Technical Report No. 1

INITIAL LISTS OF AMMA-2050 USER-RELEVANT CLIMATE METRICS

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Photo: J.Hansen (CCAFS) at Farmer workshop on climate information, Kaffrine, Senegal 2011

FUTURE CLIMATE FOR AFRICA

NERC SCIENCE OF THE ENVIRONMENT

UKaid from the British people

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Initial Lists of AMMA-2050 User-Relevant Climate Metrics

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The AMMA-2050 'Case for Support' states that "to influence decisions that will affect livelihoods over the next 5-40 years, information on specific user-relevant metrics is required". The purpose of this report is to provide a draft listing of these 'user-relevant metrics'. Specifically, these will be utilised in two areas of research:

- Pillar 1 (the physical climate science) of AMMA-2050 will provide maps of the projected changes and uncertainties in these metrics to Pillars 2&3 (the impacts science and pilot studies).
- 'Expert judgement' of the capability of the climate models, which aims to determine the trustworthiness of each model's projection. Knowledge of the metrics most relevant to users is essential to ensure that this work is appropriately focussed.

In essence, the metrics listed in this report are the measures of West African climate which we believe climate-sensitive systems (agriculture, hydrology, infrastructure, etc) are most sensitive to.

AMMA-2050 is investigating the impact of climate change on two key applications: agriculture and hydrology. Different scientific disciplines sometimes require different climate information, so separate metrics lists were produced for each. At the Kick-Off Meeting (5-9 October 2015), breakout groups were formed from the members of each the relevant Pillar 2&3 Work Packages, and were asked to:

- Review the management decisions that could be influenced by climate change (noting the requirement to focus on decisions taken now that will mitigate adverse effects of climate change on livelihoods in 5-40 years time).
- List the possible impacts of climate change that could influence these decisions.
- Decide how to measure these aspects of climate. Note, this should include aspects of climate change anticipated to strongly determine the output of an impacts model, although full lists of the requirements of these models are being discussed separately so are not covered here.
- Discuss the priority of each metric, recognising that the inevitably limited resources in Pillar 1 will necessitate a focus on some metrics more than others.

To kick-start these discussions, examples of possible metrics were provided by Pillar 1 (3&24hr local rainfall, 24hr catchment-scale rainfall, rainfall sequences over N days, rainfall onset date, wet season duration & total, dry spells with local rainfall < R mm/day for M days,

surface & 2m Tmax, Tmin, seasonal mean temperature and humidity, squalls, dust, and air quality). Note these have generally been included in each group's lists so may have had a little more influence than intended.

The tables on the following pages show the outputs of each breakout group. This now provides a valuable overview of the areas on which the AMMA-2050 Pillar 1 climate science should focus. However, it is likely that there are too many high priority metrics to enable the Pillar 1 expert judgement work to be sufficiently focussed, even if many metrics are found to be correlated across models.

Thus additional work on these metrics lists is still required, in particular to further prioritise and consolidate the metrics, as well as clarifying their calculation details through cross-disciplinary discussion, and importantly, also updating the lists following discussion with stakeholders.

HYDROLOGY: WORK PACKAGE 3 (IMPACTS SCIENCE)

Management Decision	Impact: Water Resources	Priority (H/M/L)	Climate Metric	Remarks / Questions
Hydrological drought mitigation, water resources planning	Water resource management (supply development, demand management)	H	Duration of dry spells (length of continuous period of rainfall below a specified threshold)	Is there an increase in length of such events?
As above	As above	H	Severity of dry spells (deficit of continuous period of rainfall below a specified threshold)	Is there an increase in the deficit? (Will dry spells be drier?)
As above	As above	H	Frequency of dry spells (periods of rainfall below a specified threshold)	Is there an increase in the frequency of dry spells?
As above	As above	H	Monthly T and PE (or variables to calculate PE: SW, LE net downward surface radiation, 10m wind speed, RH, 2m T	
As above	As above	H	Standard precipitation index for 1,3,6,12,24 month durations	Is there a change?
Flood defence/ urban planning	Small-scale flood (predominantly pluvial)	H	1-24hr rainfalls depths	Is there an increase in depth, duration or frequency of rainfall above a specified threshold?
As above	Flash flood (pluvial and/or fluvial)	H	1-3hr rainfall depths	As above
As above	Large-scale flood (fluvial)	H	1-30 day rainfall depths or means	As above
As above	As above	H	Monthly T and PE (or variables to calculate PE: SW, LW net downward surface radiation, 10m wind speed, RH, 2m T)	
As above	As above	H	Monthly rainfall totals	Is there a change in rainfall seasonality?
As above	As above	H	Joint probability of high rainfall, low PE or low rainfall, high PE events	Is there a change in frequency or duration of such events?

HYDROLOGY: WORK PACKAGE 6 (PILOT STUDY)

Management Decision	Impact: Urban	Priority (H/M/L)	Climate Metric	Remarks / Questions
Land use planning and city and infrastructure	Flash flooding and flooding from longer events	H+	Annual maximum rainfall amount for variable durations (1hr-6hr-12hr-24hr-48hr-72hr)	How do maxima vary in the future?
As above	Flooding - extreme events	H+	Calculation of Intensity-Duration-Frequency (IDF) relationships in observed and projected rainfall - changes to extreme event statistics	Changes to extreme rainfall peak intensities, cumulative volumes, probability distribution, extreme value distribution
As above	Economic damages, public health	M	Number days with heavy rainfall (>= 50&100 mm/day)	Indication of frequency change in number of extreme events
As above	Economic activities, disruption, flood warning & planning	H	Monsoon onset date and duration	Indicates changes in seasonality of storms
Local transport infrastructures (roads, bridges, etc)	Structural stability, disruption	M	Extreme T range (T max and Number days at which Tmax exceeds 90th percentile)	
Regional transport infrastructures	Flooding – blockage	H	Change in long duration rainfall maxima (>5 days)	
As above	As above	M	Consecutive wet days	
Water supply in Ouaga	Availability of water quantity	H	Total rainfall in wet days (Average rainfall per wet day). Number wet days/yr.	And meteorological water chemistry predictions? Eg. Acid rainfall
As above	Evaporation	M	Change in seasonal Tmax and max daily Radiation and Mean of diurnal T range	Losses of water from reservoirs due to changes in climate
As above	Water quality and siltation	L	Ann max length and number of dry spells	
As above	Seasonality of rainfall	H	Change in monthly rainfall totals	Change in availability and seasonality of drought
Sewage treatment plants / sewage network	Flooding	H	Max average intensities of extreme rainfall (duration: 15min to 1hr)	Potential for sewer network overflow and STW overload
As above	Public health	M	Max consecutive dry days per season	Potential for waste build up in network and STW
Floods protection (dykes, dams, etc..)	Flooding of infrastructure	H	Events exceeding rainfall threshold (design threshold of flood protection (? AEP x% / x mm) – requires local information)	Scale dependant – small river flood protection = short duration, large rivers dykes = long duration

NOTES:

• The most important metrics (or measures) for assessing urban flooding are changes to maximum rainfall at various durations (according to catchment scale) and changes to the IDF relationships in observed and projected rainfall. Assistance in the methods and estimation of such statistics can be provided by the FEH team at CEH.

• Wet day: rainfall depth greater or equal than 1mm

• Extreme rainfall: RR>= 90, 95^{th} percentile of daily precipitation for all wet days

AGRICULTURE: WORK PACKAGE 3 (IMPACTS SCIENCE) AND WORK PACKAGE 5 (PILOT STUDY)

Decisions and Impacts: Breeding targets & agricultural productivity enhancement, selection of climate-resilient varieties, availability & cultivation of adapted varieties

Priority (H/M/L)	Climate Metric	Remarks / Questions
H+	Number of days Tmax above threshold during rainy season	threshold depend on the crop
H+	Seasonal mean temperature	3 months after onset
M	Number of events strong wind >> 70km/h ?	
H	Rainfall onset date	Local agronomic, versus regional dynamic measures – see Fitzpatrick paper Important to implement strategies What are typical season start
H+	Seasonal total rainfall	Local and distributed measures
H	Dry spells: Local rainfall < < 1mm/day for 6 days	Sensitive to timing relative to crop cycle. Important for fertilisation
H	Wet season duration	Dekads (10-day periods) with rainfall that exceed potential evapotranspiration ?
M	3h local rainfall	
M	24h local rainfall	Very seasonal, e.g. rains in winter can damage stored seeds.
M+	Number of days with rainfall above 30mm	
M	Rainfall sequences over 10 days	How to define? Rainfall thresholds etc.
L	Squalls	
L	Surface Tmax	
L	2m Tmax	
L	Tmin	
H	Seasonal mean humidity	During the last 30 days of rainy season

NOTES:

- Time scale: Metrics computed per years or mean/SD?
- Spatial scale: on grid cells – there may be scale dependency of thresholds