological Monitoring Observatory (ROSELT)* - Use of met data, images and aerial photos to produce short & long-term environmental info.
Q1B	○ Multidisciplinary team ○ Substantial funding from EU. ○ Research questions focused on priority & public health issues ○ Work with end users	○ Improved collaboration w/ national data collecting & archiving centers & other relevant stakeholders. ○ Probable improvement in quality & reliability of forecasts.	**Project A:** ○ Collaborative partnerships with local & international institutions. **Project B:** ○ Availability & accessibility of historical observational data.	None given	○ Use of IFRC maproom data & other meteorological data ○ Early action based on predictions by meteorologists	○ No applicable factors given
	User 7	**User 8**	**User 9**	**User 10**		**User 11**
	Sasol Sand Dam	*GEF Sustainable Land Management Project* - Poverty alleviation initiative targeting poorest communities in 10 chiefdoms in the southeast of Swaziland.	*The Second National Communication (SNC) to the United Nations Framework Convention on Climate Change*	**Project A**: *Greenhouse Gas Inventory Development for the Energy Sector (GHG)* **Project B**: *Energy Chapter of Swaziland's Second National Communication to the UNFCCC* **Project C**: *Wind & Solar Mapping Project*		**Project A:** *Participatory Integrated Water Catchment Planning for Victoria & Kioga*

	○ "*Recharge of underground water*".	○ Donor funding used to transform local economy from subsistence farming to sustainable commercial agriculture. ○ Weather/climate info incorporated into planning through collaborative partnerships with NMHS & climate info providers.	○ Funding from the GEF enabled a consultative process with relevant stakeholders.	**Projects A + B**: ○ Funding received from the GEF a significant factor in success. **Projects A, B + C:** ○ Involvement of relevant stakeholders & existing collaborations.	None given

Question 2

Q2A: *Describe one or two projects that had good aims but were less effective.*

Q2B: *What were the barriers/difficulties encountered that hindered progress?*

	User 1	**User 2**	**User 3**	**User 4**	**User 5**	**User 6**
Q2A	*None given*	*Products described in Q1A*	*Short-term contract projects (in general)*	None given	None given	None given
Q2B	None given	○ Areas w/ limited data availability or restrictive data sharing policies to evaluate our products. ○ Weak collaborative partnerships w/ national stakeholders & less skilful forecasts.	○ Lack of local expertise. Most unsuccessful short-term contract projects are led by locals.	None given	None given	None given
	User 7	**User 8**		**User 9**	**User 10**	**User 11**
Q2A	*Bore hole management project*	**Project A**: *Alien plant species project* **Project B**: *Fruit tree& indigenous tree planting project*		**Project A**: *SNC (as per response Q1A above)* **Project B**: *Livestock reduction project during dry seasons*	**Project A**: *Cook stove project* **Project B**: *GHG Inventory project*	*None given*

Q2B	○ *"Too much abstraction of water without minding recharge rate"*	**Project A**: ○ First rains extend into season when livestock ordinarily impounded in rangelands. Shortens period for ploughing, sprouting and spraying of fields. **Project B**: ○ Info on rainy season not always available. As such, vegetation planted to adapt to recurrent droughts, high temperatures & to increase carbon sequestration did not yield desired results.	**Project A**: ○ Reliable data unavailable in areas where there were major livestock losses during severe droughts. **Project B**: ○ Cultural: Livestock is traditionally a measure of wealth.	**Project A**: ○ Price of stoves ○ Limited local production ○ Low public awareness ○ Stoves most efficient in daylight but most families cook in late evening. **Project B**: ○ Serious data challenges. Relied heavily on emission factors from IPCC Guidelines but the applicability of this data locally not fully known "*due to lack of ground truth*".	○ Information/policy harmonisation across ministries for the various sectors.

Question 3

Q3: *What are the priority activities and/or investments needed now to advance the use of climate information into decision making?*

	User 1	**User 2**	**User 3**	**User 4**	**User 5**	**User 6**
Q3	○ First, one needs to demonstrate to potential end users the added value of the use of climate information in their field. ○ Then, priority to put climate information in an accessible format to each end user. (Which communication format? Which communication medium? These are the priority issues to be resolved at this level).	○ Improved quality & access to observed data. ○ Strengthening collaboration & communication w/ national stakeholders. ○ Improvement in forecast skill ○ Strengthening of EW ○ Co-production of forecast & EW info to meet needs & more regular forecast updates	○ Need to train local scientists at post-grad level & on project management skills. Technicians need training on data management and quality assurance. ○ Scientific data quantity large however certain institutions have restrictive data sharing policies. Sharing platforms and policies needs urgent attention.	○ Improved measurement networks ○ Improve EWS for extreme events. ○ Improve governance of NMHSs. ○ Secure funding from high-level political support to support long-term approaches to collaboration, production & communication on climate info. ○ Insurance and micro-credit ○ Cross-border issues e.g. (transhumance)	○ Capacity building of meteorological institutions (especially national) in the West Africa region ○ Guidance on the interpretation of existing data from regional met-institutions	○ Capacity building ○ Generating greater public awareness of climate issues among public and intellectuals
	User 7	**User 8**		**User 9**	**User 10**	**User 11**

Q3	○ "*Integrated Water Resource Management*"	○ Climate prediction tools. Improvement required on rainfall onset & other seasonal rainfall characteristics data to better inform: → When to plant fruit trees & drought tolerant crops. → Timing for sand dam construction & water harvesting tanks. → Timing for the control of invasive alien plant species in rangelands. → Rehabilitation of degraded areas.	○ Public awareness campaigns to potentially dispel cultural beliefs. ○ Data collection, quality control & archiving. ○ Research. In particular on the relationships between climate, disease outbreak & critical thresholds.	○ Data Collection and Data Application ○ Streamlining climate change policies into development activities in order to support informed decision making ○ Capacity building ○ Research ○ Appropriate technology development	○ Integration of development plans ○ Capacity building ○ Sectoral coordination

Key themes/areas across users

Benefits of Climate Information

- Capacity building among users noted across the board as crucial to improved use of climate service information.
- User group respondents from WASH sector note that research is required using local climate info to demonstrate impact of diminishing water resources and changes in rainfall patterns.

Improved Availability

- Availability of existing climate information limited by restrictive sharing policies and practices.
- Some respondents from user group note they are required to request providers "dig up" climate information which, when delivered, can be untimely, inadequate or inaccurate.
- Some respondents from user group note that the frequency of information currently provided could be increased and channels for its dissemination simplified (e.g. via websites).

Timeliness

- One respondent notes that actionable climate info "usually comes too late". Additional point made that EWS must also include guidelines to advise users how to respond to a given event – this is echoed by other respondents.

Relevance

- Several users point to limited relevance of climate info received, noting it as unspecific and generalist (i.e. "cut and pasted" from the internet). E.g. one user points to information on drought occurrence provided by UK Met Office as not explaining degree of drought, variables involved or "distribution along time and space". This equally applies to information received on extreme precipitation. In addition to support for responding to climate variability issues, such information is needed to enable user to develop stronger strategies.
- Several users request that climate information is accompanied by actionable guidelines relevant to their activities as appropriate. These may also guide on the mobilisation of resources.
- User group respondents generally eager for greater interaction between themselves and providers to enhance the relevance of climate information they receive.

Quality

- Low availability of local level data noted as hindering project quality across several example user projects.
- Simple, community friendly climate information is needed to support local interventions.

Communication

- Communication of climate information to local communities should look to address: 1) The importance of climate change to the community; 2) What mitigation measures can be undertaken by organisations and communities?; 3) What happens if no mitigation measures are made?; 4) Who should be involved in climate adaption/mitigation measures?
- More direct communication channels necessary to reach target users with actionable climate information e.g. SMS (mobile phone text messaging)

Training

- Training on climate information emphasised by most users as essential to broad ranging capacity building.

- One user group respondent noted that training on climate information is sometimes unaccompanied by the means to implement learning in practice. This respondent emphasised that training needs to be applicable to a given context and, where possible, delivered on site.
- Training partnerships to support users to handle climate information delivered by providers noted as needing to be more frequent.

Additional points

- **Inclusion of stakeholders**: Noted by several user respondents as important to project success when stakeholder engagement enabled throughout planning and implementation.
- **Integrate climate info into national development plans**: Noted by one respondent. They state this is necessary to enhance ownership, give time for planning of intervention resources & ensure greater intervention sustainability.
- Cultural dimensions noted as impacting project success/failure. These appear to have been avoidable with greater communication and subsequent project adaptation.

Number of users giving rank 1 (highest priority) to various strengthening options provided Additional options added by respondees are not ranked.

	Options that will strengthen uptake of climate services	
A	*Benefits of climate information:* Studies needed to establish benefits of using climate information in my sector. I need to know how climate info can help decision making.	4
B	*Improved availability:* Information I need is not available to me – my producer organisations (NMHSs, RCCs...) need strengthening to generate this climate information.	5
C	*Timeliness:* Information I need is held by climate producers currently arrives too late, irregularly or does not reach me at all).	0
D	*Relevance:* Some info is available but not easily usable – not tailored to my needs. Need opportunity to interact closely with climate provider to develop relevant services.	2
E	*Quality:* Some information I need is available but I need to be more certain of its quality/accuracy to be confident enough to make full use of it.	1
F	*Communication:* The climate information needs to be made more easily understandable in terms of language and format and be provided through channels, which I trust.	4
G	*Training:* Training in how to interpret and use climate services would assist me to use them more actively in my decision making.	4
H	*Integrate climatic information in national development plans for ownership and sustainability*	
I	*Regional and national dialogue*	
J	*Observation stations*	

ANNEX 3

Summary of Consultations with Climate Service Providers in Africa

Org.	Provider 1	Provider 2	Provider 3	Provider 4	Provider 5	Provider 6
Sector	- Agriculture - Water - Health - DRR	- DRR	- Government	- Hydro-Met	- Agriculture & Food security - Water - DRR - Health	- West African Science Service Centre on Climate Change & Adapted Land Use
Groups worked with	- NMHS - Farmer groups - DRR platforms - Humanitarian NGOs	- National gvts. - Agencies - Universities - Schools	- General public - Energy - Water - Health - Insurance - Construction	- Agriculture - Water - Extension services	- National gvt. ministries of GHA countries - Reg & Nat climate services - National Authorities/Services - UN Agencies - NGOs, CBOs	- NMHS - Extension services - Farmer groups - Water sector - Universities
Level	Regional / Continental	Continental	National / Regional	National	National / Regional	Community / National / Regional
	Provider 7	**Provider 8**	**Provider 9**	**Provider 10**	**Provider 11**	
Sector	- Multi-sectoral (with water as entry point)	- Climate services	- Climate services	- Climate service	- Climate services	
Groups worked with	- Local gvt. - Farmer groups	*Actors across sectors:* - DRR - Health - Agriculture - Water sector - Energy - Food security	- Local gvt. - Farmer groups - Water sector	- Farmer groups - Extension services - Community radio	- Local gvt. - Extension services - Farmer groups - Construction - Insurance - Water sector - Disaster mgmt. - Media - Swazi Vulnerability & Adaptation Committee	
Level	National	Not specified	National	National / Local	National	

EVIDENCE ON DEMAND
CLIMATE & ENVIRONMENT
INFRASTRUCTURE | LIVELIHOODS

Question 1

Q1A: *Describe one or two projects you have been involved with that have made a real difference to your (or your organisation's) ability to provide climate information which was better able to support decision making? Give the project names if possible.*

Q1B: *What factors made these projects successful?*

	Provider 1	Provider 2	Provider 3	Provider 4	Provider 5	Provider 6
Q1A	*UNDP Climate Adaptation & Food Security Project*	*African Regional Training Programme on Lightning Protection*	**Project A**: *Historical & Ongoing Data Management Project*. - Capacity development in data management, enhancing monitoring, data analysis & climate info provision **Project B**: *Institutional Support to African Climate Institutions Project* - Capacity building of scientists. Grants funds supporting students post qualification	- Project to contribute to food security by strengthening resilience of agricultural & forestry production systems	**Project A**: *USAID/OFDA* - Reduce vulnerability. of GHA Communities to hydro-met disasters by increasing regional capacity, developing & applying climate info & products **Project B**: *Africa Adapt* - Collaborative knowledge sharing initiative for climate change adaptation	**Project A:** *The West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL)* **Project B:** *The Global Climate Change Alliance (GCCA)*
Q1B	○ Stakeholder ownership considered in design ○ Ongoing flexibility to involve other projects & institutions ○ Systematic consultation & consensus ○ Technical & financial quarterly reports, annual reviews & audits	○ Related to real life experience	**Project A**: ○ Availability of funds & highly trained personnel **Project B**: ○ Donor funding-EU & ADB	○ Seasonal forecast well-known by participating farmers	**General factors**: ○ Involvement of NMHS & stakeholders/users ○ Capacity building focus.	**General factors**: ○ Participative approach to implementation plans, ○ High level contact with political stakeholders
	Provider 7	**Provider 8**	**Provider 9**	**Provider 10**	**Provider 11**	
Q1A	**Project A**: *Kenya Horticulture Competitive Project, rainwater harvesting and Utilization* **Project B**: *Integrated Rainwater Harvesting, Mgmt Systems & Tech for Poverty Reduction*	**Project A**: *1st & 2nd National Communication to UNFCCC* 2nd National Communication basis for Lesotho's climate change response strategy. **Project B**: I*mprovement of EWS*	*Seasonal climate forecast services*	**Project A***: Seasonal Forecasting to Kaffrine Peasants* **Project B***: Met Assistance for Agriculture In Bambey* - Upscaling of Project A.	*Construction of Mbabane Ngwenya Highway*	

Q1B	**General factors**: ○ Technical expertise & org. capacity ○ Building on lessons learned ○ Collaboration with organized community groups & gvt ○ Community capacity building = acceptance, ownership & sustainability ○ Income generating components = increased resilience ○ Incorporating school-based WASH, nutrition & environment education.	**Project A**: ○ Access to statistically downscaled met data by university partner **Project B**: ○ Improved observation networks. ○ Access to numerical model outputs ○ Improved communications with users	○ Improved user-provider communication platforms ○ Availability of services on website ○ Press conference pre-forecast release	○ Consideration of local knowledge ○ Use of community radio ○ Participatory approach with farmers across all activities.	○ Proper planning enabled by thorough analysis of climate records & consideration of forecast info during construction phase ○ Continuous consultation between construction company and Met Services.

Question 2

Q2A: *Describe one or two projects that had good aims but were less effective.*

Q2B: *What were the barriers/difficulties encountered that hindered progress?*

	Provider 1	**Provider 2**	**Provider 3**	**Provider 4**	**Provider 5**	**Provider 6**
Q2A	*Projects to strengthen regional institutions* - Aim to strengthen capacity of regional & sub-regional technical centres to deliver climate info for adaptation.	None given	**Project A**: D*eveloping regional numerical weather prediction capacity* - Intended to serve as springboard for regional climate model. **Project B**: *Developing knowledge products on continental risk assessment, regional forecasts, EW, downscaled scenarios*.	None given	*Strengthening computing resources*	None given
Q2B	○ Limited consultation & consensus during project design ○ HR requirements underestimated ○ Poor financial & HR mgmt. ○ No mechanisms to support skill transfer of staff.	None given	**Project A**: ○ Lack of trained programmers ○ Frequent power cuts rendered model obsolete **Project B**: ○ Delays in equipment procurement ○ Lack of expertise - equipment installation & maintenance	None given	○ Computer cluster & website are running but below capacity due to issues of appropriateness of ongoing support. Mode of implementation ○ Unclear critical details of project specifics	None given

	Provider 7	**Provider 8**	**Provider 9**	**Provider 10**	**Provider 11**
Q2A	**Project A**: *Rural Drinking Water project* **Project B***: Improving Food Security, Child & Gender Based Rights*	*Both projects noted in Q1A above*	*Agricultural Climate Products*: Aimed to provide weather info for agricultural applications.	None given	**Project A**: *Climate support to major infrastructure development* **Project B**: *Irrigation development*

Q2B	**General factors**: ○ Community receptiveness & dependency syndrome ○ Heavy rains & extended droughts slowed implementation. ○ Poor gvt. support & poor collaboration with local development partners ○ Low community capacity hindered sustainability	**Project A**: ○ National Communications provided long-term climate projections but decision-makers want near-term. This info unavailable at time of 2nd National Communication. **Project B**: ○ EWS data quality questionable ○ EWS info untimely	○ Products disseminated via SMS however some users unwilling to pay SMS charges	None given	**Project A**: ○ Improper planning e.g. heavy rain floods infrastructure. Demonstrates climate info not considered at initial stage or that available info inadequate. No ob. stations existed close to build site previously. **Project B**: ○ Irrigation dam became porous, probably due to an environmental oversight during planning.

Question 3

Q3: *What are the priority activities and/or investments needed now to advance the use of climate information into decision making?*

	Provider 1	**Provider 2**	**Provider 3**	**Provider 4**	**Provided 5**	**Provider 6**
Q3 *Priority activities*	○ Inventory or review & prioritise climate sensitive sectors' service needs ○ Definition & specification of priority climate services ○ Development & validation of climate services ○ Feedback collection & use in service improvement ○ Establish help desks ○ Improvement of strategic planning and project management skills of climate service providers ○ Revision of org structure of African climate centres ○ Establishment of clearinghouses to reduce losses in cases of high uncertainty in climate info & maximize benefits in case of reliable climate info ○ Rehabilitation of African climate observing networks	○ Installation of lightning sensors to generate data that supports satellite data sets	**National:** ○ Employment of full-time programmers ○ Acquisition of super computers to run climate models ○ Training of users & providers **Regional:** ○ Strengthen the SADC-CSC ○ Post-grad training of scientists ○ Portals for climate info users ○ Funding for skilled personnel ○ Community education & mobilisation	○ Increase number of stations ○ Capacity building of forecasters ○ Installation of AgroMet stations ○ Provide automatic weather station with automatic data transmission	○ Simplification of climate products ○ Research and development ○ Capacity to develop sector specific climate info processing tools ○ "Sanitization" of key policy makers & managers on climate impacts of critical sectors ○ Dialogue between providers, users & decision-makers	○ Deployment of new infrastructure, technology & analytical tools. ○ Investment in the extension of research results ○ Climate field schools pilot sites (interactive user-provider exchanges) ○ Climate science inclusion in primary/secondary curricula ○ Development of training syllabus for extension intermediaries & political stakeholders
	Provider 7	**Provider 8**	**Provider 9**	**Provider 10**	**Provider 11**	

Q3 *Priority activities*	○ Increase community awareness on climate info & its livelihood impact ○ Strategies for addressing climate change – rainwater harvesting a viable option for climate change adaptation ○ Integration of drylands into national development agenda – water is the entry point & rainwater a promising option ○ Need to harmonize sectoral policies & rural dev. strategies	○ Provision of near-term climate projections ○ Short-term forecast quality needs to improve. ○ Improve research to understand national climate & its underlying physical processes.	○ Enhance interaction between climate information producers & users, particularly farmers. ○ Capacity building for climate scientists & users. ○ Institutional strengthening for dynamic (NWP) downscaling to improve climate products.	○ Training of farmers on climate info products. ○ Media training for rural radio stations ○ Involve all actors at national level where appropriate	○ Create forums for NMHS & stakeholders to discuss weather & climate issues & needs ○ Simplify the scientific terminology used at grass-roots level

Key themes/areas across Climate Service Providers

Observations

- Several respondents note that many studies indicate monitoring network in decline across Africa. One provider considers 'Observations' as the most significant issue in East Africa. They point to the fact that they do not have sufficient data to carry out risk mapping and inform decision-making around e.g. water resources or finding alternative livestock areas. In addition to improving observation and monitoring tools, they are eager to support new technologies such as real-time thunderstorm detectors.
- Training on maintenance of observational network tools noted by one provider respondent.

Research and Development and Analysis Tools

- Existing products for reaching users via mobile require adaptation for the African market. Research is needed to develop appropriate products serving local communities
- Analysis tools commonly raised as limiting for R&D. Respondents note need for high processor CPUs, faster web connectivity, unrestricted software licenses, open source utilities.

Climate Service Development

- One respondent raised the potential for developing commercial products for the private sector.

Operational Services

- HR shortfalls in research positions have necessitated partnerships with African and global institutions to run and build local climate service capacity. However, one respondent notes that attracting resident research advisors has been difficult.
- Similarly, several respondents note the lack of capacity to maintain and install equipment in support of their operational services.
- One respondent noted its value for this option lies in developing new technologies and products to support national met providers and the private sector to strengthen operational services.

Communication

- One provider noted its engagement of stakeholders through Climate Outlook Forums however, they contend that not only should this engagement be more frequent, but that it should allow for their support and follow-up to climate info users on actions taken. This reflects common concern among providers that communication with climate information users needs to be more strengthened.
- Greater degree of interaction at the operational level of the user noted as an important contrast to provider-led/based communications by several respondents.

- One respondent noted that widespread support for community capacity building among providers needs to be supported by simplified scientific terminology.
- Traditional dissemination channels of TV/Radio are insufficient in reaching users. Mobile phones are widespread and while mobile phone technologies for communicating climate information exist for American and European markets, these need to be better adapted for the African continent and for its community level users.

Additional points

- Several provider respondents note that an important factor in the success or failure of their projects was the degree of engagement of relevant stakeholders throughout the project process.
- **Climate science in school curricula and training for extensionists and politicians**: Inclusion of climate on primary and secondary curricula and training of relevant extension services and politicians (one respondent).
- **Climate field schools**: Develop pilot sites for the trial of climate-smart practices and interaction between users and providers (one respondent).
- **Kickstart funding for training**: Two organisations note they have capacity to broaden the training programmes they offer/support to organisations and communities (MSc's, seminars, workshops) using existing capacity.

Number of providers giving rank 1 (highest priority) to various strengthening options provided. Additional options added by respondees are not ranked.

	Options that will strengthen uptake of climate services	
A	*Observations:* An improved national observation network, data rescue, climate data management and monitoring tools	6
B	*Research and development and analysis tools:* Improved capacity of my organisation to do research to access and/or generate the climate information that underpins a service, including making use of available products from regional and global centres (staff levels, equipment, technical/scientific training)	7
C	*Climate service development:* improved capacity to interact with users, demonstrate the benefit of climate services and to develop climate services tailored to users' needs	2
D	*Operational services:* improved capacity to maintain and continually improve an operational climate service to customers.	1
E	*Communication:* Capacity to deliver the climate service in an easily understandable format and provided through trusted channels – including extension workers, media and National Climate Outlook Forums	2
	Additional recommendations	
F	*Funding: Funding required to enable agencies to kick-start existing capacity for training through university programmes, workshops, seminars etc.*	
G	*Climate Field Schools: Pilot sites for trial of climate-smart practices and interaction between users-producers of climate information.*	
H	*Training: Inclusion at primary and secondary level for schools. Also training of users, particularly farmers.*	
I	*Development of training syllabus for extension intermediaries and politicians.*	
J	*Prioritisation of Needs: These to be established in agreement with project partners.*	

ANNEX 4

Questionnaire for African climate information users (sector level) and providers

Guide for those undertaking the user consultation for scoping CIASA

CIASA (Climate Information And Services for Africa) is a large DFID programme designed to advance the development of needs-based user-led climate services in Africa. The programme is currently in its scoping phase and a series of partners across Africa will be undertaking consultations with a range of users to help shape the programme design.

As there have been many recent stakeholder consultations this interview will be short and designed to gain broad indications of the **initiatives/actions needed to make a step change in the availability, quality and uptake of climate information and services.** As a working definition Climate Information Services (CIS) may be understood to encompass the development and delivery, with key stakeholders, of accessible, timely, relevant information which can support decision making across timeframes, sectors and livelihoods.

As such, climate information services relate to the provision of a broad range of climate information – it may be monitoring of past and recent climate, and/or predictions for days, weeks, months, seasons, years or tens of years ahead. Please keep all of these timescales in mind when undertaking the consultation.

In the following, **"users"** are any organisations/individuals that can benefit from weather and climate information (e.g. river basin authority, smallholder farmer); **"producers"** are any organisation – national, regional, continental or international providing information on weather and climate (e.g. National Meteorological and Hydrological Services (NMHSs), Regional Climate Centres (RCCs), and National or International Universities/Research Centres.

The consultation is based around 3 open questions – to gain ideas from the interviewees - and set of five possible activity/investment areas which the interviewee will be asked to score in terms of importance. The open questions are the same for all interviewees, while the activity/investment areas are different for users and climate providers.

Criteria for selection of interviewees: Each regional lead will undertake interviews with at least those on the list agreed with the project lead (core team?). It is important to interview users working in a range of sectors and with planning interests over a range of timescales (including adaptation – e.g. urban development and long-lived infrastructure, as well as shorter term), up to 6 NMHSs and at least 1 Regional Climate Centre.

Time frame: It is anticipated that each interview will take around 45 mins. Please send in reports of interviews as they are undertaken by completing a copy of this guide for each interview and sending this to: Helen Ticehurst (Helen.ticehurst@metoffice.gov.uk), Richard Graham (richard.graham@metoffice.gov.uk) and Emma Visman (emma.1.visman@kcl.ac.uk). Please send in all reports with a summary/synopsis by 19 December 2014.

This guiding note should be sent to the interviewee at least two days in advance of the interview to allow them time to consider the issues to be discussed.

Consultation questions

1: Introduction to the consultation and the interviewee's role and work

Interviewer introduces self and provides a background on this initiative, and the aims of this consultation.

The interviewer initiates a discussion about the interviewee's current role, the kinds of decision making in which they are currently engaged.

Table 1: for all interviewees

Country	
Name of interviewee's institution/ organisation	
What sector do you work in? (Agriculture / Livestock/ Food Security/ Health/ DRR/ Energy/ Water/ Urban and/or infrastructure planning	
What are the major activities which your institution/ organisation undertakes? (e.g. planning, extension services, community education and mobilisation, technical expertise, input provision)	
What social groups do you work with? (e.g. extension services, local government, farmers groups, water providers, suppliers of agricultural or livestock products etc)	
Your position in the institution/ organisation	
At what level do you work at?: Sub-national (please specify county/ district, community/ ward/village) / National/ Regional /Continental/Other	
Can you outline your principal roles and activities within the organisation (planning, programme/project management, communication, training etc)	
Your name (optional)	
Your email address (optional)	
Your telephone contact (optional)	

2. Questions

2.1 Users

Open questions

1a. Describe one or two projects you have been involved with that have made a real difference to use of climate information in your decision making? Give the project names if possible and sources of information about them, if available.
1b. What factors made these projects successful?

2a. Describe one or two projects that had good aims but were less effective.
2b. What were the barriers/difficulties encountered that hindered progress?

3. What are the priority activities and/or investments needed now to advance the use of climate information into your decision making?

4. Would you be willing/available to attend a 1-day workshop in early January to help prioritise investments/activities to accelerate the uptake of climate information in decision making?

Priority investment/activity areas

To complement responses to the above questions, please indicate below where, in your view, the CIASA programme should focus its work? Please consider the options and, if the options are not sufficient, add up to 2 of your own. Then share 30 points across the most important 5 options (awarding more points for the more important options).

Table 2.1: for Users

	Options that will strengthen uptake of climate services	
A	Benefits of climate information: Studies are needed to establish the benefits of using climate information in my sector. I need to know how climate information can help my decision making.	
B	Improved availability: The information I need is not available to me – my producer organisations (NMHSs, RCCs...) need strengthening to generate the climate information I need.	
C	Timeliness: Information I need is held by climate producers currently arrives too late, irregularly or does not reach me at all).	
D	Relevance: Some information is available but is not easily usable – it is not tailored to my needs. I need the opportunity to interact closely with my climate provider to develop services relevant for me.	
E	Quality: Some information I need is available but I need to be more certain of its quality/accuracy to be confident enough to make full use of it.	
F	Communication: The climate information needs to be made more easily understandable in terms of language and format and be provided through channels, which I trust.	
G	Training: Training in how to interpret and use climate services would assist me to use them more actively in my decision making.	
H	*If the above options do not cover your views add here*	
I	*If the above options do not cover your views add here*	

Please note any other comments arising during interview.

2.2 National climate providers: NMHSs and partners (e.g. Universities)

1a. Describe one or two projects you have been involved with that have made a real difference to your ability to provide climate information which was better able to support decision making? Give the project names if possible.

1b. What factors made these projects successful?

2a. Describe one or two projects that had good aims but were less effective.

2b. What were the barriers/difficulties encountered that hindered progress?

3. What are the priority activities and/or investments needed now to advance the use of climate information into decision making?

4. Would you be willing/available to attend a 1-day workshop in early January to help prioritise investments/activities to accelerate the uptake of climate information in decision making?

Priority investment/activity areas

To complement responses to the above questions, please indicate below where, in your view, the CIASA programme should focus its work? Please consider the options and, if the options are not sufficient, add up to 2 of your own. Then share 30 points across the most important 5 options (awarding more points for the more important options).

Table 2.2: for national climate providers (NMHSs, partner Universities)

	Options that will strengthen uptake of climate services	
A	Observations: An improved national observation network, data rescue, climate data management and monitoring tools	
B	Research and development and analysis tools: Improved capacity of my organisation to do research to access and/or generate the climate information that underpins a service, including making use of available products from regional and global centres (staff levels, equipment, technical/scientific training)	
C	Climate service development: improved capacity to interact with users, demonstrate the benefit of climate services and to develop climate services tailored to users' needs	
D	Operational services: improved capacity to maintain and continually improve an operational climate service to customers.	
E	Communication: Capacity to deliver the climate service in an easily understandable format and provided through trusted channels – including extension workers, media and National Climate Outlook Forums	
F	*If the above options do not cover your views add here*	
G	*If the above options do not cover your views add here*	

Please note any other comments arising during interview.

2.3 Regional Climate providers: RCCs

1a. Describe one or two projects you have been involved with that have made a real difference to your (or your organisation's) ability to provide climate information which was better able to support decision making? Give the project names if possible.

1b. What factors made these projects successful?

2a. Describe one or two projects that had good aims but were less effective.
2b. What were the barriers/difficulties encountered that hindered progress?

3. What are the priority activities and/or investments needed now to advance the use of climate information into decision making?

4. Would you be willing/available to attend a 1-day workshop in early January to help prioritise investments/activities to accelerate the uptake of climate information in decision making?

Priority investment/activity areas
To complement responses to the above questions, please indicate below where, in your view, the CIASA programme should focus its work? Please consider the options and, if the options are not sufficient, add up to 2 of your own. Then share 30 points across the most important 5 options (awarding more points for the more important options).

Table 2.3: for regional climate providers (Regional Climate Centres)

	Options that will strengthen uptake of climate services	
A	Observations: An improved regional observation network, regional gridded datasets, climate data management and monitoring tools	
B	Research and development and analysis tools: Improved capacity of my organisation to do research to access and/or generate the climate information that underpins a service, including making use of available products from global centres (consider staff levels, equipment, technical/scientific training)	
C	Climate service development: improved capacity to interact with users, demonstrate the benefit of climate services and to develop climate services tailored to users needs	
D	Operational services: improved capacity to maintain and continually improve an operational climate service to customers.	
E	Communication: Capacity to deliver the climate service in an easily understandable format and provided through trusted channels –media and Regional Climate Outlook Forums	
F	*If the above options do not cover your views add here*	
G	*If the above options do not cover your views add here*	

Please note any other comments arising during interview.

ANNEX 5

List of Experts Consulted

DFID		
Name	**Team/position**	**Nature of consultation**
Nicola Jenns	Climate Change Advisor – Africa Region	Meetings
Nicola Ranger	Climate and Environment Advisor – Energy and Water Team	Meetings
Claire Shakya	Climate Change team leader – Africa Region	Meetings
WMO		
Name	**Team/position**	**Nature of consultation**
Mary Power	Resource Mobilisation	Workshops
Jospeh Mukubana	Offices for Africa and Least Developed Countries	Email
Jay Wilson	Offices for Africa and Least Developed Countries	Workshop
Elijah Muhala	Regional Representative for Easter and Southern Africa	Workshop
Nicolas Mangi	Secondment from KMD	Workshop
Kumar Kolli,	Climate Applications and Services Division	Workshop
Bob Stefanski	Agro-met Division	Workshop
Ayse Altunoglu	Project Coordination Unit	Workshop
Joy Shumake-Guillemot,	WHO-WMO liaison	Workshop
Lars Peter	WIGOS	Workshop
Abdoulaye Harou	Data Production and Forecasting	Workshop
Alice Soares	Data Production and Forecasting	Workshop
Wenjian Zhang	Observations and Information Systems	Workshop
Claudio Caponi,	Hydrological Operational Multipurpose System (inc Hygos project)	Workshop
Paulo Ruti	World Weather Research	Workshop
Michelle Rickson	World Climate Research Programme	Workshop

Sofia Sandstrom	GFCS Implementation Projects	Workshops
Lina Sjaavik	GFCS Implementation Projects	Workshops
Maxx Dilley	Climate Prediction and Adaptation Branch	Workshops and member of project team
Filipe Lucio	Director GFCS	Member of project team
Jeff Wilkinson	WiGOS	Workshops
UN AGENCIES		
Name	**Organisation**	**Nature of consultation**
Kate Milliken	WFP - Programme Advisor, Climate Change Adaptation, Climate Risk management unit	Email
Jo Scheuer	UNDP - Global Coordinator for UNDP-Bureau for crisis prevention and recovery.	Email
Dr Oscar Rojas	FAO Climate, energy and tenure division	Email
Fatima Denton	ACPC	Workshops
Wilfran Moufouma	UNECA	Workshops and email
John Harding	UNISDR Lead for GFCS & Programmes –	Email
RCCs		
Name	**Organisation**	**Nature of consultation**
Ben Lamptey	ACMAD	Meeting at Met Office
Professor Ogallo	ICPAC	Email
SOCIO-POLITICAL ORGANISATIONS		
Name	**Organisation**	**Nature of consultation**
Brad Garanganga	Director SADC-CSC	TBC
TBC	MASA	TBC
Tony Nyong	AfDB	TBC
INGOS		
Name	**Organisation**	**Nature of consultation**
Erin Coughlan	Red Cross	Telecon
Fiona Percy	CARE	Email
Richard Ewbank	Christian Aid	Member of Project Team
Estom Mjula	Christian Aid	Workshop
Yvan Biot	Farm Africa	Email
UNIVERSITIES		

Name	Organisation	Nature of consultation
Mark New	University of Cape Town	Email
Andy Challinor	Leeds University	Email
Mark Pelling	KCL	Email
Dr Peter Doward	School of Agriculture, Policy and Dvt	Email
Roger Stone	University of Southern Queensland	Email
Roger Stern	University of Reading	Email
Ros Cornforth	University of Reading	Member of project team
Emma Visman	Kings College London	Member of project team
Rob Wilby	University of Loughborough	CIASA scoping external reviewer
Emily Boyd	University of Reading	Member of project team
Bruce Hewitson	University of Cape Town	Email
POLICY ORGANISATIONS & CLIMATE PROGRAMMES		
Name	**Organisation**	**Nature of consultation**
Arame Tall	CGIAR	Email
Fatima Denton	ACPC	As Above
CONSULTANCIES		
Name	**Organisation**	**Nature of consultation**
Cheikh Kane	Independent consultant (former ACMAD)	Member of project team – West Africa Lead
Mxolisi Shongwe	Independent consultant	Member of project team – Southern Africa Lead
Tim Ferreira	Independent consultant	Member of project team and East Africa Lead
Jean-Pierre Roux	Project Manager at South South North	Telecon
Lindsey Jones	ODI	Telecon
Paul Watkiss	GCAP	Member of extended project team
Madeleine Thomson	IRI – Senior Research Scientist	Telecon, email and workshops
Tufa Dinku	IRI	Telecon
Cathy Vaughn	IRI	Telecon
Sumiko May	CCAFS	Member of project team
Simon Bayley	Independent consultant	Member of project team
Robert Powell	Independent consultant	Member of project team
Darren Lumbroso	HR Wallingford	Member of project team
Alexander Alusa	Climate Change Advisor to the Minister of Kenya	Workshops
Steve Lipscombe	BBC Media Action	Email
MET OFFICE		
Name	**Team/position**	**Nature of consultation**
Wayne Elliot	BBC (ex WMO)	Workshop
Steve Palmer	Voluntary Cooperation Programme	Workshop
Steve Manktelow	Voluntary Cooperation Programme	Workshop

Karen McCourt	Voluntary Cooperation Programme	Workshop
Tamara Janes	User Engagement	Workshop
Chris Hewitt	GFCS and Head of Climate Services	Member of project team
Rob Allan	ACRE project	Workshop
Helen Bye	Head of International Development	Workshop
Lizzie Good	Senior Scientist, Climate Extremes	Workshop
Andrew Colman	Seasonal Climate Prediction	Workshop
Caroline Bain	Senior Scientist, African Modelling	Member of project team
Bill Leathes	International Development Manager	Member of project team
Helen Ticehurst	International Development Manager	Member of project team
Richard Graham	International Outreach, Climate Applications	Member of project team
Tim Oakley	GCOS Implementation Manager	Member of project team
Julian Menadue	International Development Manager	Workshop
Gavin Iley	DRR Lead	Workshop

ANNEX 6

Sample of written submissions

1. Wilfran Moufouma-Okia (Ph.D): Climate Science Expert, African Climate Policy Centre, Special Initiative Division, United Nations Economic Commission for Africa

Intervention options ideas for the Climate Information and Services Programme for Africa (CIASA)

Background

Climate variability and change present unprecedented challenges to many countries in Africa, requiring that water and energy management, food security, and nutrition and public health are focus areas for adaptation programmes. These challenges are changing significantly the lens through which we look at development and protecting lives and livelihoods issues. Exposure to high levels of risk of disasters and lack of capacity to manage these risks, compounded by factors such as poor access to markets and income generation opportunities, trap vulnerable African communities into a cycle of poverty that quickly deteriorates into a food crisis and disaster with devastating effects for health and all dimensions of the society.

Different sectors of the African society and infrastructures are more or less designed to accommodate the current level of climate variability. The prospect of changing climate necessitates adapting these designs accordingly. To prevent high costs, it is of paramount importance that the most reliable and accurate climate information is used to underpin the development of new adaptation strategies. In addition better resilience can be built using quantitative information on climate variability and change. Despite these many challenges there are also opportunities to be seized with climate fluctuations. However, the overarching guiding principle and vision for policy makers across the continent remain to better "manage the unavoidable and avoid the unmanageable."

To serve better the African vulnerable communities and alleviate the poverty there is an urgent need for improved meteorological infrastructures, climate science knowledge, weather and long terms climate prediction capabilities, use of climate information, provision of tailored climate information services (CIS) in support of the decision-making, and develop the capacity of African scientists and meteorological organisations to implement the CIS.

The delivery of tailored climate information services that can effectively inform the decision-making is a multi-front challenge. It requires multi-disciplinary and cross-sector collaboration, and an agreed upon framework within which such collaboration can take place.

Emerging key sectors: the energy-water-forestry/agriculture nexus and its sensitivity to climate variability and change

Intervention ideas

- The Climate research needs to prioritize climate change scientific challenges and gaps in Africa's peoples' understanding of the interactions between the climate

system and the energy-water-forestry/agriculture (EWF/A) nexus. This nexus is likely to play a key role in socio-economic development of the African countries;

- Climate information services can yield substantial benefits by expanding research beyond natural sciences and into the social sciences, emerging climate science frontiers (e.g outcomes from the Arusha African Climate Conference 2013), as well as through improved prediction and feedback capabilities between the African climate drivers and EWF/A nexus;
- Addressing the climate-EWF/A related questions that regional decision-makers are asking will require the development of models capable of evaluating different adaptation strategies, and testing diverse mitigation options. Accounting for the trade-offs, co-benefits, and uncertainties associated with these actions – such as technology costs, performance and availability – will impact results;
- Expansion and upgrade of existing observational networks (hydrology and meteorology) – though better coordination of existing interventions and development agencies efforts (AMCOMET, GFCS, ClimDev-Africa, UNDP projects, ..etc);
- Strengthening of regional and international collaboration and partnerships;
- Development of multi-disciplinary research and capacity building fellowship programmes;
- Development of African research for development programmes to further understand the climate impact on the EWF/A in African sub-regions, as well as on other development sectors which have so far attracted very little attention from the research community (e.g energy, small islands, coastal zones, forestry, transport, tourisms, protected areas, …etc). The new Climate Research for Development of Africa (CR4D) is going into this direction, but needs to be further expanded and developed;
- Translating climate information into actionable policies for development and adaptation;

Barriers to uptake of climate information

a) Poor accessibility to credible, accurate, and comprehensive climate information, as well as related environmental information by policy makers, policy support organizations, and the population at large; in a format that meets the needs of each of these groups;
b) Lack of solid climate science knowledge and improved observational infrastructure upon which climate information systems can be based on and evaluated;
c) Lack of human and institutional capacity to conduct quality analysis (hydrology, meteorology, oceanography, energy, forestry) for decision support and management practice – with objective to enhance Africa's capacity to produce effective and quality policy-supporting analyses and utilize best practices at all levels;
d) Limited existing framework that facilitates the dialogue between end-users and producer of climate information – with objective to contribute to policy dialogue and support climate change and development policy making processes at the continental, sub-regional, national and local levels;
e) Lack of public incentive to train, retain and motivate the home grown climate scientists by local governments and educational institutions;
f) Difficulty of non-climate expert for interpretation of climate science results (predictions and projections). The usefulness of a climate service depends on the quality of the climate information that underpins it. But weather forecasting and climate predictions are still far from perfect and contain large uncertainties. Limitations in climate modelling and uncertainties in the observations that are used to drive and validate them over Africa—along with intrinsic unpredictability in the nature of the climate system—mean that climate predictions are inherently

probabilistic. Thus, it is very difficult for non-experts to interpret climate information. As a result, climate information would be most effective if tailored to meet African' needs in terms of response strategies, cultural traits, and geographic situation;

g) Limited frameworks for regional and international Cooperation in the areas of climate data generation, data exchange, data analysis, training and capacity building.

2. Professor Roger C Stone PhD, FRMetSoc, Professor in Climate Science, Director International Centre for Applied Climate Sciences, Institute for Agriculture and the Environment, University of Southern Queensland

1. What do you think the sensitivities to climate are in the sectors listed?

Climate variability and extremes (such as drought, floods, late frosts, heatwaves and cyclones) are a major driver of both the productivity and profitability of agricultural production in Australia and many world regions. This variability impacts on individual primary producers and as well as the broader agricultural sector (finance, agri-business, regional communities). Some of the key decisions that are impacted on by climate risks are highlighted in the diagram below.

Recognise the issue of scales - Agricultural Management Decisions occur at many time scales + there are climate systems operating at many time scales! (Meinke and Stone, 2005).

Decision type (eg. only)	Climate system (year)
Logistics (eg. scheduling of planting / harvest operations)	Intraseasonal (>0.2)
Tactical crop management (eg. fertiliser/pesticide use)	Intraseasonal (0.2-0.5)
Crop type (eg. wheat or chickpeas)	Seasonal (0.5-1.0)
Crop sequence (eg. long or short fallows)	Interannual (0.5-2.0)
Crop rotation (eg. winter or summer crop)	Annual/biennial (1-2)
Crop industry (eg. grain or cotton, phase farming)	Decadal (~10)
Agricultural industry (eg. crop or pasture)	Interdecadal (10-20)
Landuse (eg. Agriculture or natural system)	Multidecadal (20+)
Landuse and adaptation of current systems	Climate change

Types of relevant decisions in agriculture:

Strategic decisions: Strategic decisions require planning across seasons to multiple seasons (longer-term) in order to enhance productivity and profitability or minimising risk and reduce environmental impacts. These decisions include the selection of suitable varieties, set-up of blocks and farm layout, size and type of equipment, tillage practices, choice of irrigation equipment and technology, establishment of grazing practices, purchase of

fertilisers, herbicides and other chemicals, harvesting equipment and scheduling and forward marketing and price contracts decisions.

Seasonal climate forecasts (for such as rainfall, temperate and radiation forecasts) can provide climate risk assessments and general information on historical climate data and longer term analysis to support production strategic requirements.

Tactical (shorter-term) decisions: Tactical decisions in crop production requiring planning decisions within the growing season or at sub-seasonal basis. Tactical decisions are those that must be made much more frequently, such weekly and monthly in order to also assist the strategic objectives of the farming operations. Examples of tactical decisions in farming system include purchase or sale of livestock, timing of planting, irrigation scheduling, timing of fertilizer applications, chemical applications and harvesting.

The major difference between tactical and strategic decisions is that tactical decisions are generally made on weekly or monthly basis while strategic decisions are made on seasonal and multi-seasonal basis.

Key agricultural operations and related climate information

Planting: Rainfall and temperature are key climatic variables which impact on the success of planting operations. Depending on the region, planting may begin early/optimal time/late, provided conditions are suitable to support successful germination and crop establishment. Advance knowledge regarding rainfall and temperature through use of climate forecasts can be useful in supporting decisions about varietal choice, planting time and planting method.

*Strategic decisions for planting operation***:** For example, if the seasonal outlook suggests the probability of drier conditions, less crop area may be planted. Alternatively, if the seasonal outlook suggests probability wetter conditions, there would be higher confidence of more successful plant establishment and therefore less risk in planting.

*Tactical decisions for planting operation***:** Medium term rainfall forecasts as well as knowledge of the next likely passage of the MJO (as an example) can also inform the timing of and planning for planting operations. For example, medium term forecasts of a rainfall 'break' can affect timing of planting which could be arranged to take advantage of the likely rainfall to be received, or avoid the disruption in the period where rainfall was forecast. This information may also be useful when timing the buying and selling of livestock as prices may climb on the passage of a significant rain event (or fall on the failure of a rainfall event).

Key forecast products that can be used to support the planting decisions: A range of seasonal forecast products can be useful in supporting planting decisions. In regions where appropriate, the MJO (or similar intra-seasonal system) can provide an indication of the next most likely significant rainfall event, which can allow the scheduling of planting operations. The use of seasonal forecasts (statistical or dynamic e.g. ECMWF, POAMA), rainfall probability maps and forecast temperature conditions under different climate conditions (such as ENSO) (in the Australian context) have provided producers the opportunity to tailor planting decisions (area, planting configuration, crop selection etc).

Irrigation: Access to irrigation water, anticipated in-crop rainfall and timing of rainfall events are important considerations in planning irrigation investment and irrigation scheduling decisions. Cropping regions which rely on either supplementary irrigation or full irrigation can benefit from improved understanding as to the likelihood of wetter or drier than average conditions and whether significant rainfall events are likely to occur. Seasonal rainfall forecasts and climate risk assessments can be useful in supporting decisions regarding

when to schedule irrigation events, purchasing water allocation, investing in irrigation equipment, and system maintenance strategies.

Strategic decisions for irrigation application: If the climate risk assessment indicates a high probability of drier than average seasonal conditions, a producer may decide to purchase extra water allocations, if possible. Alternatively the producer may decide to sell their water allocation as prices increase with the onset of dry conditions. If wetter than average conditions are expected, deferring irrigation machinery investment decisions to the following year to avoid machinery warranties expiring when the machinery may not be required. In cropping regions with limited water supplies, if wetter than average conditions are expected, water could be used with more confidence, earlier in the irrigation season, with the expectation of rainfall to water the crop later in the season. If the seasonal forecast suggests drier conditions and soil moisture levels permit, it may be beneficial to schedule the timing irrigation to occur in between likely passages of an intra-seasonal system (eg the MJO) on the expectation of receiving some rainfall. In areas where irrigation equipment is dependent on electricity supply, change to a cheaper tariff if the season ahead is likely to be drier, and much higher electricity demand for irrigating is expected.

Tactical Decisions for irrigation application: Medium-term rainfall forecasts as well as information on the likely passage of an intra-seasonal system can inform irrigation scheduling. If major rain is forecast around an approaching irrigation, the operation could be delayed to ensure that water was not applied unnecessarily with rainfall likely to occur.

Forecast products that can be used to support the irrigation decisions: A range of seasonal forecast products can be useful in supporting irrigation decisions. Monitoring the forecast passage and likely strength of the MJO can provide an indication of the next most likely period of significant wet weather and allow watering schedules to be arranged to avoid impending wet weather. Strategic irrigation decisions can also benefit from the use of the both statistical forecast outputs and those derived from GCMs (eg. GLOSEA, ECMWF, POAMA), such as rainfall probability maps and data on expected in-crop rainfall.

Fertilising: Nutrient management planning decisions can be supported by an understanding of both the shorter-term weather forecasts and longer term seasonal rainfall forecasts. Application of the correct amount of fertiliser in the most appropriate form and at the right time is important to maximise crop productivity. Rainfall forecasts can be useful in supporting decisions about purchasing fertiliser, what forms to purchase, whether to split applications or not, and timing of applications.

Strategic Decisions: Longer term rainfall forecasts (seasonal forecasts) can be used to consider forward purchasing of the appropriate fertiliser for the season ahead. For example, if a wetter outlook is more likely, a more stable form of fertiliser could be purchased. In the wet tropics region, if wet conditions are forecast, urea can be used, rather than a more expensive blend including other trace elements, as productivity is likely to be reduced in such a year. The more expensive blend could then be applied in a drier season to maximise productivity. In this region too, application should occur earlier in seasons with a wetter outlook, and later if a dryer season is forecast. With a wetter seasonal forecast, fertiliser applications could also be split to occur throughout the season rather than in one application only. Decisions to use granular or liquid fertilisers may also be influenced by the rainfall outlook.

Tactical Decisions: 'Day to day' weather can also inform the timing of fertiliser application, so that the application could occur before a likely rainfall event occurs.

Forecast products that can be used to support the decision: For example, keeping an eye on weather forecasts can provide an indication of the next most likely period of significant wet weather, allowing scheduling of fertilising operations to occur appropriately around likely periods of wetter or dryer weather. In seasonal forecasting that provides rainfall probability outputs under different broad climate conditions (such as ENSO) may assist in guiding fertiliser purchasing and deciding how to apply crop nutrients.

Spraying: Chemical application decisions can be supported by an understanding of both the short term weather and longer term seasonal climate forecasts of rainfall. Rainfall forecasts can be used to support decisions about the timing chemical applications

*Strategic decisions for spraying application***:** A range of seasonal forecast products can be useful in supporting chemical application decisions, particularly for pre-emergent herbicides. ENSO and the likely timing and intensity of rainfall events through weather forecasting can assist with integrated weed management options, product selection and equipment application methods (e.g. aerial, high rise tractor or spot spraying).

*Forecast products that can be used to support the spraying decisions***:** Accessing information about the more likely timing and intensity of weather events will give a useful indication of the next likely period of predominantly wet or dry weather and allow more appropriate spraying management to be modified accordingly. Shorter term weather forecasts providing information about rainfall probabilities and wind speed in the next few days will also be critical elements.

Harvesting: Rainfall and especially excessive rainfall during harvesting can significantly disrupt operations. This is an issue for most crops (cereals, sugar, cotton) and can also impact on transport, milling and processing. Understanding the rainfall outlook for the harvesting season allows growers and millers to plan the most efficient strategy to maximise crop harvest. Rainfall forecasts can be useful in supporting decisions about the order in which to harvest blocks, adjusting the start of milling operations and investment in harvesting equipment.

*Strategic Decisions***:** If there is a high risk of excessively wet conditions, growers may harvest at risk blocks earlier than initially scheduled. This will also reduce impacts on soil structure from heavy machinery. Alternatively if a dry season is forecast, harvesting may be delayed to allow for maximise crop growth (or for maximum protein or sugar content)If a wet harvesting season is forecast there may be opportunities to modify machinery investment plans to purchase wet weather harvesting equipment to ensure the crop can be successfully harvested in the season ahead.

*Tactical decisions for harvest management decisions***:** 'Day to day' weather forecasts, medium term rainfall forecasts can also inform the timing of and planning for harvesting operations.

Forecast products that can be used to support the decision: Tracking the SOI and ENSO conditions where appropriate, along with GCM derived rainfall forecasts (e.g: GLOsea/ECMWF/POAMA), can provide an early indication of whether the harvesting season will be wetter or drier than average. Planning harvesting rotations can then occur as harvesting approaches with the relevant forecast in mind. Use of GCM derived forecast outputs (e.g: GLOsea, ECMWF, POAMA) can be made in machinery investment planning to determine the appropriate mix of wet and dry weather harvesting equipment. Use of these forecast products can also support millers and growers to plan the start of the harvest to optimise harvest season timing.

Key Agricultural Risks and Climate Information

Prior knowledge on anticipated climate risks will assist producers and the associated agricultural sector better manage in managing these risks.

Frost: Frost can have a major impact on anticipated yield. Late, extreme frosts are a significant risk particularly when crops are at their most susceptible stages of flowering and grain filling. Forecasts regarding frost timings (date of first and last frost) and severity greatly assists in reducing risks.

Temperature risk: Both periods of cold and heat can have major impacts on crop production. Most commercial cereal, fibre and horticultural crops have optimum growth temperature ranges. For example, a cold snap shortly after emergence for a cotton crop may result in the need to replant. Heatwave events especially during flowering can have catastrophic effects on expected horticultural crop yields (e.g. tomatoes).

Hail risk: Early warning of expected period of increased hail risk for cotton cropping regions may allow producers to access multi-peril crop insurance for high value crops (and farm infrastructure/machinery). Identifying regions of high hail risk will also allow producers to make strategic decisions such as investing in hail netting for tree and other horticultural crops.

Soil moisture issues: Strongly linked to seasonal rainfall forecasts. Knowledge of soil moisture profile at time of planting will allow producers to estimate in-crop rainfall needed before harvest and determine likelihood of that occurring. Producers may then modify crop inputs and costs based on anticipated yields.

Timing and amount of rainfall: Based on most on-farm decisions and key determinate of both profitability and productivity. Early warning, especially of extremes (high intensity rainfall events, floods, droughts and out of season rainfall) will provide producers the base to manage their key climate risk.

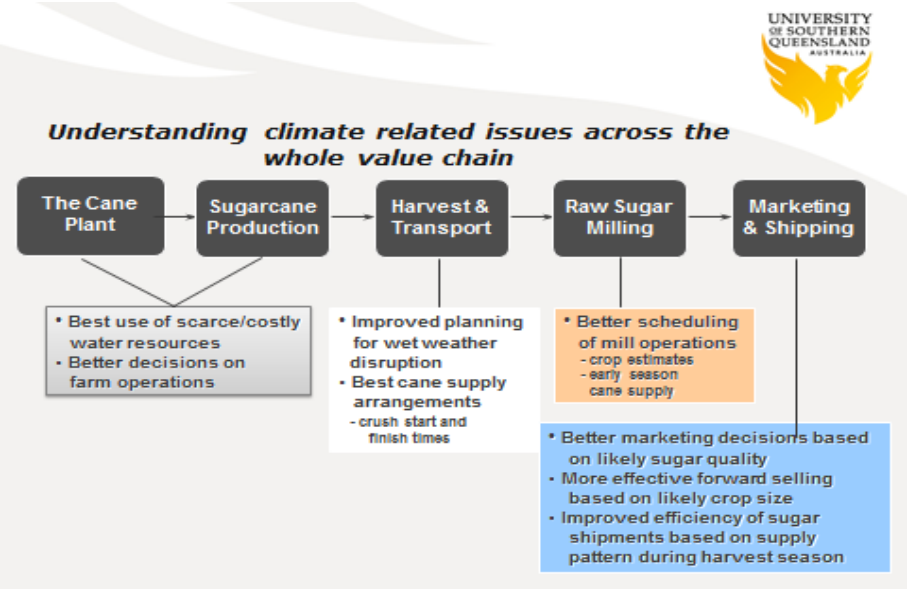
Drought forecasting: Drought is one of the key negative climate impacts on agricultural production. As it slowly develops, and then can persist for a number of years (e.g. 1991-1995) unless producers are monitoring both their on-farm conditions (soil moisture, pasture availability etc.) as well as the seasonal outlook there is a significant risk of both economic and land degradation impacts. The earlier a producer is able to respond to an impending drought, the more management options are available.

Flood forecasting: Depending on the agricultural sector and location, floods can have negative (physical damage) and positive (recharge dams, aquifers etc) impacts. Earlier identification allows producers to move equipment and livestock etc out of at-risk areas.

Agricultural Value Chain and Climate Information Requirements

To date climate-agriculture needs have been mainly focused on local farmer requirements. However, as the diagrams below illustrate (eg sugar and livestock), there are many sectors in the agricultural supply chain that are susceptible to climate impacts – at all temporal scales. Climate variability impacts on all sectors and an improvement in the understanding of managing climate risk and the tools available would significantly improve industry resilience. These additional supply chain actors (sectors) include the harvesting and transport sectors, the milling/processing sector and, very importantly, the exporting and trading sectors.

Climate risk-supply-chain example for the sugar industry:



3. Robert Powell Media Consultant and Humanitarian Communications Specialist

I have set out below some proposed additions to the summary of CIASA Intervention Options Ideas produced by a Met Office workshop on November 26th 2014.

Food Security and Agriculture

A. Sensitivities

Pastoralists in drought-prone and semi-arid zones frequently make grazing and migration decisions based on ***recent rainfall data*** as well as historic weather patterns.

Research for the Ada Consortium project in Kenya in 2014 showed that ***rainfall data for the past week and past month could be useful in helping to inform pastoralists about where to move their herds on open rangelands in order to find the best pasture for their livestock***. Such data could provide a more timely, complete and accurate picture of where rainfall has fallen, and where vegetation growth is likely to be best in the coming weeks than the information on such issues which pastoralists usually receive from scouts sent out on foot to look for new pasture and from information gleaned by word of mouth during contacts with other pastoralists.

Accurate information on the distribution and volume of recent local rainfall is likely to be of value to nomadic and semi-nomadic pastoralists throughout Sub-Saharan Africa.

However, the publication of such information could lead large numbers of pastoralists from rival clans and tribes to converge on the same grazing land and water points. This in turn could exacerbate inter-communal conflict over grazing and water rights. The publication of accurate, trusted information about recent local rainfall must therefore be accompanied by

robust policies to enforce respect for the land rights of individuals and communities and manage conflicts generated by human pressure on scarce grazing and water resources.

Farmers who rely on underground and surface water resources to irrigate their crops and feed their livestock need information about the water level in rivers and dams, the depth of the water table, borehole flow rates and the availability of water in wells as well as rainfall information to help inform decisions that affect their livelihoods.

B. Barriers to the uptake of climate information

One of the biggest barriers to the uptake of information about climate information by people who could potentially benefit from using information that is freely available is the fact that ***meteorologists and climate scientists frequently try to force local people to understand their language and scientific methodologies instead of adapting information which they disseminate to the language and thinking processes of the target audience.***

The concepts used by meteorologists and climate scientists are frequently alien to the farming and pastoralist communities which could usefully apply the information that they generate. As a result this information is not widely understood and is widely ignored when these communities come to make important decisions regarding crop growing and animal husbandry.

The Ada Consortium project in Kenya showed poor levels of public comprehension of the following concepts that are essential for understanding the seasonal forecasts issued before the start of each rainy season:

- **Tercile forecasts** – Kenyan meteorologists produce long range weather forecasts that describe the probability of predicted rainfall during the coming rainy season as being either above normal, normal or below normal. This three-way categorisation is based on a comparison of the forecast for the rainy season ahead with rainfall patterns over a 30-year reference period. It is a very abstract method of classifying the level of predicted rainfall. However, farmers in Southeast Kenya who rely on rain-fed agriculture, use a more functional binary method of describing rainfall. Rains are regarded as being “good” if they produce a reasonable harvest or “bad” if they fail to bring crops to maturity and result in a poor harvest or no harvest at all. The farmers had difficulty understanding the concept of “normal” rainfall, as articulated by the scientists, because it had no relevance whatsoever to their way of life.
- **Percentages** – Meteorologists use percentages to express degrees of probability of weather phenomena occurring. However, percentages are not well understood as a concept by the Kamba farmers of Southeast Kenya or the Somali pastoralists of the Northeast. These people, who have little or no formal education, traditionally subdivide whole units into halves and quarters when thinking figuratively, not percentages.

- **Temperature** – Scientists express temperature in degrees centigrade, yet extremes of heat and cold expressed using this scale are poorly understood by rural communities. In order for centigrade temperature readings to be relevant to such communities, they must be explained in terms of critical impacts such as “hot enough to make bean plants wilt unless they are watered” or “or so cold you may need to sleep under an extra blanket to keep warm.” The situation becomes even more complicated when they same forecast has to be explained to people who live at different altitudes in the same region and who are therefore used to different climatic conditions. For example, someone living below 300 metres altitude in an equatorial

zone may find a night time temperature of 20C rather cool, whereas for someone living at over 1,500 metres, 20C at night would be exceptionally warm.

Many of the standard scientific terms and concepts used by meteorologists have little or no relevance to the lives, linguistic concepts and traditional world view of rural Africans, particularly those who have little or no formal education. ***In order to have any deep influence on decision-making by ordinary people, meteorological information must be expressed in language and concepts that the target audience can understand and relate to easily. Meteorologists must learn to speak the language of the people they are trying to reach and express information is a way that is relevant to the important decisions they have to take, instead of simply trying to make their audience understand and adopt the scientific jargon and the methodologies which meteorologists use to talk to each other.***

This rule applies to all communication of weather and climate information to low literacy rural communities for all purposes, not just food security and agriculture. It is equally valid for warnings about weather-related natural disasters, information about drinking water availability and health hazards.

Another important barrier to the uptake of climate information by farmers and pastoralists is the ***widely perceived unreliability of weather forecasts,*** particularly forecasts about the distribution and volume of rainfall***.*** If rain is consistently forecast for a particular area, but is seldom experienced by a regular recipient of the forecast in that area, he/she will tend to regard the forecast as unreliable and ignore it as a factor in decision making, even if rain did fall as predicted in other areas nearby.

***It is often difficult to integrate the information about rainfall provided by the meteorological department with information about underground and surface sources of water required by farmers and pastoralis*ts** that is recorded and analysed by the water resources department and other sources. All too often, effective mechanisms for the timely sharing of these two sets of information do not exist.

C. Intervention Option Ideas

Promote the sharing of rainfall information from all sources
Promote common standards for the collection of meteorological data from all observers, including hydro and wind power generators, insurance companies, irrigation schemes, Agriculture Ministry meteorological observation stations, farms, schools, churches and mosques.

Provide an internet-based meteorological information platform in each country where all approved government, private sector and community-based contributors can input the data they collect and share it in real time.

Provide incentives to all meteorological data collectors to share their observations with other users through this platform.

Reports on where rainfall has fallen over the past week or month.
As explained above, such reports could be useful to help guide pastoralists towards better grazing and water resources.

Reports on where rainfall has fallen could help boost public confidence in the accuracy of weather forecasts by demonstrating that although predicted rainfall may not have materialised in the recipient's own location, it did in fact fall nearby.

Combine weather and climate information with other forms of useful information for farmers, pastoralists and fishermen in an integrated package
Weather forecasts and climate information should not be regarded as stand-alone products for rural audiences. They are likely to have a bigger impact on decision making in farming, animal husbandry and fishing if they are linked to other critical information related to these livelihoods, such as advice on crop management and animal husbandry and market prices for locally produced commodities. These different categories of information should not simply be delivered alongside each other in separate silos. They should form part of an integrated information product that explains the implications of predicted weather and climate on crop choice, crop management, animal husbandry, agricultural marketing and fishing strategies.

Develop new channels for communicating relevant climate and weather information to local rather than national audiences.
Government meteorological departments have traditionally produced weather forecasts for the general public that are aimed at national audiences.
However, the liberalisation of the media and the diversification of media ownership in most of Africa since the early 1990s have created the potential to ***develop and deliver regional and local weather information products that are tailored to the needs of specific local audiences.***

Over the past 25 years there have also been rapid technological advances in telecommunications in Africa – particularly the development of mobile telecoms networks, the internet and satellite television.

This technology revolution has been accompanied by a diversification of the ownership of telecoms platforms and increased competition between rival service providers. This competition has driven down costs for the consumer and has made telephone communications, television viewing and internet access available to hundreds of millions of ordinary people across Africa in both rural and urban areas.

Meteorological departments and their development partners can exploit this communications revolution to deliver useful new information products to rural communities in new user-friendly formats through new channels.
Foremost among these new channels are:

1. Local radio
The proliferation of local radio stations in Africa creates an opportunity for communicating much more detailed and accurate local weather forecasts to local rather than national or regional audiences - provided the source data to create accurate local forecasts is readily available.

Local radio stations also allow weather forecasts, hazard warnings and other climate information to be transmitted to rural audiences in local languages.

Climate information transmitted in the mother tongue of the listener is likely to better understood and is therefore more likely to trusted and acted upon, than information communicated in an official national language which spoken by most people as a second language.

2. Mobile telecommunications platforms
The mobile revolution in Sub-Saharan Africa has created the potential to communicate new weather and climate information products aimed at local audiences in a specific geographic area and at people engaged in specific livelihoods, such as tea growing, ranching and fishing.

The overwhelming majority of Africans now have access to a mobile phone and mobile network coverage.

However, network coverage remains poor in remote rural areas which have a low population density, particularly in arid and semi-arid regions. Many pastoralists only have sporadic access to the mobile network coverage as they move around with their herds of animals.

***Recorded voice messages* can** be used to provide weather forecasts and climate information updates to low literacy communities where oral communication is more effective than writing. Callers can access the recorded messages by calling information lines.

SMS messages can be distributed to defined user groups of several hundred or even several thousand people. Information in the form of SMS messages can also be made available on demand to individuals who request a particular report by sending an appropriate SMS request to a short code The information requested is then sent to them as an automatic reply.

Mobile internet access is growing across Africa, although internet usage is still mainly restricted to the continent's urban population and educated elite. In future years, the mobile internet, is likely to achieve greater penetration in the countryside via a new and cheaper generation of smart phones,. Densely populated high potential agricultural areas where income and literacy levels are relatively high are likely to be the first areas to benefits. Mobile ***weather apps***, which can incorporate maps and infographics as well as text, have strong potential for providing personalised weather information to literate and relatively affluent farmers and to the leaders of farmers' groups in such areas.

Satellite television is cheaper for broadcasters to deliver than terrestrial TV since it requires no terrestrial broadcasting infrastructure, apart from a small uplink station. Terrestrial television, on the other hand, requires an extensive network of transmission masts which are costly to build and maintain. The barriers to the entry of new players to television have therefore become lower.

Satellite broadcasting has also made it more difficult for governments to control the TV content that is accessible to their population. Satellite TV channels can uplink their signal from anywhere. They do not require studios or transmission points in the country where their target audience is based.

The development of satellite television and the rapid spread of satellite dishes among TV set owners in all sectors of the population have created the potential for new information products about weather and climate that are tailored for delivery to niche audiences. For example:

- TV stations can now target local, regional and transnational audiences more easily. This has given rise to the proliferation of many specialist TV channels. Some target audiences by ***region***, others by ***language*** and others by ***theme*** (eg news, sports, music, films, cartoons, education, religion). ***There is strong potential for creating meteorological information products tailored to the needs of specialised TV audiences.*** For instance, a niche Swahili language TV channel for fishermen on Lake Victoria could potentially command an audience of several million people in the lakeside fishing communities of Kenya, Uganda and Tanzania. Alternatively, special TV programmes for fishermen on Lake Victoria could be created for broadcast on several different TV channels that are viewed by fishing communities around the lake.

- ***Satellite TV can be picked up anywhere. It has brought television for the first time to many remote rural communities which are beyond the reach of terrestrial television,*** which has traditionally targeted urban viewers. Satellite TV broadcasts can be picked up easily by people living anywhere within the footprint of the satellite. It can deliver a high quality TV signal to the most remote rural communities. The increasing use of ***solar panels*** as a source of off-grid electricity now enables such communities to power TV sets easily and cheaply.

Internet television viewed on mobile devices is beyond the reach of rural audiences in most of Africa at present because there is insufficient bandwidth to carry high quality video on 2G rural mobile telecoms networks. But technological developments is some countries, such as the increasing use of wi-max systems to deliver wireless internet access over long distances in rural areas, may soon make internet TV transmitted to mobile devices a viable channel for delivering weather information to rural audiences in high potential agricultural areas.

4. Create weather information products with development partners that are integrated into more sophisticated information packages that serve the planning needs of farmers, fishermen and pastoralists

Farmers, pastoralists and fishermen can often make best use of climate and weather information when it is present as part of an integrated package of real time information whose various components can jointly inform better decision making.

Typically the main ingredients of such information packages include:

- Advice about crop and seed, selection and crop management and animal husbandry
- Advice about the price and availability of key farm inputs, such as seeds, fertiliser, vetinerary medicines and fuel for motors and pumps
- Market prices for agricultural commodities
- A deal-matching service that helps farmers to find buyers for their produce
- Alerts about animal and crop diseases and weather-related hazards

Real-time information packages containing some or all of these elements could be developed with a variety of partners, including:

- The producers of specialist TV and radio programmes
- The Ministry of Agriculture and other government agencies
- Commercial and not-for-profit organisations that already deliver farming advice, market prices and other kinds of specialist information to farmers, pastoralists and fishermen
- Mobile phone companies keen to become content providers in their own right as well as channels of communication for third parties

Integrated information services of this nature can be delivered to the end user through a variety of channels. These range from face-to-face communication via a local agent (such as an agricultural extension worker) who receives the information packages electronically, to direct delivery on either a supply-led basis (radio, TV, SMS, website) or a demand-led basis (SMS on demand, mobile app, email subscription etc).

Energy

A. Sensitivities

Past rainfall data for river basins is required to evaluate the feasibility of hydro-electric projects and dams to create water reservoirs.

B. Barriers to the uptake of climate information

Poor real time integration of rainfall information provided by the meteorological department with hydrological data collected by the water resources department, even though both often form part of the same ministry.

Private collectors of meteorological and hydrological data, such as farmers, irrigation schemes, river basin management authorities, companies that use water in industrial processing and private hydro power companies do not always share their information in a timely manner with the government's meteorological department.

Neighbouring countries do not always share hydrological data about rivers that run through the territories of both in a timely manner.

C. Intervention Option Ideas
Promote common standards for the collection of data on rainfall, wind, evaporation rates and hydrology by all observers.

Provide an internet-placed platform in each country where all approved government, private sector and community-based contributors can input and share this data in real time.

Provide incentives to all data collectors to share their observations with other users through this platform.

Water

A. Sensitivities
The planners and managers of water supply and water management projects need timely information about the water level in rivers and dams, the depth of the water table, borehole flow rates and the availability of water in wells alongside rainfall information to help inform their decision making.

B. Barriers to the uptake of climate information
Real time Information about rainfall and groundwater and surface water resources is not always readily available to match with rainfall and other weather information from the meteorological department

C. Intervention Option Ideas
Promote common standards for the collection and recording of data on rainfall, wind, evaporation rates and hydrology by all observers.

Provide an internet-placed platform in each country where all government, private sector and community-based contributors can input and share this data in real time.

Provide incentives to all data collectors to share their observations with other users through this platform.

Health

A. Sensitivities
Several diseases are more likely to occur during periods of high rainfall.
They include ***malaria and dengue fever***, which are carried and transmitted by mosquitoes. Mosquitoes breed and increase rapidly in numbers when it rains.

The risk of ***diarrhoea and cholera*** also increases with wet weather since water sources become polluted and sanitation conditions deteriorate in communities without access to proper toilets and sewage treatment systems.

Flooding caused by high rainfall may also lead to the ***pollution of water sources***.

Temperature
Extremes of high and low temperature can cause health problems and even death from exposure.

Wind speed and direction
Wind speed and direction also have a direct impact on health. High winds may cause ***skin conditions.*** Winds from a particular direction may bring sand or dust storms which increase the risk of ***breathing difficulties*** and ***lung infections.***

B. Barriers to the uptake of climate information
There is frequently no routine exchange of real time information between the meteorological department and the Ministry of Health. This often results in a failure to issue hazard warnings about weather conditions which may give rise to health problems, accompanied by appropriate advice to the population about how to avoid or mitigate these problems.

C. Intervention Option Ideas
Establish a system of routine consultation between the meteorological department and the Ministry of Health whenever weather conditions which may carry health implications are forecast. This in turn would allow appropriate health warnings and advisory messages to be included more systematically in weather forecasts distributed to the public.

Urban Environments and Infrastructure

A. Sensitivities
Weather conditions, especially wind speed and direction and temperature inversions, affect ***air pollution levels*** in major cities

C. Intervention Option Ideas
Include information about air pollution and related advisory messages from local health officials as a routine addition to city weather forecasts disseminated via local radio and TV stations and the internet to the local population.

Disaster risk reduction (DDR)

A. Sensitivities
Heavy rainfall may cause ***flooding*** that damages crops, disrupts transport and damages buildings. It may also provoke ***landslides and mudslides*** in hilly areas with denuded steep slopes.

Heavy rainfall upstream in river basins may determine the extent and timing of future flooding downstream, several ***days or even weeks before water levels rise there***, even if no rainfall is experienced in the downstream areas affected.

Hail can destroy crops and damage buildings.

High winds onshore may damage crops, cause structural damage to buildings, provoke sand and dust storms and trigger health problems for the human population
High winds and stormy weather offshore may give rise to high waves and dangerous navigation conditions for fishing boats, commercial shipping and leisure craft, dangerous bathing conditions for coastal tourists. They may also cause heavy waves and high tides that

erode the coastline and cause structural damage to buildings, flood defences and port facilities.

Tornadoes may cause heavy localised damage to life and property.

Extremes of high or low temperature may damage crops and harm the health of domestic livestock and the human population.

Lightning increases the risk of bush and forest fires

B. Barriers to the uptake of climate information

The absence of a functional rapid communication and coordination system linking the meteorological department to emergency response organisations such as the police, the fire and rescue service, the coastguard and the Red Cross frequently prevents warnings of impending adverse weather conditions from being shared in a timely manner with relevant organisations. This in turn prevents or delays the communication of hazard warnings to at risk communities, accompanied by information and advice about how to avoid or minimise the impact of the forecast weather.

Lack of public trust in the reliability of the meteorological department weather forecasts may persuade people to disregard warnings about the impending occurrence of weather-related hazards.

People may disregard hazard warnings and associated advice if they are not narrowly targeted at the communities which are generally at risk. Eg Coastal communities may ignore evacuation instructions before the arrival of a powerful storm because in the past such warnings have not always been followed by dangerous weather conditions or flooding in their own area , even though other communities on a different part of the coast have experienced the conditions forecast and the associated consequences.

C. Intervention Option Ideas

The creation of ***more effective rapid communication and coordination mechanisms linking the meteorological department and organisations that play a key role in emergency response*** to ensure that hazard warnings are published in a timely manner, accompanied by appropriate advice to the public.

The development of new channels of communication that ***convey hazard warnings and associated advice to at risk communities more rapidly with better geographical targeting.*** Such channels could include:

- ***Detailed local hazard warnings*** for hazard-affected areas distributed through local and regional radio and TV stations that target audiences in these areas
- ***Broadcast SMS messages distributed to all phones that are currently linked to a defined set of mobile mobile phone masts*** (the Red Cross TERA system which is being set up in Kenya can do this) Agreements must be put in place with mobile phone companies and some investments in special technology may have to be made before such a system can be implemented effectively
- ***Standby arrangements with telecoms operators and call centre operators for the rapid establishment of emergency hotlines which people can call for up the minute information and advice about impending and ongoing weather-related emergencies*** Members of the public should also be able to use these hotlines to report problems which their community is experiencing
- ***Hazard warning apps*** for internet-enabled mobile phones

- ***Hazard warnings and associated advice displayed prominently on the meteorological department website*** along with maps and infographics showing clearly the affected area and the differing degrees of risk that may exist within it.

Robert Powell
January 12th 2015

ANNEX 7

Summary of Sensitivities, Barriers to Uptake and Intervention Option Ideas from Evidence Gathering by Sector

Agriculture and Food Security

Timescales	Sensitivities/Needs	Barriers to uptake of climate information	Intervention Option Ideas
Past data (before today)	~ Agricultural insurance index setting informed by historic data records ~ Pastoralists and farmers make grazing and planting decisions on historic patterns ~ Analysis of localized vulnerability to climate extremes and risk thresholds, enabling humanitarian actors to better target their efforts. ~ For mapping of populations and systems at risk of climate variability and change (e.g. farming system characterization of agricultural technology and management options.	~ Unavailability of climate data particularly over rural Africa, where it is needed most ~ Lack of capacity in the agriculture community to understand and use climate in formation ~ Poor liaison between NMHS and agriculture sector so services which integrate data from both are not developed ~ Climate information often has to be used by people with poor education and understanding of it ~ Lack of understanding of how indigenous knowledge (often highly trusted) can integrate with climate information ~ Forecaster training tends to be traditional and in silos. As it is often theoretical it doesn't teach forecasters how to develop user-led impact based services (aviation is the only example where this is not true)	**Data** ~ Ensure historic data is digitised to support Agricultural insurance schemes ~ Improve use of satellite data which can be very useful for agricultural purposes but developments in this haven't really trickled down (e.g. temperature blending, drought indexes and soil moisture). Currently available but uptake very low. ~ Provision of weather monitoring equipment to local communities to raise awareness and promote dialogue and data exchange **Governance/policy/partnerships** ~ Create formal link or improved partnerships between agriculture sector and NMHS - e.g. liaison officer ~ Improve ability to share and compare agricultural and climate data
Short Range (1-10 days ahead)	~ Crop failure and livestock death due to severe weather ~ Crop failure and livestock death due to rainfall distribution ~ Crop failure due to seasonal		

Timescales	Sensitivities/Needs	Barriers to uptake of climate information	Intervention Option Ideas
	variability and delayed rainfall onset ~ Rainfall related diseases such as potato blight ~ Pastoralists moving to find better pasture if weather affects their normal areas ~ Agricultural insurance payments triggered by climatic conditions ~ Recurrent crop and livestock stress due to heat, moisture deficits, etc. reduce productivity ~ Increased weather variability undermines efficient use of inputs	~ Lack of understanding generally about what needs are across Africa for agricultural climate services and what decision making 'windows' are where farmers can apply climate info – tools tend to be generic rather than specific (e.g. for potato blight) ~ 'Translation' for use is critical (e.g. tercile forecasts are not useable) – and needs time for dialogue at local level – cost effectiveness an issue, but plenty of examples already working out there ~ Users want specific information (based on geographical location, crop and livestock types etc.) which is not readily available ~ Agro-met advisories and agri-business info services (which CIS can easily link to) tend to focus on high potential agric areas where they most affect national economy, but are not usually created for marginal areas where people are more impacted by adverse weather ~ Advice from using CI is likely to conflict with 'modern commercial export oriented' agriculture advice (which aims to defy the weather and deplete water resources, but is the aspiration of developing countries). Or put another way, CI is unlikely for be really useful in responding effectively to CC impacts in the long term unless combined with commitments to invest in environmentally sound land and water management and use and agric practices ~ Climate forecasts do not reach input suppliers so farmers cannot always e.g.	~ Encourage governments to create positions within presidents offices which are responsible for coordinating any donor led climate service activity – with sector focus ~ Develop guidance on the specification of agri-climatic advisory centres that will enhance integration of climate and agricultural advisory services ~ **Capacity Building** ~ Develop a toolbox of potential and already implemented/tested climate services which can be used by agricultural sector across Africa (region and geography specific). For each tool, establish how link between GPCs, RCCs and NMHS can support development of these tools - ideally going beyond just data provision ~ **Communication** ~ Improve communication of climate information to agricultural sector – changing format according to level of education/understanding of user ~ Develop multi timescale RCOF style forums for agriculture sector which support the delivery of these services **Training** ~ Train forecasters and in how to interact with and develop services for the agricultural sector ~ Look for centres for excellence in Africa and use NMHS staff to train others –
Medium Range (10 days to 3 months ahead)	~ Planting activities influenced by anticipated rainfall during season (often informed by indigenous techniques). Note: context of delayed/more erratic start dates to rainy seasons ~ Government may be required to buy in food aid due to crop failure. Geo-political issues then can arise if neighbouring governments sell at too high a price. ~ Exports may be affected by crop failure (e.g. tea, coffee) ~ Agricultural insurance indexes may be increasingly influenced by seasonal predictions in light of increased variability ~ Water demand may change due to irrigation needs ~ Location of aid/government health centres can result in nomadic communities taking permanent		

Timescales	Sensitivities/Needs	Barriers to uptake of climate information	Intervention Option Ideas
	residence in a specific area which means agricultural stress may increase ~ Forecasts of favourable conditions enable farmers to maximise productivity	match the forecast to a climate resilient choice on crop or crop variety due to lack of local seed supply ~ Agricultural recommendations based on forecasts may e.g. propose pest control methods through agrichemicals that farmers cannot afford, are not locally available, have negative environmental and health impact ~ Focus on single-channel communication approaches can leave most vulnerable out of the forecast use process e.g. radio may not use local language, SMS may not reach people without mobile phones or illiterate ~ Lack of feedback loops between farmers and agricultural advisors/forecasters to promote continual assessment, confidence and improvements in the utility of forecast products	potentially through regional centres ~ Train agricultural advisors and other intermediaries in how to interact successfully with climate service providers ~ Expand farmers own capacity to monitor climate through e.g. use of rain gauges, farmer group-managed climate stations **Research** ~ Expand understanding of how farmers and pastoralists can use (short to seasonal range) scientific forecasts to increase agricultural sustainability, productivity and reduce input costs ~ Conduct research into how closely indigenous techniques represent seasonal forecasts and stress test their effectiveness against increasing seasonal variability ~ Look for examples of best practice in climate service uptake in agricultural/food security sector (e.g. WMO project to provide SMS to fishermen of Lake Victoria) ~ Improve understanding of detailed needs in agricultural sector which may be specific to regions or geographical areas ~ Development of crop-based regional modelling to support climate resilient agricultural planning by farmer groups and organisations ~ Increase understanding of the gender dimensions of climate service access and use
Long range (1 – 50 years ahead)	~ Crop types may need to change due to differences in climate ~ Crop and livestock enterprises will need to progressively integrate climate resilient methods to maintain viability ~ Import and export profiles for country may need to change according to what can be grown successfully which may affect GDP/currency value ~ Better infrastructure for irrigation may be required ~ Pest behaviour and range may change due to difference in climate ~ Sea level rises may deem some agricultural land unusable ~ Perennial crop (coffee, cocoa, etc.) enterprises and multi-year investments in land management (e.g. agroforestry, soil and moisture management structures) will need to change in response to changing climates ~ Some sub-tropical range land and crop production areas will become non-viable		

Timescales	Sensitivities/Needs	Barriers to uptake of climate information	Intervention Option Ideas

Energy

Timescales	Sensitivities/Needs	Barriers to uptake of climate information	Intervention Option Ideas
Past data (before today)	~ Wind and sunshine data influence where wind and solar farms are positioned and can be used to make output and profitability estimates ~ Hydropower design (precipitation, evapo-transpiration and flow data)	~ Poor liaison between NMHS and energy sector so services which integrate data from both are not developed ~ Users lack understanding of how to interpret climate information ~ Lack of historic data may prevent stimulation of renewable market in some countries – especially those which are and have been unstable ~ Where available, historic data costs charged by NMHS may be prohibitive ~ Lack of data and understanding of relationship between climate and demand ~ Poor severe weather forecasting capability ~ Continent wide lightning data poor over Africa ~ Energy companies may not trust national institutions to provide them with operational services and therefore will go to private providers. ~ Donor led activity to stimulate renewables sector does not always adequately seek to build capacity of NMHS (e.g. giving them ownership for wind maps). ~ Lack of capacity in African river basin authorities ~ Limited integration of energy and forecasting services e.g. solar charging for	**Data** ~ Global centres need to improve the packaging of the data they send to RCCs and NMHS to assist them to use this to develop accessible services ~ Ensure state of the art forecasting developments by GPCs and private weather sector benefit users through appropriate dissemination ~ Improve ability to share and compare energy and climate data ~ Improve access in NMHS to literature regarding energy (e.g. journals) ~ Improve historic data records through data rescue/satellites/reanalysis ~ Improve ability to share and compare energy and climate data **Governance/policy/partnerships** ~ Create formal link or improved partnerships between energy sector and NMHS - e.g. liaison officer ~ Encourage NMHS to liberalise raw data by illustrating how they can develop value-added data services which they can charge for ~ Find way to ensure donor-led initiatives to stimulate renewable markets involve the NMHS where mapping and profiling involved. Perhaps encourage governments to create positions within presidents offices which are responsible
Short Range (1-10 days ahead)	~ Renewable Energy outputs directly linked to weather ~ Space weather affects all energy types and can lead to blackouts ~ Severe weather and lightning can lead to black outs ~ Level of demand influenced by weather - e.g. heatwaves lead to greater use of air conditioning ~ Flooding has impact on hydropower stations ~ Impact on local communities linked to sluice opening in times of flood ~ Severe weather can damage unprotected small scale RE infrastructure (solar panels, etc.)		
Medium Range (10 days to 3 months ahead)	~ Renewable Energy and hydropower companies calculate how much energy they will need to buy in or sell based on medium range forecast (which affects their profitability and potentially use of government subsidies) ~ Less water = increased sedimentation		

Timescales	Sensitivities/Needs	Barriers to uptake of climate information	Intervention Option Ideas
	which can compromise hydro-power operations and create long term issues.	mobile phones that enhances access to SMS forecasts, early warning systems ~ Increasing global fossil fuel subsidy	for coordinating any donor led climate service activity – with sector focus ~ Develop marine climate change partnerships to support coastal and offshore infrastructure development **Capacity Building** ~ Improve ability and professionalism of NMHS to support private sector in order to generate revenue through operational services and consultancy for the energy sector. Look into partnerships with private providers of weather services as reputation and professionalism may reassure energy firms. ~ Develop a toolbox of potential and already implemented/tested climate services which can be used by energy sector across Africa (region and geography specific). For each tool, establish how link between GPCs, RCCs and NMHS can support development of these tools - ideally going beyond just data provision ~ Develop guidance for small-scale renewable energy users to assist integration of relevant climate factors into their planning processes **Communication** ~ Develop regional energy forums to promote information sharing between GPCs, RCCs, NMHS and users. **Training**
Long range (1 – 50 years ahead)	~ Network resilience can be affected by changing climatic conditions ~ Attractiveness of investment in renewable energy may be influenced by projected changes in climate ~ Energy needs of population may change due to changes in climate ~ Low carbon targets may influence how a country plans its future energy mix		

Timescales	Sensitivities/Needs	Barriers to uptake of climate information	Intervention Option Ideas
			~ Train forecasters in how to interact with and develop services for the energy sector **Research**

Water

Timescales	Sensitivities/Needs	Barriers to uptake of climate information	Intervention Option Ideas
Past data (before today)	~ New water infrastructure projects will be influenced by past climate records (used for resource estimation and abstraction licensing).	~ Poor liaison between NMHS and water sector so water services which integrate data from both are not developed ~ Lack of data sharing between NMHS and water sectors (including the developing of independent weather station networks) ~ Demand is low as classic climate services for health, such as EWS are not performing with great skill. ~ Users lack understanding of how to interpret climate information ~ Lack of access to data on all timescales ~ Insufficient understanding of river basins and how they are affected by regional climate ~ Lack of interaction/data sharing between countries within river basin due to political sensitivities wrt resource allocation and impacts of 'upstream' development.	**Data** ~ Improve ability to share and compare water and climate data ~ Improve historic data records through data rescue ~ Strengthen and extend programmes to improve water monitoring using ground based and satellite observations, e.g. AMSED and Niger-HYCOS **Governance/policy/partnerships** ~ Improve relationship between governments and NMHS affected by river basins with the objective of developing shared services ~ Increase demand for health services but ensure that what is promised can be delivered. **Capacity Building** ~ Develop a toolbox of potential and already implemented/tested climate
Short Range (1-10 days ahead)	~ Water quality and security affected by severe weather. ~ Changes in land use and contamination due to severe weather		
Medium Range (10 days to 3 months ahead)	~ Lake levels reduced due to rainfall across season ~ User needs/demand changes due to rainfall		
Long range (1 – 50 years ahead)	~ Changes in seasonal flows (volumes, timing) ~ Changes in groundwater table due to changes in average rainfall ~ Changes in the water available for		

Timescales	Sensitivities/Needs	Barriers to uptake of climate information	Intervention Option Ideas
	abstraction ~ Changes in river basins and surrounding land and it productivity may occur due to increases/decreases in rainfall ~ Deforestation affects run off, erosion and sedimentation	~ Lack of capacity in African river basin authorities ~ Lack of clarity in definitions - e.g. 80 definitions exist for a heatwave. ~ Lack of context-specific understanding of the inter-relationships between catchment management, land use, climate change and groundwater availability/sustainable use	services which can be used by water sector across Africa (region and geography specific). For each tool, establish how link between GPCs, RCCs and NMHS can support development of these tools - ideally going beyond just data provision **Communication** ~ Develop multi timescale RCOF style forums for water sector which support the delivery of these services ~ Standardise terminology (e.g. for a heatwave) to create consensus and clear messaging. **Training** ~ Train forecasters and in how to interact with and develop services for the energy sector **Research** ~ Improve understanding of East Africa Paradox and its impact on the water sector ~ Learn from examples of best practice where climate data is integrated into decisions within the water sector and use these to design pilot projects

Health

Timescales	Sensitivities/Needs	Barriers to uptake of climate information	Intervention Option Ideas
Past data (before today)	~ Health decision-making culture is strongly evidence based. Quality assured consistent long time series of past climate data at appropriate temporal and spatial scales is needed to create any climate service that can be of value to the health community. These services may be used to identify populations at risk, use seasonality in the timing of interventions, establish evidence-based early warning systems, identify longer term changes in risk and used in the routine impact assessment of climate sensitive health outcomes. ~ Water infrastructure projects and their anticipated profitability/output may be influenced by previous climate ~ Seasonality information for use in nutritional interventions	~ Ministries responsible for provision of weather and climate services receive inadequate technical inputs from ministries of health therefore they are not appropriately informed of the specific needs of public health. ~ Lack of an institutionalized approach to the development of climate services for the health sector. ~ Health policies not flexible to incorporate climate information ~ Early response mechanisms poorly developed ~ Lack of capacity to incorporate climate information in to decision-making tools ~ Lack of confidence in the met data provided ~ No discipline focused on climate-health interactions – so no skills in user community ~ (unlike agrometeorology) ~ Poor climate service results in weak demand ~ Poor liaison between NMHS and health sector so services which integrate data from both are not developed ~ Link between health and weather is not as obvious as in other sectors so health workers/policy makers may not seek	**Data** ~ Implement integrated environment and health surveillance to support timely and evidence-based decisions for effective management of environmental risks to human health ~ Improve ability to share and compare health and climate data – need to engage through Universities and applied research institutes ~ Develop in-country capabilities for better local knowledge (including collection of epidemiological, climate and socio-economic data). ~ Create clear inventories of what types of data products are available and how they meet the range of needs in the health community. ~ Improve the information on timing of rainfall rather than just seasonal totals ~ Improving the access to climate and health data sets, including epidemiological data to enable the development of warning systems e.g. MEWS, DEMETER, ENSEMBLES FP6 ~ Improve collection disease surveillance data and ensure governments have info to make decisions about when and where to
Short Range (1-10 days ahead)	~ Diarrheal health conditions linked to poor sanitation caused by heavy rainfall ~ Vector borne diseases affected by rainfall (and links between temperature, rainfall, standing water		

Timescales	Sensitivities/Needs	Barriers to uptake of climate information	Intervention Option Ideas
	and vector life cycle) ~ Links between meningitis dust and rainfall ~ Extreme temperatures can exacerbate other conditions (e.g. COPD) especially when combined with obesity and poor housing ~ Extreme weather impacts on mortality and traumatic injury ~ Extreme weather/changing rainfall patterns preventing or limiting access to health facilities/outreach by health workers	out climate information.	preposition drugs or time health campaigns – for example, seasonal malaria in Sahel **Governance/policy/partnerships** ~ Promote public-health oriented environmental management to ensure active involvement of public health experts in the development of environmental management interventions to reduce vulnerability ~ Strengthen partnerships and inter-sectoral collaboroation ~ Create formal link or improved partnerships between health sector and NMHS - e.g. liaison officer **Capacity Building** **Communication** ~ Develop multi timescale MALOF style forums for health sector to use climate information in decision-making. ~ Undertake awareness raising and social mobilization using information generated from baseline risk and capacity assessment and from integrated surveillance and response to inform communities about the local level public heath risks of climate change. **Training** ~ Develop research and professional training for the health community to
Medium Range (10 days to 3 months ahead)	~ Malnutrition linked to crop failure ~ Vector borne diseases affected by rainfall ~ Links between meningitis and rainfall ~ Crop failure due to seasonal variability and rainfall onset		
Long range (1 – 50 years ahead)	~ Changes in temperature and rainfall may change marginal areas for vector borne diseases ~ Implications of climate change on malnutrition/ nutrition-related disorders ~		

Timescales	Sensitivities/Needs	Barriers to uptake of climate information	Intervention Option Ideas
	~ Implications of climate change on malnutrition/ nutrition-related disorders ~ Implications of climate change on exposure to novel zoonotic infections due to changing biodiversity distribution (e.g. changing bat migration patterns and new areas of vulnerability to ebola)		assess the impact of climate on health outcomes of interest and opportunities for improved intervention using climate data. **Research** ~ Identify climate information needs for influencing decisions related to climate-sensitive health risk. ~ Intensify operational research on the use of policy-relevant climate information - past, present and future. ~ Explore if climate information can really enrich the decisions made in health sector ~ Promote research on climate change impacts and adaptation ~ Undertake baseline risk and capacity assessments ~ Gather evidence of the cost/benefit value of climate services to the health community ~ Improve understanding of thresholds for when a climate condition will trigger health impacts. ~ Increase understanding of the use of forecasts in anticipating disease outbreak e.g. building on use of seasonal forecasting of malaria risk

Urban Environment & Infrastructure

Timescales	Sensitivities/Needs	Barriers to uptake of climate information	Intervention Option Ideas
Past data (data before today)	~ Local planning decisions may be influenced by previous climatic conditions	~ Poor liaison between NMHS and urban infrastructure and environment sector so services which integrate data from both are not developed ~ Lack of clear and digestible impact based information (including elevation models for flood risk assessment and information on vulnerability, resilience etc) ~ Climate projections unavailable or inconclusive for purposes of long-term decision making ~ National and Local Government terms of office do not encourage long-term planning, especially if decisions have high cost implications ~ Due to lack of verification by NMHS of their short-range forecasts, accuracy isn't understood. May be reluctance on part of government to integrate climate information into longer-term decisions if they don't feel information they are provided with is accurate. Upgrading programmes to improve high density housing areas do not factor in climate variability and change ~ High turn-over of population in high density areas restricts their perceptions of the relevance of weather and climate	**Data** ~ Encourage NMS across Africa to carry out verification activities to illustrate and improve, where necessary, forecast accuracy ~ Improve drought monitoring networks and warning systems, particularly quality and effective disseminations/comms methods **Governance/policy/partnerships** ~ Create formal link or improved partnerships between urban infrastructure and environment sector and NMHS ~ Encourage government to put legislation in place so that climate change factors are considered in long term infrastructure projects ~ Where long term infrastructure projects are funded by international donors, encourage them to include consideration of climate change into TOR and subsequent contracts **Capacity Building** ~ Develop a toolbox of potential and already implemented/tested climate services which can be used by urban
Short Range (1-10 days ahead)	~ Traffic problems linked to flash floods ~ Flooding can affect communications links for businesses & government offices ~ Severe weather can have catastrophic impact on slums		
Medium Range (10 days to 3 months ahead)	~ Urban migration may increase if seasonal crop failure threatens rural livelihoods ~ Crop failure and associated food shortages could lead to unrest in urban environments		
Long range (1 – 50 years ahead)	~ Long term urban migration patterns may change due to climate changes which affect livelihoods in rural areas ~ Thermal stress to buildings associated with rises in temperature ~ Anticipated changes in climate could influence the design and location of		

Timescales	Sensitivities/Needs	Barriers to uptake of climate information	Intervention Option Ideas
	major infrastructure projects ~ Sea level rise may increase the frequency of coastal flooding affecting towns and cities	forecasting ~ Acting on climate information to improve resilience can result in disincentives through increased rents ~ Climate risk can be perceived as relatively less important than other more immediate threats e.g. urban crime, economic insecurity	infrastructure and environment sector across Africa (region and geography specific). For each tool, establish how link between GPCs, RCCs and NMHS can support development of these tools - ideally going beyond just data provision **Communication** ~ Develop multi timescale RCOF style forums for urban environment and infrastructure sector which support the delivery of these services **Training** ~ Provide government officials with training in climate change and understanding of uncertainties **Research** ~ Look for examples of best practice where medium to long range climate data has been included into infrastructure plans and use these to design pilot projects.

DRR

Timescales	Sensitivities/Needs	Barriers to uptake of climate information	Intervention Option Ideas
Past data (data before today)	~ Local planning decisions may be influenced by previous climatic conditions, however… ~ Basing DRR measures (early warning, shelter) on past thresholds of e.g. storm surges may underestimate the risk amplification impacts of climate change	~ Lack of clear mandate and accountability about which organisation responsible for issuing warnings for DRR in many countries – NMHS/Disaster Management Ministry/NGOs etc. Warnings therefore don't have a clear communication chain ~ People may disregard hazard warnings and associated advice if they are not narrowly targeted at the communities which are generally at risk ~ If warnings do get to right user – often lack of preparedness strategies which means severe weather is dealt after it's occurred rather than prevented ~ Lack of trust in NMHS makes people reluctant to act on information received ~ Communication and acceptance (by both producers and users) of the limitations of climate information. ~ Donor commitment to DRR (wrt responding to emergency) still far below need even if EWS in place. ~ Recognition by DRR practitioners that CC is affecting nature, timing, frequency etc of disasters is still a work in progress.	**Data** ~ Develop standardised analysis techniques for post – weather events NMHS need to ensure they collect data after severe weather events so threshold analysis and vulnerability assessments can be made to improve future warnings ~ Explore use of non-traditional high density observations to enrich data for forecasters to enhance their ability to forecast severe weather ~ Invest in improved lightning data across Africa ~ Improve the information on timing of rainfall rather than just seasonal totals ~ Improve drought monitoring networks and warning systems, particularly quality and effective dissemination/comms. Methods ~ Improve the quality and effectiveness of flood warning systems and risk assessments **Governance/policy/partnerships** ~ Governments could stipulate in mobile phone operators contracts that they have to disseminate warnings to subscribers (which costs relatively little to company)
Short Range (1-10 days ahead)	~ Severe weather has impacts on all sectors above		
Medium Range (10 days to 3 months ahead)	~ Severe weather has impacts on all sectors above		
Long range (1 – 50 years ahead)	~ Severe weather has impacts on all sectors above		

Timescales	Sensitivities/Needs	Barriers to uptake of climate information	Intervention Option Ideas
		~ Lack of capacity for protection of highly-valued assets e.g. livestock by disaster response infrastructure can reduce motivation to respond to EW/ seek shelter in time ~ Political reluctance to take effective early action in response to drought early warning ~ Early warning systems across large catchments undermined by national boundaries that prevent information sharing on e.g. river hydrology – even cross-district coordination can be weak	**Capacity Building** ~ Develop climate information and services specifically for women **Communication** ~ Assess effectiveness of WMO's SWFDP project as a model for communication between a GPC, RCC, NMHS and user ~ Explore use of private sector for information dissemination – e.g. coke delivery vans for medium range forecasts ~ Improve communication between NMHS within a region so neighbouring countries inform each other if severe weather systems are approaching ~ Improve dialogue between vulnerable communities and producers **Training** ~ Run education programmes with the public on how to respond to severe weather - with particular emphasis on how to stay safe with lightning **Research** ~ Look for case studies of DRR – e.g. Cuba's response to hurricanes and use these to design pilot projects. ~ Look at other sectors to explore where there has been a successful link between global, regional, national

Timescales	Sensitivities/Needs	Barriers to uptake of climate information	Intervention Option Ideas
			and sub national initiatives and see what the climate service field could learn from them – for example, how do innovations within the health sector improve public health in African countries ~ Improved understanding of climate and catchment hydrology linkages to enhance flood risk assessment and early warning systems ~ Expand understanding of relationships between cumulative seasonal rainfall and enhanced early warning reliability of drought

ANNEX 8

Executive summary of the literature review

DFID is considering a new programme on climate information and services in Sub-Saharan Africa (SSA), building on existing initiatives and a providing a step change in the use of climate information to support poverty reduction and promote socio-economic development.

As part of the scoping for the design of the Climate and Information Services for Africa programme (CIASA), this report provides a short literature review on user needs, gaps and potential intervention options. It adopts the structure of the Global Framework for Climate Services (GFCS, see Section 1) with individual sections on 'Users', 'User Interface Platforms (UIPs)', 'Climate Services Information Systems', 'Observations and Monitoring', 'Research, Modelling and Prediction' and 'Capacity Development'. The review identified a number of gaps in climate services, which were then considered alongside other evidence in a synthesis report and for the design of intervention options.

The literature review found that the requirements of users of climate information are demanding relative to current levels of provider capacity in Africa (Section 2, Section 7). Needs are differentiated across a wide range of users working across decision time- and geographic scales (Section 2). Climate services should be reliable in terms of accuracy, robust in terms of operational delivery, relevant in terms of content and format and accessible in terms of channels of communication and language employed. To deliver the best possible climate services, at scales down to sub-national, synthesis of a wide range of information from global, regional and national centres is required together with the means for effective two-way communication. The appropriate operational hardware and expertise, institutional linkages, data exchanges (Section 4) and institutional capacity (Section 7) require development to facilitate this synthesis and a reliable operational service.

Some of the literature reviewed outlined the benefits[30] of investing in climate services:

- A focus on climate risk management and resilience (rather than climate change risks and adaptation) is more appropriate for poverty reduction (e.g. Ambani and Percy, 2014; Hansen et al., 2014); activities that improve the management of weather and climate risks are regarded as 'low regrets' adaptations to future climate change as well as offering good value for money (Watkiss and Savage, 2015).
- In particular, there is significant potential for the use of historical and 'season-to-date' daily rainfall to provide real-time monitoring and to provide information rapidly that largely illiterate communities can understand and act on (e.g. Tarhule and Lamb, 2003; Cornforth et al., 2013).
- A number of case studies highlight the social and economic benefits of services which have enabled weather and climate information to support communities to

[30] There is limited research published on costs and benefits of investing in meteorological services in Africa. In developed countries cost:benefit ratios of meteorological are reported between 1:2 and 1:6; higher values of 1:10 are reported in Central Asian countries (See LR Section 8).

prepare for floods and protect lives and livelihoods, undertake health planning and make a range of agricultural decisions, including selection of crop and seed types.

- Investment in strengthening integrated frameworks for risk management offers significant, multiple benefits, for example:
    - Development of User Interface Platforms should include strengthening of risk management structures at community, sub-national, national and regional levels and can therefore support more inclusive forms of risk governance (Visman, 2014).
    - Likewise, where UIPs are developed through existing networks and frameworks, investment in climate services may simultaneously boost key public services, enabling livelihood groups to benefit from the multiple advantages of more accessible agricultural, health, education, DRR and climate information .

The literature review shows that current progress in the development of climate services is variable in different sectors (Section 2), different decision timescales and for important components or links in the GFCS framework (Sections 3-7). The following eight points are important considerations for the design of the CIASA programme (six of these are focused on capacity development in one form or another):

- **Progress in different sectors:** Unsurprisingly progress appears to be greatest in the Food Security and Agriculture sector, with many examples of successful small-scale projects and relatively well developed services generated and disseminated at Regional Climate Outlook Forums. Potential needs include strengthening existing mechanisms, greater integration into wider government frameworks and plans and scaling up of successful pilots. The literature suggests less progress in Health and a significant demand but limited progress in areas like energy and urban infrastructure that were not original priority areas for the GFCS (Section 2).
- **Information for different decision timescales**: While some capacity, with support from regional and global centres, exits for the short (1-5 days) and seasonal (3-6 months) timescales. There are notable gaps in information on the sub-seasonal (~50 day), decadal and multi-decadal timescales. The 50 day timescale is of key importance particularly to the agricultural sector – and has potential to provide valuable information on season onset and cessation timing and frequency of heavy rain and dry spells. A key opportunity here is the WWRP/THORPEX-WCRP research programme on sub-seasonal to seasonal timescales, which includes a dedicated Africa project to investigate sub-seasonal predictability over Africa. There are also key knowledge gaps in predicting changes in the probability and characteristics (intensity, spatial, temporal) of high impact weather and climate events, including the potential for unprecedented events. Finally, the peer-reviewed literature suggests that the overall uptake of climate information for long-term policy making is limited (Jones, 2015, Wise, 2014), although guidance on climate change risks and adaptation has been developed in some sectors, e.g. by the African Ministers Council for Water (AMCOW) and Global Water Partnership (GWP) in the Water sector.
- **Involvement of users:** In order for climate information to inform risk management and adaptation effectively, it is helpful to have it embedded within an institutional system that starts with monitoring of weather and climate events and ends with a community level response (e.g. Srinivasan et al., 2011). As recognised in the GFCS, an effective User Interface Platform and strong involvement of users are essential components of effective climate services (e.g. Challinor and Visman, 2014; Tall, et al., 2014; WMO, 2014c). This suggests that

UIP and engagement needs to be extended to sub-national levels to reach the users of climate services and to feedback their requirements to national-regional-global 'producers' of services (e.g. Ambani and Percy, 2014; Visman et al. 2012b).

- **Capacity**: Many African National Meteorological and Hydrological Services (NMHSs) are currently able to provide only very basic climate services. There is therefore a need to develop greater capacity. There is also a need for NMHSs to develop links with global and regional centres to fill gaps in service provision; however, this in itself requires capacity that is not available in many countries. Some African regional organisations and initiatives are providing support to NMHSs by providing rendered products for onward dissemination. However, the regional organisations themselves are not currently reaching minimum standards required by WMO. Poor NMHS capacity can lead to low organisational reputation – which further inhibits user trust and uptake of services – and can lead to lack of the necessary interactions/relationships to develop user-led services. Some recent initiatives have worked to strengthen the capacity of the regional organisations (e.g. ISACIP) however the impact is not yet fully quantified. There have been few coordinated efforts to strengthen national capabilities – though these are increasing (e.g. ENACTS, BRACED, StARCK+) and, where implemented, appear to be having a positive effect on user uptake of some services. Nevertheless, even in such instances, the resources provided to support NMHSs are quite limited in comparison to the amount invested in adaptation funds and initiatives, while these efforts are themselves reliant on reliable, relevant climate information. There is a clear need to invest in the structures and capacities required to develop climate information which can support appropriate resilience building and adaptation.
- **Institutional linkages**: Specific activities to support climate services in Africa, coordinated across global, regional and national centres, are most developed for the seasonal prediction activity. Coordination includes operational commitments on global centres to provide forecast guidance out to 3-months ahead to regional centres and NMHSs. However, the data exchanges are not yet optimal – with NMHSs requiring operational data feeds and tools, manuals and training to analyse and tailor the data to regional and national requirements, in preference to the currently provided visualised forecast maps on internet sites. For shorter ranges (1-5 days) the WMO Severe Weather Forecast Demonstration Project (SWFDP) is providing support to NMHSs through a process of cascading forecast information from global centres to regional centres – where it is synthesised and disseminated to NMHSs. However, the geographical reach of SWFDP is still limited and the process of moving from demonstration project to continuous operational services is incomplete. For predictions on sub-seasonal (~50 day) timescales and projections to multi-decadal timescale there is little coordinated support available. Climate monitoring activities are frequently rudimentary, with many NMHSs not possessing capacity to develop gridded analyses (though this has been introduced in some countries by the ENACTS programme), digital archiving of data is also relatively new in some countries – with an additional need for data rescue.
- **Knowledge development:** Climate prediction information is often available from a range of sources with little information on the reliability of each source – this hinders an objective synthesis of the information. For example the relative performance of differing climate model-based predictions is not well understood. The relative performance of model-based predictions relative to simple statistical prediction methods also requires clarification. Methodology to clearly delineate forecast uncertainties at all timescales is also required.

- **Capacity development**: In addition to institutional strengthening, climate science capacity also requires enhancement with the aims of creating sustainable growth of climate science in Africa (see, for example, Annex 6 in Wilby, 2014). There is a need to develop tools to interpret information from regional and global centres, including downscaling methodology, and for manuals on and training in the use of such tools. It is frequently observed that training needs to extend beyond the often used workshop format to include visiting scientist programmes with staff exchanges between NMHSs and regional and global centres. Roving workshops serving RCCs and NMHSs could also be used
- **Research:** Overall research outputs from Africa are growing but from a very low base and there are gaps in research in specific sectors, such as climate impacts on the built environment, coastal zone and human health (Wilby, 2014). There is a requirement to improve the understanding of the African climate system as outlined at previous Climate Research for Development (CR4D) meetings[31] and the CR4D agenda as well as improving impacts, adaptation, vulnerability and risk research across all sectors. There are specific requirements for social science research, for example. The need to strengthen risk communication and methods for conveying uncertainties is widely recognized (WMO 2014b, Ranger 2013), but more research is needed on the relative effectiveness of different communication methods (Lumbroso et al., 2014).

What does this imply for interventions?

Overall the evidence from the literature review suggests that climate service programme design should consider options that (1) integrate with and strengthen existing complementary activities, (2) extend 'User Interface Platforms' ,(3) extend the services offered and finally, (4) integrate climate information with socio-economic information to support poverty reduction and economic growth. Potential activities based on the literature review are highlighted below (these have been considered alongside other evidence in the project's Synthesis Report):

1. Strengthening NMHS and existing GFCS global-regional-national activities inc. O&M, CSIS, RMP and capacity building (Sections 4-8)[32].
    a. Strengthening business strategies of NMHSs, raising profile with national government and other user sectors.
    b. Strengthening hardware facilities and technical support at NMHSs and RCCs.
    c. Establish modern climate system monitoring at RCCs and NMHSs including, data rescue, use of climate databases and gridded regional and national datasets - building on existing programmes to include use of satellite estimates (such as ENACTS).
    d. Strengthen links between national, regional and global centres. Providing better access to the climate model products of global centres, evaluation of their performance and benefits and tools to facilitate their use (e.g. downscaling).
    e. Several authors have argued that this should be linked to the establishment and operation of an agreed framework of accountability on the part of providers, users and supporting agencies (e.g. Wilby, 2014).
    f. There is considerable scope for further investment in developing tools and approaches which enable both providers and users of climate information to be able to better support and monitor uptake and

[31] http://www.wmo.int/amcomet/en/events/africa-climate-research-development-cr4d-strategy-meeting
[32] The points raised in this list were raised by multiple authors and, in many cases, are recognised in the WMO GFCS documents. We have not referenced each point to specific papers but have highlighted the most relevant report sections and or pillars of the GFCS.

application of climate information across decision making processes. In this regard, there are clear opportunities for enabling emerging learning to be shared across complementary initiatives, including DFID investments in FCFA and BRACED.

   g. Within this framework, there is huge potential for the use of historical and season-to-date daily rainfall to provide real-time monitoring guidance and nowcasting thereby helping to provide information rapidly that largely illiterate communities can understand and act on (Cornforth, *pers. comm*).

2. Extending the UIPs to sub-national level and ensuring the two-way communication between providers and users required to develop user-relevant climate information, support its appropriate application, track its use and impact and so create a well articulated and evidenced demand for improved services (Sections 2 and 3).
   a. Strengthening of Regional Climate Outlook Forums and National Climate Outlook Forums, including sector-based forums and forums dealing with different timescales.
   b. Developing strategies for two-way communication, which are based on comprehensive assessment of the most appropriate and sustainable channels for communication, which ensure reach to the marginalised and are tailored for specific contexts and user groups.
   c. Research on how local and indigenous weather and climate information can support the reliability, understanding and uptake of national climate services, including through locally-managed rain gauges, offers possibilities to build trust and ownership amongst users simultaneous with supporting sustainable national observations networks.
   d. Frameworks for climate information services need to be more inclusive of the range of user needs, across sectors, livelihood and marginalised groups, including women, older people and pastoralist groups.
   e. There is equally a need to more fully engage with the wider humanitarian, disaster risk reduction, development and climate change adaptation communities, to engage their extensive networks in ensuring the reach and benefits of enhanced climate services.
3. Extending the services offered (in response to 2) (Section 2).
   a. With users, develop products that fill current gaps in the timescales currently catered for and conduct operational trials. The sub-seasonal timescale (~50 days) is a key gap and there is an opportunity to build seamless provision from days to seasons by linking with existing activities, namely a) on 1-5 days ahead (SWFDP) and b) on seasonal timescales. Interaction of climate providers and users is also needed to bring multi-annual to decadal predictions into use and to develop operational provision of multi-decadal predictions from CMIP5 and CORDEX, together with guidance in interpretation and communication of uncertainty.
4. Better integration of social, economic, food, health, water and disaster risk information with climate information to add value to services offered (as part of 3) (Sections 2 and 3). Climate information is most useful when different knowledge sources are combined and 'translated' to relate to local livelihoods, contexts and experience (Ambani and Percy, 2014). This involves co- exploration to find out and understand what is available from different sources, highlighting any existing gaps in the information and barriers to understanding and using the information (see for example, Table 1, Boyd and Cornforth, 2013).

Finally, further situational analyses of the ability of specific NMHSs, national partners and associated regional centres to provide the identified user needs for climate services at national and sub-national levels will be needed (Sections 3-8). Such an analysis

would be best conducted for selected regions and include assessing requirements for strengthening national networks of providers, intermediaries and users as well as links to global centres. Outcomes would be used to design and implement a programme of institutional strengthening and consolidation of networks. Prototype climate services for specific sectors could be defined and developed as a tangible means to demonstrate progress.

ANNEX 9

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ANNEX 10

The 5 strategic pillars (SPs) of the AMCOMET Integrated Strategy on Meteorology (weather and climate services)

SP1: Increase Political Support and Recognition of NMHSs and related WMO Regional Climate Centres

SP2: Enhance the Production and Delivery of Weather and Climate Services for Sustainable Development

SP3: Improve Access to Meteorological Services in particular for the Marine and Aviation Sectors

SP4: Support the Provision of Weather and Climate Services for Climate Change Adaptation and Mitigation

SP5: Strengthen Partnerships with Relevant Institutions and Funding Mechanisms

ANNEX 11

Proposed Outline CIASA logframe: Pan-African and Regional Programmes

<table>
<tr><td colspan="6">PROJECT TITLE: Climate Information and Services for Africa (CIASA)</td><td></td></tr>
<tr><td>IMPACT</td><td>Impact Indicator 1</td><td>Baseline</td><td>Milestone 1</td><td>Milestone 2</td><td>Target</td><td rowspan="6"></td></tr>
<tr><td rowspan="6">Increased use of weather and climate information and mainstreaming into development and sector policies, plans and programmes supports sustainable development in Africa</td><td rowspan="2">Value of socio-economic benefits and reduced losses (e.g. number of lives saved, improved agricultural productivity and property value protected)</td><td></td><td></td><td></td><td>To be confirmed during Inception Stage</td></tr>
<tr><td colspan="4">Source</td></tr>
<tr><td colspan="4">Specific qualitative and quantitative studies, programme research</td></tr>
<tr><td>Impact Indicator 2</td><td>Baseline</td><td>Milestone 1</td><td>Milestone 2</td><td>Target</td></tr>
<tr><td rowspan="2">Number of people with improved resilience (ICF KPI 4)</td><td></td><td></td><td></td><td>5,000,000</td></tr>
<tr><td colspan="4">Source</td></tr>
<tr><td colspan="4">ICF Monitoring and Evaluation</td></tr>
</table>

OUTCOME	Outcome Indicator 1	Baseline	Milestone 1	Milestone 2	Target	Assumptions
Increased use of reliable, co-produced and accessible weather and climate services based on better data, information, knowledge and tools informs regional, national, sub-national and community level policy, planning and decision-making in Africa.	Number of projects and programmes where integrated regional approach promoted by CIASA is adopted for development of climate services	0			3	Improved climate information translates into better decisions and greater resilience to climate variability and change
		Source				
		Specific programme studies				
	Outcome Indicator 2	**Baseline**	**Milestone 1**	**Milestone 2**	**Target**	All the requirements for an effective climate service are effectively supported and coordinated
	Number of organisations and institutions reporting 'improved' or 'considerably improved' use of weather and climate information to inform their decision making	0			50	
		Source				
		Specific Programme Studies (self reporting and/or external assessment)				
	Outcome Indicator 3	**Baseline**	**Milestone 1**	**Milestone 2**	**Target**	
	Number of government departments/ ministries/ institutions reporting 'improved' or 'considerably improved' understanding of weather and climate issues and links to development related to their sectors	0			20	
		Source				
		Specific Programme Studies (self reporting and/or external assessment)				
	Outcome Indicator 4	**Baseline**	**Milestone 1**	**Milestone 2**	**Target**	
	Number of households reporting using of improved climate services for decision making that improves their livelihoods (assumed to be 25% of number with improved access to services and a household size of 5)	0			875,000	
		Source				
		Specific Programme Studies (self reporting and/or external assessment)				

OUTPUT 1	Output Indicator 1.1	Baseline	Milestone 1	Milestone 2	Target	Assumptions
Strengthened enabling environment for the generation, uptake and use of weather and climate services to support development	Volume of government and donor funding coordinated around agreed plans for development of climate services	0			£100 million	Suitable working arrangements between ACPC/AMCOMET and WMO are developed and work effectively Pan African initiatives are able to exert influence and demonstrate impact at the regional and national levels
		Source				
		Financial tracking				
	Output Indicator 1.2	**Baseline**	**Milestone 1**	**Milestone 2**	**Target**	
	Number of joint initiatives between ACPC/WMO/AMCOMET supporting a better enabling environment rated by indentified decision makers as 'useful' or 'very useful' (for example data protocols, value for money research, political engagement, development partner coordination, shared platform to access tools etc) [note: the detail of the work programme will be further developed during Inception Stage].	0			5	
		Source				
		ACPC/WMO/AMCOMET reporting/stakeholder feedback				
	Output Indicator 1.3	**Baseline**	**Milestone 1**	**Milestone 2**	**Target**	
	Number of countries where AMCOMET, WMO and ACPC use their influence to generate regular dialogue on weather and climate services across government (measured through increased support to NMHSs from national budgets and increased requests to NMHSs for information and services)	0			5	
		Source				
		ACPC/WMO/AMCOMET reporting/national budgets/NMHS records				
IMPACT WEIGHTING	**Output Indicator 1.4**	**Baseline**	**Milestone 1**	**Milestone 2**	**Target**	
20%	Number of new interagency agreements to strengthen climate services (e.g. MoUs/service level agreements between NMHSs and line ministries, NGOs etc for co-production of products and services, long term investment planning and funding)	0			50	
		Source				**RISK RATING**
		ACPC/WMO/AMCOMET reporting/NMHS records				H

INPUTS (£)	DFID (£)	Govt (£)	Other (£)	Total (£)	DFID SHARE (%)
	£6.5 million				
INPUTS (HR)	**DFID (FTEs)**				

OUTPUT 2	Output Indicator 2.1	Baseline	Milestone 1	Milestone 2	Target	Assumptions
Innovative interdisciplinary research programme (a) supports the generation, uptake and use of weather and climate services and (b) builds sustained intellectual leadership in climate science in Africa	Number of research outputs directly contributing to the development, uptake or understanding of new climate services	0			10	A 'critical mass' of African research capacity can be attracted and retained
		Source				
		Programme reporting/feedback from global, regional and national producers and users of weather and climate information				
	Output Indicator 2.2	**Baseline**	**Milestone 1**	**Milestone 2**	**Target**	
	Number of peer reviewed climate and social science articles authored by African scientists and available in an open access format [disaggregated by gender and primary and secondary authorship]	0			50	
		Source				
		Programme reporting				
IMPACT WEIGHTING	**Output Indicator 2.3**	**Baseline**	**Milestone 1**	**Milestone 2**	**Target**	
20%	Number of African scientists and researchers [disaggregated by gender] working in African institutes that have built expertise the development of user-led weather and climate services	0			100	
		Source				**RISK RATING**
		Programme reporting				M

INPUTS (£)	DFID (£)	Govt (£)	Other (£)	Total (£)	DFID SHARE (%)
	£10 million				
INPUTS (HR)	**DFID (FTEs)**				

OUTPUT 3	Output Indicator 3.1	Baseline	Milestone 1	Milestone 2	Target	Assumptions
Improved data at historical, present and future timescales and better production systems support the generation of improved weather and climate information and services	Number of countries with revised freer data sharing policy (rated by identified stakeholders as 'useful' or very 'useful') and coordinated national plans for data rescue and digitisation developed	0			5	Political will and support for revision of data policies and new approaches to improving observation
		Source				
		Programme reporting				
	Output Indicator 3.2	**Baseline**	**Milestone 1**	**Milestone 2**	**Target**	
	Number of NMHS's using and sharing new/improved datasets supporting design and production of new/improved national and regional climate services (to a level rated by identified stakeholders as 'useful' or very 'useful')	0			5	
		Source				
		Programme reporting/NHMS institutional assessment/benchmarking				
	Output Indicator 3.3	**Baseline**	**Milestone 1**	**Milestone 2**	**Target**	
	Number of NMHS's with improved technology/hardware and related capacity for production of climate services	0			5	
		Source				
		Programme reporting/NHMS institutional assessment/benchmarking				
IMPACT WEIGHTING	**Output Indicator 1.4**	**Baseline**	**Milestone 1**	**Milestone 2**	**Target**	
20%	Number of countries with improved observations network and credible long term plans for operation and maintenance in place	0			5	
		Source				**RISK RATING**
		Programme reporting/NHMS institutional assessment/benchmarking				M

INPUTS (£)	DFID (£)	Govt (£)	Other (£)	Total (£)	DFID SHARE (%)
	£5 million				
INPUTS (HR)	**DFID (FTEs)**				

OUTPUT 4	Output Indicator 4.1	Baseline	Milestone 1	Milestone 2	Target	Assumptions
Strengthened global-regional-national networks and partnerships support the improved generation, uptake and use of climate information	Number of Regional and National Climate Outlook forum processes initiated and/or strengthened (regional/national) [measured by level of satisfaction amongst user community]	0			6	A sustainable model for global/regional/national cooperation between multiple collaborators can be developed and agreed
		Source				
		Programme reporting and participant/stakeholder feedback				
	Output Indicator 4.2	**Baseline**	**Milestone 1**	**Milestone 2**	**Target**	
	Number of partnership networks with programmes to promote uptake and use of weather and climate information rated by identified stakeholders as 'useful' or 'very useful'	0			3	
		Source				
		Programme reporting and stakeholder feedback				
	Output Indicator 4.3	**Baseline**	**Milestone 1**	**Milestone 2**	**Target**	
	Number of service agreements/MoUs in place between global and regional centres, and regional and national centres	0			8	
		Source				
		Programme reporting				
IMPACT WEIGHTING	**Output Indicator 4.4**	**Baseline**	**Milestone 1**	**Milestone 2**	**Target**	
20%	Number of RCCs and NMHS's using in house processing of GPC data to generate new and/or improved climate services as a result of CIASA support	0			10	
		Source				**RISK RATING**
		Programme reporting				M

INPUTS (£)	DFID (£)	Govt (£)	Other (£)	Total (£)	DFID SHARE (%)
	£3.5 million				
INPUTS (HR)	**DFID (FTEs)**				

OUTPUT 5	Output Indicator 5.1	Baseline	Milestone 1	Milestone 2	Target	Assumptions
Improved access to weather and climate information at national, sub-national and community levels through strengthened capacity of and integration between NMHS's, collaborators and users that promotes improved service development and delivery	Number of National Meteorological and Hydrological Services with modernisation plans focussing on improved service delivery, and being implemented with CIASA support	0			5	Sufficient institutional and cultural change can take place within relevant organisations to enable co-production of climate services and promote new approaches to delivery
		Source				
		Programme reporting/NHMS institutional assessment (WMO Service Delivery Framework of similar) /benchmarking				
	Output Indicator 5.2	**Baseline**	**Milestone 1**	**Milestone 2**	**Target**	Improved access to and co-production of climate information leads to increased uptake and use
	Number of households able to access new and/or improved climate services through a range of intermediaries and communication channels [assumed to be approximately 60% of the LVB population of 30 million, and an average h/h size of 5.0]	0			3,500,000	
		Source				
		Programme reporting (supply side assessment)				
	Output Indicator 5.3	**Baseline**	**Milestone 1**	**Milestone 2**	**Target**	
	Number of organisations and institutions reporting improved access to new and improved climate services through a range of channels [disaggregated by type and size of organisation and reach]	0			50	
		Source				
		Programme reporting /specific studies				
IMPACT WEIGHTING	**Output Indicator 5.4**	**Baseline**	**Milestone 1**	**Milestone 2**	**Target**	
20%	Number of new or improved co-produced climate service products being delivered on time and in full and to organisations and institutions in various sectors and being reported as effective (government departments, private sector, NGOs, multilateral organisations etc)	0			20	
		Source				**RISK RATING**
		Programme reporting /specific studies				M

INPUTS (£)	DFID (£)	Govt (£)	Other (£)	Total (£)	DFID SHARE (%)
	£10 million				
INPUTS (HR)	**DFID (FTEs)**				

Notes:
All targets and milestones are indicative and will be further refined during the Inception Stage;
All indicators to be disaggregated for gender and other parameters as required; 3)
All targets at output level relate to 'added value' as a result of the CIASA programme

ANNEX 12

Glossary

ACPC	African Climate Policy Centre
AfClix	Africa Climate Exchange
AMCOMET	African Ministerial Conference on Meteorology
AMCOW	African Ministers Council for Water
AMESD	African Monitoring of the Environment for Sustainable Development
BRACED	Building Resilience and Adaptation to Climate Extremes and Disasters
CBO	Community-Based Organisation
CIASA	Climate Information and Services for Africa
ClimDev	Climate and Development for Africa programme
CMIP5	Climate Model Intercomparison Project number 5
CORDEX	Coordinated Regional Climate Downscaling Experiment
CR4D	Climate Research for Development
DFID	Department for International Development (UK)
DRR	Disaster Risk Reduction
EAC	East African Community
ENACTS	Enhancing National Climate Services (programme)
EWS	Early Warning System
FCFA	Future Climate For Africa
GEF	Global Environment Facility
GEWEX	Global Energy and Water Exchanges Project
GFCS	Global Framework for Climate Services
GFDRR	Global Facility for Disaster Risk Reduction
GHA	Greater Horn of Africa
GHG	Greenhouse Gas
GWP	Global Water Partnership
HyNEWS	HydroClimate to Navigational Early Warning Systems (project)
HyVic	Hydrology of Lake Victoria Basin (project)
IAPS	Invasive Alien Plant Species
ICPAC	IGAD Climate Prediction and Applications Centre
IFRC	International Federation of Red Cross and Red Crescent Societies
IGAD	Intergovernmental Authority on Development (East Africa)
INGO	International Non-Governmental Organisation
IPCC	Intergovernmental Panel on Climate Change
ISACIP	Institutional Support to Africa Climate Institutions Project
LVBC	Lake Victoria Basin Commission
MESA	Monitoring of Environment and Security in Africa (EUMETSAT programme)
NASA	National Aeronautics and Space Administration (USA)
NCOF	National Climate Outlook Forum
NGO	Non-Governmental Organisation
NMHS	National Meteorological and Hydrological Services
REC	Regional Economic Community
RCC	Regional Climate Centre
RCOF	Regional Climate Outlook Forum
RWX	Rainwatch-AfClix (project)
SADC-CSC	Southern African Development Community – Climate Services Centre

SASSCAL	Southern African Science Service Centre for Climate Change and Adapted Land Use
SHEAR	Science for Humanitarian Emergencies And Resilience
StARCK+	Strengthening Adaptation and Resilience to Climate change in Kenya (follow on programme)
SWFDP	Severe Weather Forecasting Demonstration Project
SWNDP	Severe Weather Nowcasting Demonstration Project
THORPEX	The Observing System Research and Predictability Experiment
UIP	User Interface Platform
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convection on Climate Change
USAID/OFDA	United States Agency for International Development/Office of Foreign Disaster Assistance
WASCAL	West African Science Service Centre on Climate Change and Adapted Land Use
WASH	Water Sanitation and Hygiene
WB	World Bank
WCRP	World Climate Research Programme
WMO	World Meteorological Organisation
WWRP	World Weather Research Programme